U.S. ARMY
SUBMISSION OF PROPOSALS

Topics

The Army works to maintain its technological edge by partnering with industry and academia. Agile, free thinking, small, high tech companies often generate the most innovative and significant solutions to meet our soldiers' needs. The Army seeks to harness these talents for the benefit of our soldiers through the SBIR Program.

The Army participates in one DoD solicitation each year with a two-tiered Phase I and Phase II proposal evaluation and selection process. Army scientists and technologists have developed 180 technical topics and the Phase III dual-use applications for each which address Army mission requirements. Each topic relates to one of the following 13 technology areas: Air Platforms, Chemical/Biological Defense, Information Systems Technology, Ground and Sea Vehicles, Materials/Processes, Biomedical, Sensors, Electronics, Battlespace, Space Platforms, Human Systems, Weapons, and Nuclear Technology. Please do not submit SBIR proposals against the above general technology areas. Only proposals submitted against the specific topics following this introduction will be accepted.

Please Note!

- ✓ The Army requires proposers to submit the Proposal Cover Sheet (formerly Appendix A and B) and Company Commercialization Report (formerly, Appendix E) electronically. Visit the Army SBIR Website (address: http://www.aro.army.mil/arowash/rt/) to get started. This page has a link to the DoD-wide SBIR proposal submission system (available directly at http://www.dodsbir.net/submission), which will lead you through the preparation of the Proposal Cover Sheet and Company Commercialization Report. Refer to section 3.4n at the front of this solicitation for detailed instructions on the Company Commercialization Report. You must print out these forms directly from the Website, sign them, and submit them with the hard copies of your proposal. Please note that a proposal is not considered accepted until the Army receives the entire packet in hard copy. Please read the detailed electronic submission instructions, which follow. **Improper handling of these forms may result in the proposal being substantially delayed. Information provided on the Company Commercialization Report will have a direct impact on the evaluation of the proposal.**

- ✓ This year the Army will also accept the full technical proposal and the Cost Proposal (Reference A of this solicitation) via the Internet on a voluntary basis. Follow the instructions on the DoD SBIR proposal submission site. This is a test in preparation for full electronic proposal submission in the future.

- ✓ ***Phase II Plus*** is a three-year pilot program which was implemented as of the release of the 99.2 DoD SBIR solicitation. The objectives of ***Phase II Plus*** are to (1) extend Phase II R&D efforts beyond the current Phase II contract to meet the product, process, or service requirements of a third party investor, preferably an acquisition program, and (2) accelerate the Phase II project into the Phase III commercialization stage. "Third party investor" means Army (or other DoD) acquisition programs as well as the private sector. The general concept is to provide qualified Phase II businesses with additional Phase II SBIR funding if they can obtain matching non-SBIR funds from acquisition programs, the private sector, or both. Under ***Phase II Plus***, additional funds may be provided by modifying the Phase II contract, and where appropriate, use will be made of the flexibility afforded by the SBA 1993 Policy which allows total Phase I + Phase II SBIR funding to exceed $850,000. Additional SBIR matching funds, subject to availability, will be provided on a one-to-one matching basis with third-party funds, but not to exceed $100,000. The additional SBIR funds must be used for advancing the R&D-related elements of the project; third-party investor funds can be used for R&D or other business-related efforts to accelerate the innovation to commercialization. More information is available on the Army SBIR Website address: http://www.aro.army.mil/arowash/rt/.

Operation and Support Cost Reduction (OSCR)

The U. S. Army spends a large part of its overall budget, directly or indirectly, on the operation and support (O&S) of equipment ranging from small generators to large, sophisticated weapon systems. O&S costs cover a broad spectrum of items including spare/repair parts, fuels, lubricants, and the facilities and people involved in training operators and mechanics. The Army is seeking ways to reduce these costs as a broad Acquisition Reform initiative. To this end, the Army has implemented the Operation and Support Cost Reduction (OSCR) Program. This solicitation includes 89 topics that address specific OSCR concerns identified by the Army's research and development community.

Phase I Proposal Guidelines

The Army has enhanced its Phase I-Phase II transition process by implementing the use of a Phase I Option that the Army may exercise to fund interim Phase I - II activities while a Phase II contract is being negotiated. The maximum dollar amount for a Phase I is $70,000. The Phase I Option, which **must** be proposed as part of the Phase I proposal, covers activities over a period of up to four months and at a cost not to exceed $50,000. All proposed Phase I Options must be fully costed and should describe appropriate initial Phase II activities which would lead, in the event of a Phase II award, to the successful demonstration of a product or technology. **The Army will not accept Phase I proposals which exceed $70,000 for the Phase I effort and $50,000 for the Phase I Option effort**. Only Phase I efforts selected for Phase II awards through the Army's competitive process will be eligible to exercise the Phase I Option. To maintain the total cost for SBIR Phase I and Phase II activities at a limit of $850,000, the total funding amount available for Phase II activities under a resulting Phase II contract is $730,000, unless ***Phase II Plus*** funds are provided.

Companies submitting a Phase I proposal under this Solicitation must complete the Cost Proposal (Reference A of this solicitation), within a total cost of up to $70,000 (plus up to $50,000 for the Phase I Option). Phase I and Phase I Option costs must be shown separately; however, they may be presented side-by-side on a single Cost Proposal. The Phase I Option proposal must be included within the 25-page limit for the Phase I proposal. In addition, all offerors will prepare a Company Commercialization Report, for each proposal submitted. The Company Commercialization Report does not count toward the 25-page Phase I proposal limitation.

Selection of Phase I proposals will be based upon scientific and technical merit, will be according to the evaluation procedures and criteria discussed in this solicitation, and will be based on priorities established to meet the Army's mission requirements. The soundness, technical merit, and its incremental progress toward topic or subtopic solution (refer to section 4.2 at the front of this solicitation), is given slightly more weight than the other two evaluation criteria which are equal. Due to limited funding, the Army reserves the right to limit awards under any topic, and only those proposals of superior scientific and technical quality will be funded.

Proposals not conforming to the terms of this solicitation and unsolicited proposals will not be considered. Awards will be subject to the availability of funding and successful completion of contract negotiations.

Phase II Proposal Guidelines

Phase II proposals are invited by the Army from Phase I projects that have demonstrated the potential for commercialization of useful products and services. The invitation will be issued in writing by the Army organization responsible for the Phase I effort. Invited proposers are required to develop and submit a commercialization plan describing feasible approaches for marketing the developed technology. Fast Track participants may submit a proposal without being invited. Cost-sharing arrangements in support of Phase II projects and any future commercialization efforts are strongly encouraged, as are matching funds from independent third-party investors, per the SBIR Fast Track program (see section 4.5 at the front of this solicitation) or the ***Phase II Plus*** program. Commercialization plans, cost-sharing provisions, and matching funds from investors will be considered in the evaluation and selection process, and Fast Track proposals will be evaluated under the Fast Track standard discussed in section 4.3 at the front of this solicitation. Phase II proposers are required to submit a budget for a base year (first 12 months) and an option year. These costs must be submitted using the Cost Proposal format (Reference A of this solicitation), and may be presented side-by-side on a single Cost Proposal Sheet. The total proposed amount should be indicated on the Proposal Cover Sheet, Proposed Cost. Phase II projects will be evaluated after the base year prior to extending funding for the option year.

The Army is committed to minimizing the funding gap between Phase I and Phase II activities. With the implementation of Phase I Options effective with the 98.2 Solicitation, all Army Phase II proposals will receive expedited reviews and be eligible for interim funding. Accordingly, all Army Phase II proposals, including Fast Track submissions, will be evaluated within a single two-tiered evaluation process and schedule. Phase II proposals will thus typically be submitted within 5 months from the scheduled DoD Phase I award date (the scheduled DoD award date for Phase I, subject to the Congressional Budget process, is 4 months from close of the DoD Solicitation).

Submission of Army SBIR Proposals

All proposals written in response to topics in this solicitation must be received by the date and time indicated in Section 6.2 of the introduction to this solicitation. Submit your proposal(s) well before the deadline. The Army does not accept late proposals.

All Phase I proposals - one original (clearly marked, with original signatures) and four copies - must be submitted to the Army SBIR Program Management Office at the address below. Each copy must include the Proposal Cover Sheet and the Company Commercialization Report (formerly Appendices A, B, and E) generated and printed out by the on-line systems. All hand deliveries must be made to the Army Materiel Command (AMC) building mail room, located at the

rear of the AMC building. Proposers should be aware that the AMC mail room hours are 0730-1530 hrs (local) and are subject to change without prior notice. A confirmation of receipt form should be included with both hand delivered and mailed proposals, if desired. Confirmation of receipt will only occur with this form, accompanied by a self-addressed stamped envelope.

Dr. Kenneth A. Bannister
U.S. Army Research Office-Washington
Room 8N31, Army Materiel Command Building
5001 Eisenhower Avenue
Alexandria, VA 22333-0001
(703) 617-7425

Electronic Submission of Proposals Using the DoD SBIR Proposal Submission System

You must submit your Proposal Cover Sheet to the Army using the online forms. This site allows your company to come in any time (prior to the closing of the solicitation) to edit or print out your Proposal Cover Sheet. **The Army WILL NOT accept any form other than those from the DoD SBIR proposal submission system as valid proposal submissions**. The full Technical Proposal and Cost Proposal may be submitted using the online system at the proposers discretion. An overall file size of 5MB or less is recommended for each electronic proposal submission. You are responsible for performing a virus check on each proposal to be uploaded electronically. The detection of a virus on any submission may be cause for the rejection of the proposal. The Army will not accept e-mail submissions. You should contact your Internet Service Provider if you have questions concerning the provider's file size transmission allowance.

Key Dates

00.2 Solicitation Open	3 July - 16 August 2000
Phase I Evaluations	August - November 2000
Phase I Selections	November 2000
Phase I Awards	December 2000*

* Subject to the Congressional Budget process.

Recommendations for Future Topics

Small Businesses are encouraged to suggest ideas that may be included in future Army SBIR solicitations. These suggestions should be directed to the SBIR points-of-contact at the respective Army research and development organizations.

Inquiries

Inquiries of a general nature should be addressed to:

Dr. Kenneth A. Bannister
Army SBIR Program Manager
U.S. Army Research Office - Washington
Room 8N31
5001 Eisenhower Avenue
Alexandria, VA 22333-0001
(703) 617-7425

Dr. Robert Rohde
Headquarters, Department of the Army
Office of the Assistant Secretary of the
Army (Acquisition, Logistics, and Technology)
2511 Jefferson Davis Highway
Arlington, VA 22202-3911
(703) 601-1515

DEPARTMENT OF THE ARMY
PROPOSAL CHECKLIST

This is a Checklist of Requirements for your proposal. Please review the checklist carefully to ensure that your proposal meets the Army SBIR requirements. **Failure to meet these requirements will result in your proposal not being considered for review or award**. Do not include this checklist with your proposal.

____ 1. The Proposal Cover Sheet (formerly Appendix A and B) was completed using the SBIR proposal submission system, which can be accessed via the Army's SBIR Web Site (address: http://www.aro.army.mil/arowash/rt/) or directly at http://www.dodsbir.net/submission. The Proposal Cover Sheet clearly shows the proposal number assigned by the system to your proposal. The full technical proposal may be submitted Online at the proposer's discretion.

_____ 2. The proposal addresses a Phase I effort (up to **$70,000** with up to a six-month duration) AND an optional effort (up to **$50,000** for an up to four-month period to provide interim Phase II funding).

_____ 3. The proposal is limited to only **ONE** Army solicitation topic.

_____ 4. The Project Summary on the Proposal Cover Sheet contains no proprietary information, does not exceed 200 words, and is limited to the space provided.

_____ 5. The Technical Content of the proposal, including the Option, includes the items identified in Section 3.4 of the solicitation.

_____ 6. The Company Commercialization Report is submitted in accordance with Section 3.4.n. This report is required even if the company has not received any SBIR funding. (This report does not count towards the 25-page limit)

_____ 7. The proposal, including the Phase I Option, is 25 pages or less in length. (Excluding the Company Commercialization Report.) Proposals in excess of this length will not be considered for review or award.

_____ 8. The proposal contains only pages of 8-1/2" X 11" size. No other attachments such as disks or video tapes are included.

_____ 9. The proposal contains no type smaller than 11-point font size (except as legend on reduced drawings, but not tables).

_____ 10. The Cost Proposal (Reference A) has been completed for **the Phase I and Phase I Option** and their costs are shown separately. The Cost Proposal is included as the last page of the proposal.

_____ 11. The proposal is stapled in the upper-left-hand corner, and no special binding or covers are used.

_____ 12. An original with original signatures **(clearly marked)** and four copies of the proposal are submitted.

_____ 13. Include a self-addressed, stamped envelope and a copy of the Notification Form (Reference C) located in the back of the solicitation book, if notification of proposal receipt is desired. **No responses will be provided if these are not included with your proposal**.

_____ 14. The proposal must be sent registered or certified mail, postmarked by August 9, 2000, or delivered to the Army SBIR Office no later than **August 16, 2000, 3:00 p.m. local time** as required (see Section 6.2). Offerors who elect to use commercial courier services do so at their own risk. The Army **can not** accept responsibility for proposals delivered late by commercial couriers.

INDEX OF ARMY FY00 TOPICS

U.S. Army Armaments Research, Development and Engineering Center (ARDEC)

Also see OSCR Topics A00-092 thru A00-096

U.S. Army Research Institute (ARI)

Also see OSCR Topics A00-097 thru A00-098

U.S. Army Research Laboratory (ARL)

See also OSCR Topics A00-099 thru A00-117

U.S. Army Test and Evaluation Command (ATEC)

See also OSCR Topics A00-118 thru A00-123

U.S Army Aviation Research, Development, and Engineering Center (AVRDEC)

A00-030 Low Conductivity for Thermal Barrier Coatings (TBCs)
A00-031 Comanche Tactics and Survivability Expert Planner
A00-032 Wing-Store Unmanned Aerial Vehicle

See also OSCR Topics A00-124 thru A00-131

U.S. Army Communications and Electronics Command (CECOM)

A00-033 Retrofit Antijam Applique for Handheld GPS Receivers
A00-034 Interoperability between Modeling and Simulation Applications and Army Command and Control (C2) Systems for Planning/Decision Support
A00-035 Photovoltaic (PV) Solar Panel Camouflaging
A00-036 Rapidly Deployable Shelter Extension Module System
A00-037 Individual Profile Centered Interactive Tailored Information Visualization for Semi-Autonomous Command Post (CP)
A00-038 Integrated Computer Mouse (ICM) For On-The-Move Operations
A00-039 Truth Maintenance /Belief Revision in Data Fusion Systems for Enhanced Information Trustworthiness
A00-040 Geolocations with Distributed Signals Intelligence (SIGINT) Sensors
A00-041 Architectures and Enabling Technologies for Intelligent Information Operations/Information Warfare (IO/IW) Decision Aids
A00-042 Data Sonification
A00-043 Digitally-Based Phase-Coherent Radar Environment Simulator
A00-044 Low Noise, Narrow Gate-Width 640x512 Short Wavelength Infrared (SWIR) Mini-Camera for Low Light Level Imaging Applications
A00-045 Real-Time Image Restoration for Generation 3 Forward Looking Infrared Systems
A00-046 Electromagnetic-Based Computer Aided Design (CAD) for Wavelength Scale Optics
A00-047 Micro Air Vehicle and Weapon Sight Infrared (IR) Camera
A00-048 Adaptable Packet-Switched, Battle Command Information
A00-049 Soldier Antenna
A00-050 Single Chip, Low Cost, Very Short Range Radio Frequency (RF) Systems for Military Applications
A00-051 Malicious Mobile Code Detection Using Artificial Intelligence Methods
A00-052 Mobile Agents for Tactical Communication Networks

See also OSCR Topics A00-132 thru A00-141

U.S. Army Construction Engineering Research Laboratory (CERL)

A00-053 Electro-Osmotic Pulse Technology to Control Leaching and Groundwater Intrusion in Containment Sites
A00-054 Advance Anode Materials for Electro-Osmotic-Pulse Technology to Control Water Intrusion in Porous Structures

See also OSCR Topics A00-142 thru A00-143

Edgewood Chemical Biological Center (ECBC)

A00-055 Combinatorial Screening of Synthetic Nanomaterials for Chem/Bio Agent Detection

See also OSCR Topic A00-145 thru A00-147

U.S. Army Missile Research, Development, and Engineering Center (MRDEC)

A00-056 Breakthrough Advances in Non-Hermetic Electronic Encapsulant Materials
A00-057 Transient Jet-Interaction Combustion Modeling
A00-058 Wave Equation Conduction Thermal Analysis Software Development
A00-059 High Resolution Precise Doppler Light Detection and Ranging (LIDAR)
A00-060 Missile Aero-Acoustic Response Modeling
A00-061 Polarization Laser Detection and Ranging (LADAR)

See also OSCR Topics A00-148 thru A00-159

U.S. Army Medical Research and Materiel Command (MRMC)

A00-062	Improvements in Generation of High-Density Microarrays
A00-063	Systems for Improved Freeze-Drying of Blood Products
A00-064	General Purpose Miniature Thermometer for Remote Monitoring of Soldiers
A00-065	Development of an Imaging Technique to Identify Angiogenesis
A00-066	Development of a Multivalent Vaccine for Travelers' Diarrhea
A00-067	Cold Sterilizer Solution for Sterilization of Medical Instruments in Austere Environments
A00-068	A System for Acquisition, Transmission, and Analysis of High Frequency EEG Signals for Real Time Determination of Alertness State
A00-069	Synthesis of Combinatorial Chemical Libraries Containing Potential Inhibitors of Botulinum Neurotoxin Protease Activity
A00-070	Telemedicine and Advanced Medical Technology - Medical Modeling and Simulation
A00-071	Development of a Vaccine for the Treatment and/or Prevention of Cancer

See also OSCR Topics A00-160 thru A00-161

Natick Soldier Center (NSC)

A00-072	Soldier Conformal Antenna Suite
A00-073	Cogeneration of Heat and Electricity for Military Equipment
A00-074	Flame/Thermal Protective Fabric Test Apparatus
A00-075	Thermoacoustic Refrigeration of Large Food Storage Containers

See also OSCR Topics A00-162 thru A00-163

U.S Army Space and Missile Defense Command (SMDC)

A00-076	Development of Radio Frequency Mitigation Technologies for Missile Defense Electronics
A00-077	Enhanced Munitions
A00-078	Variable Optical Filter
A00-079	Mitigation of Magnetohydrodynamic (MHD) Electromagnetic Pulse (EMP) Effects on Long Lines for Missile Defense System and Infrastructure Protection

See also OSCR Topic A00-164

U.S. Army Tank, Automotive, and Armament Research Development and Engineering Center (TARDEC)

A00-080	High-Temperature High-Power Silicon Carbide Power Device for Hybrid Vehicles
A00-081	Bridging Anchorage Systems
A00-082	Position Sensing and Situational Awareness for Robotic Vehicles
A00-083	Wide-Angle Broadband Polarizing Beamsplitter
A00-084	High-Speed High-Temperature Silicon Carbide Motor Drive Inverter for Hybrid Vehicles
A00-085	Information Intelligence Based Program Management System
A00-086	Mission Payload for Small Urban Robots

See also OSCR Topic A00-170 thru A00-178

U.S. Army Topographic Engineering Center (TEC)

A00-087	Spatial Schema Generation Tools

See also OSCR Topic A00-179 thru A00-180

U.S. Army Waterways Experiment Station (WES)

A00-088	An Ultrasonic Tomography System for Imaging Reinforcement Steel in Concrete Bridge Girders

A00-089 Rapid Prediction of Pavement Performance Using Time Dependent Surface Deflection Profiles, Obtained Under Rolling Wheel Loads
A00-090 Advanced Multispectral Decoy Technologies
A00-091 In situ Biological Treatment for Explosives in Ground Water

Topics Addressing U.S. Army Operating and Support Cost Reduction (OSCR) Intiatives

U.S. Army Armaments Research, Development and Engineering Center (ARDEC)

A00-092 Lightweight Gun Barrel
A00-093 Innovative Hands-Free Point-and-Click Computer Control Device Within a Moving Vehicle
A00-094 Adaptable and Reusable Hardware/ Software (HW/SW) Architectures And Components for Automated Materiel Handling
A00-095 Innovative Coating Technology to Mitigate Erosion of Large Caliber Gun Tubes
A00-096 Electronic Sight Unit (ESU)

U.S. Army Research Institute (ARI)

A00-097 Assessing Decision-Making Skills in Virtual Environments
A00-098 Training Media to Support Night Operations in Urban Settings

U.S. Army Research Laboratory (ARL)

A00-099 True Time Delay and Constant Phase Shift Circuit Elements
A00-100 Seeing Through Smoke, Fog, and Obscurants Using Circular Infrared (IR) Polarimetric Imaging
A00-101 Synthesis Of Affordable Phase Pure Gamma-Aluminum Oxynitride (AlON) Powders
A00-102 High Volume, Low-Cost Production of High-Purity Carbon Nanotubes
A00-103 Low Cost, Minimally Invasive Sensor Network for Structural Polymer Composites
A00-104 Electromagnetic Modeling of Complex Structures
A00-105 Dynamic Simulation of Human and Vehicle Motion Interaction for System Design
A00-106 Platform Noise Reduction
A00-107 Development of Thallium-containing Semiconductor Materials for High Speed Electronic Devices
A00-108 Crew Station Design Tool
A00-109 High Speed Solid State Mid-Infrared Spectral Tuner for Laser Radar Applications
A00-110 Powder Injection Molding for Large Military Components
A00-111 Magnetic Microsensor Modules
A00-112 Continuously Variable Transmissions For In-The-Wheel Electric Motors
A00-113 Alternative Energy Storage System
A00-114 Software Agent Technology for Large Scale, Real-time Logistics Decision Support
A00-115 Low Cost, High-Purity Boron-Rich Boron Carbide Powders for Lightweight Armor Applications
A00-116 Proton-Conducting Inorganic Membranes for Fuel Cells
A00-117 Ultra-lightweight Field Unit for Production and Repair of Chemical Biological Warfare (CBW) Protective Materials and Instant Bandages

U.S. Army Test and Evaluation Command (ATEC)

A00-118 High Speed Direct X-ray Imaging System
A00-119 High Resolution/High Speed Infra-Red Imagers
A00-120 Image Generation for Forward Looking Infrared Sensor Stimulation
A00-121 High-Output Near-Monodisperse Aerosol Generator
A00-122 Low Cost High-Resolution Radar System
A00-123 Ruggedized High Volume Tracking System

U.S Army Aviation Research, Development, and Engineering Center (AVRDEC)

A00-124 Scaleable Aerodynamics and Coupled Comprehensive Methods for the Prediction of Rotorcraft Maneuver Loads
A00-125 Knowledge Acquisition Tools for Cognitive Design Aid and Development
A00-126 Optical Assessment of Component Creep/Fatigue
A00-127 Data Mining for Aircraft Maintenance and Logistics Management
A00-128 Variable Geometry High-Lift Airfoil for Rotorcraft
A00-129 Advanced Corrosion Protection Scheme for Magnesium Helicopter Components
A00-130 Integrated Warning Caution and Advisory System (IWCA)
A00-131 High Temperature Material Application for Turboshaft Engines

U.S. Army Communications and Electronics Command (CECOM)

A00-132 Bandwidth Management
A00-133 Information Assurance Protection for Command and Control (C2) Intelligent Software Agents
A00-134 Global Positioning System (GPS) Pseudolite Elevated Platform
A00-135 Knowledge-Access Portal Technology for Medium Brigade and Command Post XXI Decision Makers and Other Knowledge Warriors
A00-136 Unmanned Aerial Vehicle (UAV) Antennas
A00-137 Micro-Laser Transmitter
A00-138 Real-Time Image Intensifier Simulation
A00-139 Sensor Effects Card for PC Based Simulators
A00-140 Dynamic Bandwidth, Delay, and Delay Variation Management for Supporting of Quality of Service
A00-141 Scalability of Advanced Network Protocols

U.S. Army Construction Engineering Research Laboratory (CERL)

A00-142 Field-Portable Infrastructure Fiber-Reinforced Polymer Composite Inspection & Evaluation System using Ultrasound Technologies
A00-143 Microencapsulated Phase Change Materials (MPCM) in Thermal Energy Systems

U.S. Army Cold Regions Research and Engineering Laboratory (CRREL)

A00-144 Electro-Osmotic Pulse Demolition of Concrete Structures

Edgewood Chemical Biological Center (ECBC)

A00-145 Nontoxic Biodegradable Nanomaterials and Biomaterials Signature Reduction
A00-146 Stabilization of Enzymes for the Destruction of Toxic Materials and Chemical Agents
A00-147 Compact, Lightweight, Modular Infrared Spectroscope For Chemical And Biological Agent Detection

U.S. Army Missile Research, Development, and Engineering Center (MRDEC)

A00-148 Mixing And Combustion Of Gel Propellants
A00-149 Development of Universal, Inexpensive Optics for Uncooled Infrared Commercial and Military Applications
A00-150 Sensor Data Fusion for Target Classification and Identification
A00-151 Semi-active Laser Simulator for Multi-mode Hardware-in-the-Loop Simulations
A00-152 Selective Application of Electromagnetic Interference (EMI) Protection and Electromagnetic Compatibility (EMC) Conformal Coatings Onto Circuit Card Assemblies
A00-153 Demonstration of Advanced Detection Techniques Against Low Probability of Intercept Avionics Waveforms
A00-154 Onboard Flight Digital Data Recorder for Measuring the Shock and Vibration Environment Associated with the Dispense and Flight of Missile Submunitions
A00-155 Large Aperture Trichroic Window for Multi-mode Hardware-in-the-Loop Simulations
A00-156 Low Temperature Catalyst for Reduced Toxicity Monopropellant
A00-157 Laser Detection and Ranging (LADAR) Simulation Techniques for Multi-mode Hardware-in-the-Loop Simulations
A00-158 Compact Range Implementation of RF Target Glint Signatures for multi-mode Hardware-in-the-loop simulations
A00-159 Composite Aeroshells with Integral Heat Shield Designs

U.S. Army Medical Research and Materiel Command (MRMC)

A00-160 Generation of Serum Carboxylesterase Deficient Mice
A00-161 Dry System for Thawing Frozen Blood

Natick Soldier Center (NSC)

A00-162 Flexible Photovoltaics for Fabric Structures
A00-163 Self-Deploying Tentage for Smart Cities

U.S Army Space and Missile Defense Command (SMDC)

A00-164 MMW 95 GHz Intermediate Power Amplifier

U.S. Army Simulation, Training, and Instrumentation Command (STRICOM)

A00-165 Innovative Synthetic Natural Environment Database Design Methodology and Tool
A00-166 Advanced Technology for Real-Time Image Generation
A00-167 Analysis and Design Tools for Live Instrumentation Infrastructures and Processes

A00-168 Automated Interoperability Evaluation Systems
A00-169 Next Generation Distributed Simulation Technology -- Capability to Scale Up Networking of Simulations

U.S. Army Tank, Automotive, and Armament Research Development and Engineering Center (TARDEC)

A00-170 User Interaction Tools Supporting Collaborative Applications in Immersive Virtual Environments
A00-171 Advanced Military Diesel Engine, High Temperature Tribology
A00-172 Architecture Based Integrated Development Environment
A00-173 Lightweight Durable Titanium Tank Tracks
A00-174 Increased Service Life, Performance and Durability of Filtration System Components For Military Vehicles
A00-175 Suppression of Thermal Emission from Exhaust Components Using an Integrated Approach
A00-176 Prediction of Time to Failure of Automotive Tires Using Remote Sensing
A00-177 Innovative Design for Light Tactical Vehicle Brake Rotors & Pads
A00-178 Integration of Hybrid Electric Vehicle Design Tool and Signature Tool for 21st Century Truck Total Thermal Management System

U.S. Army Topographic Engineering Center (TEC)

A00-179 Abstraction and Removal of Feature Data to Generate Bare Earth Models from Light Detection and Ranging (LIDAR) Technologies
A00-180 Fusing Terrain and Sensor Data During Spectral Feature Extraction

ARMY FY00 TOPICS

U.S. Army Armaments Research, Development and Engineering Center (ARDEC)

A00-001 TITLE: Software System for Advanced Warhead Computer Aided Engineering (CAE)/Computer Aided Design (CAD)

TECHNOLOGY AREAS: Information Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Deputy Project Management – Tank Main Armament System

OBJECTIVE: To obtain a vertically integrated CAD (Computer Aided Design) system for advanced warhead development that integrates the functions that are part of warhead CAE (Computer Aided Engineering) and higher fidelity design software that are able to model and simulate complex warhead geometry for future smart munitions. These would include liner designs, model preparation and analysis, and simulation of warhead performance that would offer an opportunity to perfect an optimized design with a shorter turnover than current methods.

DESCRIPTION: Advanced warhead development is currently done with a mix of horizontally integrated, general purpose software packages including hydrocodes, mesh generators, post-processors, CAD systems and various utilities which glue everything together. Learning each tool is extremely time-consuming and designers are typically required to delegate much of the work to specialists, who are difficult to find. Furthermore, maintaining the system and adapting the tools to new projects is expensive and time consuming. Thus, a warhead specific CAE/CAD system which is developed using the most recent technologies is desired to eliminate these problems and provide a platform that can be used for more advanced development work.

State-of-the-art simulation technologies that must be addressed include fracture mechanics for liner separation and tear prediction, burn simulation around 3-D wave shapers, and improved simulation of the effects of explosive-liner interaction at the edges of liners. Another problem that needs addressing is the simulation of warheads involving soft materials such as foams and plastics that undergo extremely large deformations during the detonation process.

PHASE I: To design an overall specification for an advanced warhead software system that incorporates the latest advanced warhead design parameters and iterates to an optimized computer solution meeting identified performance goals. A single Graphical User Interface (GUI) should provide the designer's interface to the system and allow for accessing and controlling resources. The simulation program will be an object oriented programming based hydrocode which will be developed specifically for the task. The hydrocode will need to be modular and easily modifiable to permit the adaptation to new warhead technologies.

PHASE II: To develop the software system according to specifications realized under Phase 1. The contractor will develop the software system around modular, modern object oriented structures and RAD (Rapid Software Development) tools that can be quickly adapted to new warhead design. This effort will involve expanding the GUI and solver to deal with real systems, validating the computer design with the real systems, and addressing the problems identified above. The software system design must also be made compliant with secure networking protocols.

PHASE III DUAL-USE APPLICATIONS: This CAE system can be used in commercial engineering to design, manufacture and inspect complex surfaces such as those found on appliance housings, automobile bodies, furniture or machine parts. This tool enables the engineer/designer to not only design these components, but also to conduct the necessary stress analyses and fit checks, then generate the numerical control instructions for fabrication and inspection. In all commercial engineering design, the stress analysis techniques are used extensively to check out all mechanical part designs prior to committing to hardware fabrication. The stress analyses portion of the CAE will be developed using the latest cross platform object oriented (OO) programming techniques. Almost all current finite element codes utilize non-portable structure programming languages, such as C and Fortran. The transition to a modular, object oriented approach will permit complex general purpose solutions to product design problems to be replaced with easy to use, product specific design/simulation packages that are quickly adapted from the modules.

REFERENCES:
"Three Dimensional Computer Simulation of Non-Axisymmetric EFP Warheads", R. Fong, W. Ng and B. Rice; 1998 NDIA International Ballistics Symposium.
"Explosively Formed Penetrator Warhead", Richard Fong and William Ng; Tech Report U184

KEYWORDS: CAD, advanced warhead CAE, weapons design, software, hydrocodes, computer design, integrated, RAD, Object Oriented Programming

A00-002 TITLE: Ultra-fast Hyperspectral X-ray Imaging

TECHNOLOGY AREAS: Materials/Processes, Electronics

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Deputy Project Management - Tank and Medium Caliber Armament Systems

OBJECTIVE: Determine the cause of electronic polarization in monolithic cadmium zinc telluride (CZT) x-ray detector arrays.

DESCRIPTION: Cadmium zinc telluride (CZT) is the x-ray sensor of choice for non-destructive inspection imaging applications. Monolithic arrays are necessary for ultra-fast hyperspectral x-ray imaging enabling immediate discernment of material composition defects and anomalies at production rates in all kinds of products including propellants and explosives, as well as identifying material in security screening applications. CZT monolithic arrays can be found through careful screening which can be used with very high flux output x-ray sources to perform the hyperspectral imaging in milliseconds. Presently it is not known how to consistently fabricate such arrays. The present method of screening CZT material for such excellent arrays requires fabrication and operational testing. This is a long, arduous task with very low yield. Most monolithic arrays, when exposed to high x-ray flux as commonly used for rapid inspection, suffer from "electronic polarization" which limits inspection throughput and is defined below.

CZT is fabricated using the High-Pressure Bridgeman Technique. It is then cut and pixilated to form monolithic arrays that seem to exhibit electronic polarization when exposed to high x-radiation flux. Whereas, if cut and fabricated into single pixel elements, it does not show polarization under the same high flux. When operated in pulse mode polarization is observed in the detectors as they are exposed to an increasing radiation flux. Polarization causes a decrease in observed electronic pulses whereas an increase is expected. Pulse events stop altogether as the flux is further increased. Recent work seems to indicate that CZT material that polarizes when pixilated as monolithic arrays often do not polarize when formed into single pixel devices. This solicitation is to study the polarization effect clearly establishing whether single pixel devices of the same material do actually behave differently from arrays; establish and affirm the CZT (microscopic) properties which cause the polarization; and develop monolithic arrays which do not polarize when radiated with high flux. The study must concentrate on flux rates of over one million photons per second. Phase 1 proposals must detail how the study will be performed, describing the contractor equipment to measure the electronic pulses from single photon events in CZT at over one million photons per second, and describing contractor equipment to create the high x-ray photon events. The study must include that of polycrystalline versus single crystal CZT and the crystal lattice direction between the electronic contacts versus electronic properties.

PHASE I: Clearly establish if single pixel CZT devices of the same material behave differently in polarization from pixilated arrays. If that is the case, theorize the reason. Determine means to prevent polarization within the arrays. Prove through experimentation that the conjectures are valid.

Phase II: Through experimentation clearly establish the cause of polarization and means of preventing it. Fabricate and test numerous samples of the polarization free CZT.

PHASE III - DUAL-USE APPLICATIONS: CZT is currently the semiconductor material whose characteristics are deemed best for x-ray spectroscopy sensors operating at room temperature. Polarization affects are the largest impediment to the creation of very fast line scanners and staring arrays from CZT. Such devices have broad application in the x-ray spectroscopy, imaging of gamma radiation sources, non-destructive inspection field, the medical diagnostic field, and the detection of illicit substances. Systems built for these broad applications could be vastly improved by cheap, high quality CZT. DoD applications include all standard x-ray and gamma ray inspection techniques (especially inspection of munition items), medical diagnostic procedures, and multi-spectral x-ray imaging which is just evolving, Compton cameras for detection of radioactive material, inspection of munitions, inspection of closed containers, illicit substance detection. CZT in the battlefield will be the sensor of choice for detection and imaging of radioactive material. For example, Compton cameras are used for finding small volumes of radioactive material. Non-DoD applications are even greater in number than DoD and parallel DoD applications.

REFERENCES: Tumer, T.O., et.al. "Preliminary Results Obtained from Novel CdZnTe Pad Detectors," IEEE Transactions on Nuclear Science, V43, No 3 (Jun), p1417-1421, June 1996

Hermon, H. et.al.,"Study of the Homogeneity of Cadmium Zinc Telluride Detectors,
Paul, http://www.geocities.com/Eureka/Gold/5240/study.html

KEYWORDS: cadmium zinc telluride, x-ray detectors, sensors, High Pressure Bridgeman, inspection, x-ray, medical diagnosis.

A00-003 TITLE: Innovative Acoustic Sensor(s) for Multiple Target Acquisition

TECHNOLOGY AREAS: Sensors, Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Project Manager, Mine, Countermine and Demolition

OBJECTIVE: Design and test a novel Target Counting Technique (TCT) for unattended acoustic sensors (individual sensors or networked sensors) to detect, classify, count, and report multiple ground vehicles in a clutter environment within a designated area.

DESCRIPTION: The Army needs to use unattended passive ground sensors for battlefield surveillance, situation awareness and cueing for other sensors and weapons. As a result, advanced acoustic sensors are exploited to acquire ground vehicle information, such as target locations, target movement, target types, etc. The use of networked acoustic sensors to detect, track and classify single vehicle targets in ranges up to 1000 meters has been demonstrated. However, the detection, tracking, and classification of multiple vehicles in a target rich environment remains a technical challenge. In addition, the field commanders often want to know the numerical size of an enemy convoy that consists of heavy and light vehicles. The current acoustic sensor designs (either individual or networked), employing algorithms based on acoustic signature characteristics such as the engine firing rate (EFR) and sound pressure level (SPL), have difficulty in detecting, tracking, and classifying multiple vehicles when they are closely spaced (around 50m to 200m apart). The inability to detect and determine the number of targets in multiple target scenarios would effect the field commanders' decisions for fire missions. The use of advanced signal processing techniques such as adaptive beamforming would potentially detect multiple vehicles in a target rich environment by zeroing or canceling out the effects of neighboring vehicles in multi-vehicle scenario. The objective of this research is to investigate and develop a novel technique and algorithm to detect and count multiple vehicle targets of interest, and then count the interested vehicles in a clutter environment in a 1000m square grid in all atmospheric conditions and at any time of day. The TCT would enable the acoustic sensors to detect, classify and count vehicles varying from wheel to track, diesel to turbine engine, and/or light to heavy, in any formation entering the designated 1000 m square grid.

PHASE I: Define operational scenario, and sensor configuration and design. Develop a novel method for detecting, classifying, and counting multiple targets using specific acoustic signature characteristics. Validate the TCT software algorithm in MATLAB environment.

PHASE II: Implement the TCT and algorithm into a sensor test platform (individual or networked sensors) and conduct proof-of-principle demonstration in a field environment.

PHASE III DUAL USE APPLICATIONS: The TCT would have wide utility in domestic security applications where automatic surveillance operations by industrial security personnel, airport security teams, state police, Sheriffs' organizations, or border patrol personnel are necessary. The novel TCT and algorithm can also be used on a street to monitor and control traffic.

REFERENCES:

1. Johnson, Don H., Dudgeon, Dan E., "Array Signal Processing: Concepts and Techniques", Prentice-Hall, Englewood Cliffs, NJ, 1993

2. Bar-Shalom, Yaakov, Li, Xiao-Rong, "Estimation and Tracking: Principles, Techniques, and Software", Artech House, Boston, MA, 1993

KEYWORDS: Target counting, adaptive beamforming

A00-004 TITLE: Innovative Human Amplification System

TECHNOLOGY AREAS: Human Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Executive Officer – Ground Combat and Support Systems

OBJECTIVE: Design and build an innovative, inexpensive light weight, portable human assist lift system that can aid soldiers to lift and to move ammunition and other heavy hardware/objects with minimal physical exertion.

DESCRIPTION: Currently Fire Support troops are required to lift and move 103 pound projectiles from a prime mover truck or resupply vehicle to the firing platform (towed howitzers or self-propelled howitzers). Lifting and moving 103 pound projectiles is

a strenuous and fatiguing task which needs to be made easier and faster than it is today. Any time a towed weapon platform moves, all ammo has to be put back onto the prime mover truck and then again downloaded when it reaches its new firing point destination. Moving of the howitzer takes place numerous times during a single day. In addition to the labor involved in weapon relocation, the two soldier crew may have to lift and handle 458 of these 103 pound projectiles every day to meet firing rates. To assist soldiers in the execution of their mission, a lightweight,one man portable, low cost human mechanical amplification hardware/device would make the task of moving heavy projectiles significantly easier. The hardware/device should be easy to set up and carry by one person in a field environment under all kinds of environmental conditions. The hardware/device is required to lift items up to a height of 7 feet at a speed faster than current manual capabilities. The mechanism/device should be one man portable and capable of lifting a fully assembled 155mm projectile with fuze. The total lifted weight is expected to be approximately 120 pounds. Any kind of amplification technology (hydraulic, electrical, mechanical, exoskeleton, etc.) or combination of technologies that is robust and simple is acceptable. This technology may also have application to ammo platoons which operate forward ammo storage areas as it may reduce the need for heavy and expensive materials handling equipment.

PHASE I: Develop overall system design in the form of drawings and applicable technologies with weights, cost estimates, dimensions, and capabilities. Demonstrate proof-of-principle design by at least a Computer Aided Design technique that integrates all subsystems, or show individual subsystems and how they would meet final design capabilities.

PHASE II: Develop and demonstrate a prototype system in a realistic environment with Army supplied samples (individual bare projectiles, and removing individual projectiles on pallets). Perform testing over an extended period of time with various platforms and ammunition packaging configurations (single rounds, projectiles with/without lifting plugs, and projectiles in cylindrical individual ammo containers).

PHASE III DUAL USE APPLICATIONS: The amplification device can be used by industry to move any heavy objects in and out of vehicles, off pallets/platforms, to remove from racks, for food and beverage delivery services, automobile factory, airport services, construction business, etc. A lightweight inexpensive human amplification system could also be used in the home for moving furniture, appliances, and other necessities.

REFERENCES:
http://www.ornl.gov/seer/research/robotics_research.html
http://natick.army.mil/warrior/96/nov/mobility.html
http://stelarc.va.com.au/exoskeleton/index.html
http://sbir.gsfc.nasa.gov/SBIR/successes/ss/035text.html
http://www.darpa.mil/dso/rd/materials/smartmat/meetings.html

KEYWORDS: Human Amplification, light weight, inexpensive, technology, exoskeleton, power assist, strength enhancer, power enhancement

A00-005 TITLE: Digital Target Range Acquisition from Digital Mapping / Imagery

TECHNOLOGY AREAS: Information Systems, Sensors, Weapons

OBJECTIVE: Design and build a digital range acquisition system capable of providing azimuth and elevation ranges for multiple targets, obtaining and processing continuous information from a digital mapping / imagery system and terrain data, accepting target positions prior to battlefield missions, functioning unattended, and capable of continuously updating target ranges on wide field of views.

DESCRIPTION: Recent advances in digital mapping imagery systems, information systems technology applications, and digital computer technology support the potential for development of a new generation of digital range acquisition systems. Similar technology has been demonstrated with the M1A2's InterVehicular Information System (IVIS), but target position information in that system is manually updated on the mapping system and individual vehicle position resolution in the map is inadequate for extraction of target range data. This effort would use existing technology acquired through Army Digitization Programs and the National Imagery and Mapping Agency (NIMA) projects to develop a system that has the capability to provide continuous range acquisition and distribution of range information for multiple targets through a network of battlefield systems. The systems could further be used to predict target motion for estimation of future target position when direct observation or measurement of actual target dynamics and location are not possible

PHASE I: Develop the overall design, architecture and operational protocol for the system to be developed in Phase II. Develop the specifications and requirements for map and imagery processing products to insure suitability with the technology employed in determining range and elevation differences between friendly and target vehicles. Select the simulation environment and platform that will be used to test the prototype system.

PHASE II: Develop a prototype system that uses digital mapping, imagery and terrain data to determine, and continuously update in real time, the range and elevation differences among multiple moving targets and friendly vehicles in a simulated battlefield environment. Interpret and process map and terrain data so as to determine whether or not an unobstructed "line-of-sight " exists between the friendly and target vehicles. Demonstrate the functioning of the prototype system in the simulation environment selected in Phase I.

PHASE III DUAL-USE APPLICATIONS: This system would have wide utility in current and future Fire Control Systems. In addition, future use is possible in applications such as the Embedded Battle Command (EBC) and Force XXI Battle Command Brigades and Below (FBCB2) systems, where target range acquisition can be improved. From a commercial application standpoint, this technology could be used to calculate the travel distance, and hence the estimated time of arrival (ETA), for fire fighting, police, or rescue personnel responding to an emergency. Additionally, the feature that determines unobstructed lines of sight between points could have commercial application in planning transmission tower locations for wireless networks. These towers require direct line of sight for proper operation.

REFERENCES:
1. Langan, C., "Distributed Interactive Fire Mission (DIFM), Tank Extended Range Munitions (TERM) and Digitization" White Paper, MEMORANDUM FOR RECORD, March 1999.
2. DiGiacomo, R., "Distributed Interactive Fire Mission (DIFM) System Description", 1999

KEYWORDS: Fire Control, Hit Probability, Range Finder, Sensors, Mapping, Imagery, Statistics

A00-006 TITLE: Digital Wideband Antijam Technology for Global Positioning System (GPS) Protection

TECHNOLOGY AREAS: Sensors

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Project Manager, Arms

OBJECTIVE: Develop an innovative low cost GPS antijam technique(s) using digital signal processing schemes to cancel wideband noise jamming and interference to the two GPS satellite microwave carrier signals bands (L1 and L2) suitable for integration in volume restricted precision guided munitions.

DESCRIPTION: GPS is widely used as a precision navigation reference for precision guided munitions, aircraft, ships and land vehicles. These systems are expected to encounter jammers and interference in the battlespace. Current GPS antijam technology and advanced GPS receivers typically use filtering techniques to cancel multiple narrowband noise and/or continuous wave jamming and interference signals. Although these techniques are effective in removing narrowband interfering artifacts, they have detrimental effects on GPS signal processing when the bandwidth of the noise or the composite bandwidth of the filters exceed a large percentage of the processing band. The intent of this topic is to investigate and develop innovative digital signal

processing techniques to counter wideband noise jamming threats, exceeding 80% of the bandwidth, for guided munition applications.

PHASE I: Investigate and define a low cost innovative digital signal processing technique(s) and concept(s) that provide significant attenuation of a wideband noise signal. The design and associated antenna must be compatible with precision guided munition applications/integration and result in minimal impact to GPS tactical military performance. The design needs to operate and interface with Selective Availability Anti-Spoof Module (SAASM) GPS and have the capability for direct digital interface to a GPS processor/receiver. Various implementation and fabrication approaches are to be investigated. Specific form factors and packaging concepts will be devised. Phase I will demonstrate design feasibility through analysis, modeling and/or breadboard hardware.

PHASE II: Conduct the design, fabrication and test of a digital signal processor prototype as defined in Phase I using conventional-off-the-shelf (COTS) components. Establish compatibility with the storage, operating and dynamic environments of precision guided munitions. Build sufficient hardware and conduct performance and environmental qualification tests. Demonstrate performance effectiveness level against wideband noise, and characterize antijam performance against simulated threats. Identify producibility processes and techniques, and develop a plan that will afford the transition of this design to low-cost, high-volume production.

PHASE III DUAL USE APPLICATIONS: This technology will be considered for direct insertion into a number of developmental GPS precision guided munitions to include the Army's Excalibur, Quicklook and Low Cost Competent Munition programs, the Navy's Extended Range Guided Munition (ERGM) program, the Navy's Advanced Gun System program, the joint Navy/Army Projectile Common Guidance (PCG) program, and the joint US/Sweden Trajectory Correctable Munition (TCM) program. Additionally, this technology can also be inserted to military air, land and sea platforms that utilize GPS navigation/positioning systems. Commercially, it is applicable to the aviation industry, which is vulnerable to terrorist threats employing GPS jammers against navigation and airport landing systems, and also to the shipping industry for navigational information threats. The civilian GPS user will also be subject to increased wireless communications interference environments that may restrict GPS availability and reliability.

REFERENCES: Navstar GPS Space Segment/Navigation User Interfaces, ICD-GPS-200C, GPS Joint Program Office (Arinc Research Corp.), 25 SEP 97.

KEYWORDS: Antijam; Global Positioning System (GPS); Digital Signal Processing; Precision Guided Munitions (PGM); Countermeasures; Counter-Countermeasures.

A00-007 TITLE: Adaptable Cognitive Decision Aids For Embedded Weapon Applications

TECHNOLOGY AREAS: Human Systems, Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Deputy Project Management

OBJECTIVE: Develop real time cognitive decision aiding, visualization and natural MMI technologies to enhance the performance, survivability and sustainability of next generation crew served weapon systems on the digital battlefield. Demonstrate capability to fully integrate muti-source platform sensor/intelligence data and provide mission focused view of battlespace with predictive course-of-action and mission rehearsal capability.

DESCRIPTION: Advances in artificial intelligence, cognitive science, information processing, distributed processing and software engineering technologies now make possible the automation and intelligent aiding of many labor and time intensive tasks associated with weapon crew operations on the future digital battlefield. Although limited decision aiding capabilities exist at the crew station level, they are computational as opposed to cognitive in nature, have limited functionality, require extensive mouse/keyboard interaction by the user, and are not architectured to facilitate integration of emerging cognitive engineering and decision aiding component technology. Futher research is required to provide a highly modular, muti-functional and scalable architectures and a baseline component repository of cognitive decision aiding components that can be rapidly configured to meet a broad range of embedded, muti-platform requirements to include rapid plan generation across multiple platforms, real time plan monitoring and synchronization, generation of a common operating picture of the battlespace and provide appropriate alerts and alarms based on multi-sourse sensor/intelligence data. Scalable/ adaptable decision aid components are also required to support sustainment and self defense, including projecting asset utilization based on mission requirements, asset monitoring and resupply, threat course-of-action projection, and sensor placement, coverage and control. Research effort will exploit emerging voice, natural language and eye tracking technology to permit hands free/ eyes free operator interface during tactical operations. Implementation architectures must conform to emerging weapon system Technical Architecture and distributed object computing standards. Proposals may address development of one or more reusable decision aid application components with the goal of achieving a 50% reduction in cognitive work load and operator response time compared to an unaided mode of operation.

PHASE I: Develop algorithm approach and architecture design concept and formulate preliminary development and implementation approach. Develop top-level hw/sw architecture specification and demo concept feasibility.

PHASE II: Development and demonstration of a functional prototype decision aid component(s) and operator interface in a realistic simulation scenario. Demonstrate component adaptability and reusability by addressing a minimum of two application platform scenarios, e.g. mortar platoon movement/ fire direction and/or movement/ engagement planning for platoon size, direct fire unit.

PHASE III DUAL USE APPLICATIONS: This work has a very high probability of commercialization. The methodology and reusable decision aid component technology developed in this SBIR are applicable and adaptable to online embedded decision aids for commercial piloting systems, ground vehicle navigation systems, commercial warning and alerting systems, automated transportation and shipping applications and decision aiding for law enforcement applications.

References:
Offroad Navigator-An Adaptive Decision aid, Klein Assoc. Inc 1990

An Intelligent Pilot Vehicle Interface for Day/Night Adverse Weather; AIAA Computing In Aerospace Conf. Oct 1991

Adaptive Tactical Navigation Program; AGARD, Machine Intelligence for Aerospace, Sept 1991.

Knowledge-Based Cockpit Assistant For IFR Operations; In AGARD, Knowledge Based System Application for G&C.

Integration of Intelligent Avionics Systems for Crew Decision Aiding; AAIC '88

KEYWORDS: Artificial Intelligence, cognitive engineering, soft computing, sensor fusion, software engineering, fuzzy logic, genetic programming, Baysian nets.

A00-008 TITLE: Lightweight, Low Cost, Low Collateral Damage Mortar Fuzing Utilizing MicroElectroMechanical Systems (MEMS)

TECHNOLOGY AREAS: Sensors, Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Manager NonLethel Materials

OBJECTIVE: Design, fabricate and test a lightweight, low cost fuze utilizing commercially developed microelectromechanical systems (MEMS) components. The MEMS-based fuzing components shall significantly reduce fuze size and weight at reduced manufacturing cost with reduced power requirements, and also minimize fuze debris and resulting collateral damage when used on non-high-explosive mortars, particularly in Operations Other Than War (OOTW) and urban environments.

DESCRIPTION: Current pyrotechnic fuzes such as the M84A1 Time Fuze possess several detractive features. They are quite heavy, occupy a large volume, are expensive to manufacture, and produce a large variability in fuze function times. One contributor to the significant variability in timing is due to the fact that the burning rate of the pyrotechnic delay mixture is temperature sensitive. For applications where low collateral damage is required, this type fuze is unacceptable. However, current electronics technologies such as Micro Electrical Mechanical Systems (MEMs) offer significant potential application to fuze component technology in munitions to include safe & arming devices, setback g-switches, accelerometers, and micro-actuators. This technology enables the significant benefits of reduced component weight and size, parts elimination, and reduced manufacturing and assembly cost for improved affordability. The insertion of this commercial technology into specific ordnance items further offers capability for reducing collateral damage when used in non-explosive munitions in urban environments and OOTW - again due to the greatly reduced size, weight, parts distribution within the fuzing, and corresponding reduced impact energies. Recent advances in MEMS technology indicate that an improved electronic fuze or an improved proximity fuze addressing all the shortcomings of pyrotechnic fuzes could be designed and prototypes demonstrated that could achieve the following Phase I & II specific design and performance goals.

a. The MEMS-based fuze shall withstand the severe launch environments of typical mortar cartridges. The fuze must be capable of sensing two independent launch signatures and must possess a dual independent safe and arm (S&A) mechanism utilizing two of these launch signatures. Some environments which can be sensed for the non-lethal mortar fuze S&A are setback, set-forward at barrel exit, and flight air pressure / flow.

b. The proposed MEMS-based fuze shall have a small pyrotechnic output for integration into a payload dispersal mechanism

c. The proposed fuze shall be either an electronic time based fuze with a fuze setter capability or a proximity fuze. Design concepts providing the most accurate burst height timing are preferred. The fuze shall be accurate to within .05 seconds of the

preset function time. If other than a proximity MEMS fuze design is proposed, the design shall also contain a feature enabling the fuze function time to be inductively set from 0.25 sec to 50 seconds prior to firing using a hand held fuze setting device. The proposed MEMS fuze shall reduce fuze and S&A weight by at least 60 %, and reduce size/volume by one order of magnitude. (As a sample proximity fuze baseline for comparison, the present M734 Proximity Fuze and safe and arm device weigh 183 grams, without the secondary explosives, so the proposed MEMS-based fuze would therefore need to reduce the weight down to 70 grams. As a sample time fuze baseline, the current M84A1 Time Fuze has a mass of 0.8 kg and occupies a volume of approximately 178 cm3).

d. Debris from fuze function shall be lightweight to minimize collateral damage. Use of MEMS based componentry enables fuze and S&A designs with fewer parts and more distributed components to help reduce fuze debris-related collateral damage upon functioning. A 40% reduction in fuze parts shall be achieved.

e. The MEMS based fuze design shall also specify the type of power supply, e.g., a fuel cell. The power supply shall provide the fuze with approximately 30 mA / 3.5 volts sufficient to last the entire mortar flight duration. The power supply shall be no larger than .35 inch in diameter and .5 inch long.

f. Improved affordability of the MEMS based fuze shall be supported with design-to-cost comparative data between proposed MEMS-based design and existing mortar fuzes. A minimum 25 % S & A cost reduction shall be substantiated compared to baseline mortar fuzes.

PHASE I: Design a MEMS based fuze componentry utilizing commercial technology insertions and innovative new technologies towards achieving the required technical objectives.

PHASE II: Optimize the MEMS fuze design concept and develop a MEMS based R&D prototype fuze. Conduct contractor demonstration of functional MEMS fuze component prototype(s) to assess viability of achieving technical objectives when integrated into a lightweight, low cost, low collateral damage mortar munition.

PHASE III DUAL-USE APPLICATIONS: The MEMS based components and corresponding fabrication methods will have direct commercial application for microelectromechanical switching, activation and accelerometers as used throughout the electronic, automotive (airbags) and aerospace industries, and potentially for fuzing in the commercial fireworks industry, with corresponding affordability improvements through expanded markets, higher fabrication volumes, and lower cost production techniques enabled by MEMS.

KEYWORDS: MEMS, Microelectromechanical Systems, Fuzing, Safe & Arming, G-Switch, Setback, Spin, Air Flow, Fuel Cell, Munitions, Mortars Background

A00-009 TITLE: Modeling & Simulation for Combined Target Effects

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Design and develop a PC software program capable of simulating the deployment and operation of multiple directed energy weapon systems (individually and in combination) across a wide range of environments to include Military Operations on Urban Terrain (MOUT). The software will also be capable of modeling target effects for these directed energy weapon systems against personnel and materiel targets. The goal of the software will be to analyze the effectiveness and utility of multiple directed energy weapon systems.

DESCRIPTION: The Army needs to simulate the effect of combined directed energy weapon systems against personnel and materiel targets. The directed energy technologies of interest include millimeter/microwaves, acoustics, and laser/white light energies. The software program/computer code should include energy source information, transfer of energy to target, and related effects. The block diagram illustrates all parts of the energy transfer process which needs to be addressed in the algorithm.

Operational utility->Target Effect-> Target-Interaction->Propagation->Beam Forming /Antenna-Energy of Source-Energy Convergence->Prime Power

This should be done for individual directed energy technologies as well as the combined effects of multiple directed energy technologies. The purpose of this modeling and simulation is the assessment of weapon effectiveness and the optimum combinations of technologies for the myriad of MOUT and battlefield scenarios which will guide the developmental and operational implementation process. The computer code will need to undergo a validation process using experimental data. What is sought is a program capable of modeling the non-linear compounded effect of multiple energy sources at the single target level. The analysis must be able to import weapon data from actual tests into the model using a visual battlefield tracking system. The battlefield tracking system will need to take into account movement and kill data of the battle.

PHASE I: Develop overall software design algorithm architecture in block-diagram form or "pseudo" code that includes software specification documentation for the PC-compatible model of directed energies against multiple targets. Validation of equations must be accomplished utilizing known data and known results.

PHASE II: Develop, compile and execute the computer code according to specifications developed under Phase I. Additionally, develop and demonstrate battlefield tracking of troops with a combination of conventional and directed energy equipped weapons. Validate and benchmark the computer simulation with experimental data. Provide a data format file containing raw data that can be used by Government test engineers in expanded battlefield scenarios.

PHASE III - DUAL-USE APPLICATIONS: The modeling and simulation code produced can have broad application across domestic law enforcement and security applications where new, directed energy technologies and concepts are being considered for less-than-lethal force options. Examples include facility protection, riot and crowd control, hostage rescue, and prison security.

REFERENCE:
Kennedy, Paul K. et. al., " Executive Summary of PIKL Phase-I Bioeffects Analysis," Technical Report AL/OE-TR-1995-0088, Armstrong Laboratory, Brooks Air Force Base, TX, 1995

Sneddon, Leigh, "Pulsed Impulsive Kill Laser," Technical Report AL/OE-TR-1995-0099, Armstrong Laboratory, Brooks Air Force Base, TX, 1995

Honig, Emanuel M. et. al., "Surface Discharge Initiated Chemical Laser Program, Final Report," Technical Report LA-CP-99-354, Los Alamos National Laboratory, Los Alamos, NM, 1999

http://www.de.afrl.af.mil

KEYWORDS: Modeling, simulation, energy transfer, validation, directed energy, weapons

U.S. Army Research Institute (ARI)

A00-010 TITLE: Automatic Adaptive Support for Selection and Rapid Team Building Leadership Skills Using Latent Semantic Analysis

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: This effort will conduct exploratory research to develop an intelligent software agent for embedding automatic, continuous, and cumulative assessment and tutorial feedback based on verbal dialog in distributed collaborative learning environments, such as the portal for the Army's University After Next. The agent may also provide an automated ontology for retrieving queries from a library of relevant information, and provide input and process guidance for self development of technical, interpersonal, and leadership skills. A major requirement of the assessment component is that it measures and provides tutorial feedback on the ability of individuals and groups to autonomously generate, verbally express, and share needed knowledge, create their own problem solution options, and make their own plans, rather than only to choose among alternatives provided on multiple choice tests.

DESCRIPTION: The rapidly changing global environments for joint and coalition expeditionary operations create a need for new tools to enhance cognitive readiness by rapid selection, self development, and training of individuals and teams for mission-critical assignments. Individuals and teams will often seek out new information or reach back to critical expertise, and often must be trained or retrained quickly for new systems and unique missions. At the same time, today's operational needs demand rapid selection, assembly and training of individuals with specialized knowledge and skills. Leaders must be able to rapidly select the most able soldiers for novel, unexpected group operations; or to replace missing team members; or to right-size their teams for a mission. Advanced Distributed Learning (ADL) will enable remotely stationed groups, or groups of geographically dispersed individuals, to engage in automated, supported self - development, or train both by individualized instruction through CBI and ITS and in group discussion, problem solving, and mission scenario and simulation exercises. Knowledge-based resources and competencies, especially tacit knowledge, will be key drivers of future organizational and leader effectiveness. Future leaders will not only be required to acquire knowledge, but also leverage it in the face of organizational change and adaptation. These modes of learning will be valuable for traditional general knowledge and problem-solving skill training for cognitive readiness as well as for just-in-time training for expeditionary missions.

Collaborative problem centered adaptive learning is a proven learning technology ideally suited for this need. Properly implemented, collaborative problem centered learning can enhance student motivation and focus, increase rapid knowledge acquisition, and promote group problem solving and teamwork skills. Embedding automatic, continuous, and cumulative assessment and feedback for individual and group knowledge and performance would materially improve the effectiveness and logistic utility of this mode of learning. Latent Semantic Analysis (LSA) is a promising technology for this purpose because it can evaluate the content of free-form verbal contributions (potentially in speech as well as typed). LSA is automatically trained on existing bodies of relevant text rather than through laborious expert-knowledge extraction and hand-coding. Object - oriented programming approaches can encapsulate knowledge for re-use and world wide distribution on the tactical internet. Natural language processing technologies, including voice recognition and speech generation are improving rapidly to capture and digitize spoken communications for interaction with text knowledge bases. Two-way natural language dialog would be useful, but text - based assessment, interaction, and planning is essential. Applied research is needed to develop intelligent software agents that use the best of these technologies for embedding automatic, continuous, and cumulative assessment and tutorial feedback in collaborative learning environments.

To track the knowledge levels of each potential team member and the total cognitive readiness of a team, methods are needed to continually and cumulatively assess the knowledge of each member and the state of shared and functionally integrated group competence, and to do so in a valid manner that does not disrupt cohesion and the practice of teamwork skills. Research is needed for unobtrusive and tutorially effective assessment for development of individual knowledge and effective team collaboration. A major requirement of the assessment component is that it measure and provide tutorial feedback on the ability of individuals and groups to create their own problem solution options, and make their own plans, rather than only to choose among alternatives provided on multiple choice tests.

A very valuable addition to learning and performance in these situations would be instant access to highly pertinent stored textual information containing relevant doctrine historical accounts, after-action reports, procedural instructions, or briefing discussions from similar training or operational situations, during reachback in remote operations, or during preparation at home stations. An intelligent software agent based on these advanced technologies will monitor the semantic content of computer presented instructional material, open-ended student or participant answers, questions, and comments, and search the text repositories for documents or parts thereof that it determines to be most relevant to current participant concerns and most likely to provide new information, examples, or ideas that are at the same time understandable to the recipients. Attention to interface and usability issues will be crucial. The agent will also be designed to enhance the DOD's status as a learning organization through feedback-based adaptive evaluation and refinement of it use of archived experience in the University After Next.

PHASE I: The phase I effort will result in a proof-of-concept technology for the objectives and description of the topic. It will demonstrate the feasibility of a technology-based software agent to assist leaders in assessing and selecting the right members for future missions, evaluate free-text open ended knowledge expression and problem solution generation in a problem centered collaborative learning environment, provide feedback and recommend training. Phase I proposals must include a detailed market survey activity and letters of interest. Commitment from potential commercial partners must be obtained prior to Phase II consideration.

PHASE II: Phase II will fully develop, test and validate an intelligent software agent for continuous embedded assessment of open-ended learner verbal productions in a distributed program-centered collaborative learning environment. Proposals should assume that the technology will run in the platform-independent web-based infrastructure of ADL. Phase II will fully develop, test and validate a technology-based intelligent software agent to interface users to large scale libraries of information and experience of all sorts, such as those in the University After Next. It will provide data and analyses useful to leaders in the planning of unit and overall organizational composition of personnel for new missions.

PHASE III DUAL USE APPLICATIONS: Almost every present-day industry or business has a need to train personnel frequently in new operating procedures and problem-solving methods, and to select individual and teams capable of generating and verbally communicating task-relevant knowledge and solutions. No flexible automatically constructed assessment and tutorial capability for this training and assessment purpose, based on libaries of textual knowledge, such as the one described herein, exists. The development of such a technology will help Government and Private Sector organizations meet the needs of rapidly changing markets, technologies, and labor forces in a timely, effective and economical manner.

POTENTIAL COMMERCIAL MARKET: Every large industry that trains and selects individuals and teams for knowledge and problem solving activities, and has repositories of textual information that is relevant for future plans and actions, is a potential customer for this technology.

REFERENCES:

Foltz, P. W. (1998) Quantitative approaches to semantic knowledge representation. Discourse Processes, 25, 127-363.

Graesser, A.C., Wiemer-Hastings, P., Wiemer-Hastings, K., Harter, D., Person, N., and the Tutoring Research Group (2000). The Evaluation of the Contributions of Students in AutoTutor. Interactive Learning Environments, 8, 74 -103.

Landauer, T.K. & Psotka, J. (2000) Simulating text understanding for educational applications with Latent Semantic Analysis: Introduction to LSA. Interactive Learning Environments, 8(1), 1 -14.

Scardamalia, M., & Teplovs, C. (1999) Keeping track of knowledge exhibited by students in an interactive on-line discussion class. In preparation.

Shute, V. J. & Psotka, J. (1996) Intelligent tutoring systems: Past, present, and future. In D. Jonassen (Ed.) Handbook of research in educational communications and technology. New York: Simon and Schuster Macmillan.

KEYWORDS: advanced distributed learning, just-in-time training, mission performance, performance support systems, simulation, training, University After Next, program evaluation, Latent Semantic Analysis, LSA, LSI, embedded assessment, intelligent tutoring systems, adaptive training, speech understanding, collaborative learning, natural language processing, natural language comprehension

U.S. Army Research Laboratory (ARL)

A00-011 TITLE: Advanced, Small, Internal Combustion Engine

TECHNOLOGY AREAS: Air Platform, Space Platforms

OBJECTIVE: Develop an advanced, small internal combustion engine concept that overcomes the numerous limitations of existing small engines.

DESCRIPTION: Small, unmanned vehicles (UV's) (for both air and ground applications) are expected to play a significant role in the Fuel Efficient Army After Next (FEAAN). While major achievements in various technologies (e.g. aerodynamics, structures, electronics, sensors, autonomous operability, etc.) promise to continually reduce the size of such vehicles, a persistent shortcoming is the lack of a proper power plant. The ideal power plant would be compact, light weight, powerful, fuel efficient, smooth running, durable, and able to use heavy fuels (including JP-8). Such a power plant would have widespread application

beyond UV's, as described in PHASE III DUAL USE APPLICATIONS. Existing small engines are deficient to some degree in many, if not all, of the desired attributes

The power density of any internal combustion engine is a strong function of speed. However, current small piston engines are speed limited by the low flame propagation rate of heavy fuels, and rotary engines (e.g. Wankels) suffer the additional penalty of very thin combustion volumes. While small gas turbine engines have no direct speed limitations, they are severely compromised by very low component efficiencies inherent with small turbomachinery components and are not expected to be a contender for this class of small engines.

There is an urgent need for a small engine that overcomes the size related penalties of conventional, small internal combustion power plants. Without such an engine, the expected benefits from the use of UV's in FEAAN could be limited. Novel, small engine concepts (less than 10 kW power) are sought that are compact, light weight, powerful, fuel efficient, smooth running, durable, and able to use heavy fuels (including JP-8). Primary emphasis is to be on engine power density (power/volume) and durability. An engine power density greater than 35 horsepower per cubic foot engine volume is desired.
The proposr must demonstrate the analytical capabilities to predict the concept's thermal efficiency, dynamics (loads, vibrations, etc.), and must rigorously address (and show solutions to) sealing issues, thermal management, and engine durability. The proposr must also show the ability to determine the limits to which the engine concept can be scaled (up and down in power), and to determine the corresponding changes in performance due to scaling

PHASE I: Choose a demo engine power level. Analyze the proposed small engine concept and perform a preliminary assessment of performance, dynamic behavior, sealing, thermal management, and longevity. Perform preliminary engine design for the chosen power level. Conduct bench testing of key components to verify functional feasibility. Prepare PHASE II plan.

PHASE II: Perform final engine design for the chosen power level. Build and test demo engine. Verify all aspects of predicted engine performance. Conduct endurance testing at max power.

PHASE III DUAL USE APPLICTIONS: An advancead, small internal combustion engine that meets the attributes called out for in this SBIR solicitation will not only benefit miltary UV's, but will have excellent potential for use in small military power generators and individual soldiers' power packs. On the civilian side, there is virtually unlimited potential for wide spread use in power tools, emergency power generators, lawn mowers, motor scooters, motorcycles, snow mobiles, and water craft.

KEYWORDS: Internal Combustion Engine, Fuel Efficiency, Power Generation, Heavy Fuels

A00-012 TITLE: Low Cost Alternatives To Polishing for Transparent Ceramics

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop a low cost alternative to polishing of transparent ceramics. This technique would replace polishing as the final finishing step for transparent ceramics and render them optically transparent.

DESCRIPTION: Transparent ceramics such as sapphire, ALON, are at, or reaching, the stage of manufacturing where they can be used in transparent armor systems1. Single crystal sapphire has been grown commercially in sheets as large as 12" x 14". The DoD is currently funding a 6.3 effort to increase the manufacturing capability to produce ALON, with the goal of producing 14" x 20" windows. At this time polishing these materials for large windows is prohibitively expensive. Polishing large curved windows is even more expensive. For large windows polishing can be 50% of the cost of the finished window. A low cost alternative to polishing using a coating technique would greatly cut the costs of using advanced transparent materials in transparent armor systems. It should also allow for the repair of transparent armor windows that are scratched or have minor cracks, thereby reducing the life cycle costs of the windows.
The low cost finishing alternative must be compatible with the present manufacturing techniques, and materials used in making transparent armor. Techniques such as coating with an index matching glass or a polymer based coating, that will give an optical finish or be easier to polish will be considered. Because of the high index of refraction of sapphire, ALON, and spinel it will be difficult to make a polymer with an index of refraction high enough to match these materials. It may not be necessary to match it exactly though. Techniques that reduce the time and cost of polishing without coatings, will also be considered. Many advanced polishing techniques have been developed for advanced optics2. The advanced optical systems require great precision in polishing. Transparent Armor applications do not require this degree of precision. It may be possible to modify these techniques for low cost polishing.

PHASE I: Identify the most promising technique to give a low cost near optical quality finish suitable for use in transparent armor. Demonstrate the feasibility of the chosen low cost alternative to polishing can be used on samples of sapphire at least 2" x 2" x 0.25." and give at least 70% in line-transmission in the visible spectrum and less than 10 % haze as measured by a Garner Haze Guard. Demonstrate that the alternative technique to polishing chosen is compatible with autoclaving sapphire to sapphire

with a polyvinyl butyral (PVB) interlayer and polyurethane interlayer and bonding sapphire to polycarbonate with a polyurethane interlayer, using 2" x 2" x 0.25" sapphire plates.

PHASE II: Scale up polishing procedure to polish sapphire at least 12" x 14. Perform cost analysis for polishing 12" x 14"piece. Test and optimize polishing parameters with the goal of getting 80% in line-transmission in the visible spectrum with less than 5.0 % haze as measured by a Garner Haze Guard Demonstrate the ability to bond two pieces of sapphire 2" x 2" x 0.25"so treated, with (PVB) in a autoclave and then bond the sapphire laminate to a piece of polycarbonate. Demonstrate that the bonding in the autoclave operation is at least as strong as a autoclave bond using traditionally polished sapphire using a standard peel test.

PHASE III DUAL USE APPLICATIONS: Any low cost alternative to the costly polishing of hard transparent ceramics would greatly reduce there costs and allow them to be used in many more applications than has been previously imagined. Dual use applications could include armored bank cars, armored cars for police, VIP vehicle protection and architectural windows.

OPERATING AND SUPPORT COST (OSCR) REDUCTION:
Lighter transparent armor systems will increase the pay loads in vehicles and reduce the were and tear on suspensions, reduce fuel costs, and reduce the manufacturing cost of the components needed to bear the weight of heavy transparent armor systems. All these will result in operating cost reductions. Additionally have a coating that could repair scratches or minor cracks in either today's glass transparent armor systems or advanced transparent armor systems will greatly reduce costs.

REFERENCES:
1.R.W. Tustison, " Trends In Window and Dome technology" Proceedings Of The 7th DoD Electromagnetic Windows Symposium, May 1998

2. V. Prokhorov, W. I. Kordonsky, L. K. Gleb, G. R.Gorodkin and M. L. Levin, "New High-Precision Magnetorheological Instrument-Based Method of Polishing Optics"; pp. 134-36 in Optical Fabrication and Testing Workshop, 24, OSA Technical Digest Series. Edited by the Optical Society of America, Washington, D.C., 1992

3. "Symposium D: Finishing of Advanced Ceramics and Glasses"; to appear in Ceramic Transactions, v. 102, 101st Annual Meeting of The American Ceramic Society (Indianapolis, Ind., April, 1999). Edited by R.Sabia, V. A. Greenhut and C. Pantano. American Ceramic Society, Westerville, Ohio, 1999.

4. I. Kordonski, S. D. Jacobs, D. Golini, E. Fess, D. Strafford, J.Ruckman and M. Bechtold, "Vertical Wheel Magnetorheological Finishing Machine for Flats, Convex and Concave Surfaces"; pp. 146-49 in Optical Fabrication and Testing Workshop, 7, OSA Technical Digest Series. Edited by the Optical Society of America, Washington, DC, 1996.

5. Golini, S. D. Jacobs, W. Kordonski and P. Dumas, "Precision Optics Fabrication Using Magnetorheological Finishing", pp. 251-74, in SPIE CR67: Advanced Materials for Optics and Precision Structures. Edited by M. A. Ealey, R. A. Paquin. And T. B. Parsonage. SPIE, Bellingham, Wash., 1997.

6. Golini, "Magnetorheological Finishing Automates Precision Optics Fabrication," Laser Focus World, [9] 187-90 (1998).

7. I. Kordonski and S. D. Jacobs, "Model of Magnetorheological Finishing"; pp. 63-74 in Sixth International Conference on Adaptive Structures. Edited by C. A. Rogers, J. Tani and E. J. Breitbach. Technomic Publishing Co., Lancaster, Pa., 1996.

8. A. Arrasmith, S. D. Jacobs, H. J. Romanofsky, L.L. Gregg, A. B. Shorey, I. A. Kozhinova, D. Golini, W. I. Kordonski, S. Hogan and P. Dumas, "Studies of Material Removal in Magnetorheological Finishing (MRF) from Polishing Spots"; in "Symposium D: Finishing of Advanced Ceramics and Glasses," to appear in Ceramic Transactions, v. 102, 101st Annual Meeting of the American Ceramic Society (Indianapolis, Ind., April, 1999). Edited by R. Sabia. American Ceramic Society, Westerville, Ohio, 1999.

9. D. Jacobs, "Nanodiamonds Enhance Removal in Magnetorheological Finishing," Finer Points 7 [1] 47-54 (1996).

10. D. Jacobs, F. Yang, E. M. Fess, J. B. Feingold, B. E. Gillman, W. I. Kordonski, H. Edwards and D. Golini, "Magnetorheological Finishing of IR Materials"; pp. 258-69 in SPIE 3134: Optical Manufacturing and Testing II. Edited by H. P. Stahl. SPIE, Bellingham, Wash., 1997.

11. Lambropoulos, F. Yang and S. D. Jacobs,"Toward a Mechanical Mechanism for Material

Removal in Magnetorheological Finishing"; pp.150-53 in Optical Fabrication and TestingWorkshop, 7, OSA Technical Digest Series. Editedby the Optical Society of America, Washington, D.C.,
1996.

12. Zygo NewView100™ White Light Optical Profiler, a real sampling over 0.25 mm x 0.35 mm with a 20x Mirau objective, no filter, was used for all roughness data. A Zygo Mark IVxp™ or Zygo GPI™ phase shifting interferometer system was used for all data acquisition and analysis related to polishing spots, workpiece surface figure, and transmitted wavefront quality reported in this article; Zygo Corp., Middlefield, Conn..

KEYWORDS: Transparent armor, polishing, coatings, transparencies.

A00-013 TITLE: Environmental Sensor Data Fusion

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Develop stand-alone system for the 4 D (space and time) assimilation of environmental data from radar, radiometer and Gobal Position System (GPS) slant path water vapor array measurements for the improvement of artillery meteorology and other applications.

DESCRIPTION: Meteorology affects artillery accuracy through initial, trajectory, and terminal effects. An example of an initial effect is the launch area cross wind error for the Multiple Launch Rocket System (MLRS). During its ballistic flight, a projectile is affected by wind, density, and the transition from supersonic to subsonic flight. In the terminal phase, deployable munitions may be affected by wind, fog, cloud, or other weather. Present meteorological systems (mainly the balloon borne radiosonde) are only accurate enough to permit correction for a portion of these effects.

New sensors, new patterns for deploying sensors, and new methods for information fusion offer the opportunity for substantial improvements in accuracy of determination of the crucial meteorological variables. There is a need for a compact hardware and software system for meteorological data fusion for artillery accuracy improvement.

The present topic proposes development of such a system for three sensors: wind radar, microwave radiometers, and GPS slant water vapor systems. These systems can measure dynamically the most important meteorological variables, namely wind, temperature and atmospheric water vapor. These variables are also crucial for artillery. Wind radars measure profiles of atmospheric winds by measuring the Doppler shift of clear air radar returns, and microwave profilers infer temperature profiles and water information from microwave brightness measurements. A newer instrument, the GPS slant water vapor sensor, uses the fact that water vapor in the atmosphere causes a delay in the time of arrival of the GPS signal (for details, see the referenced internet site and locations). By determination of the delays for several satellites as each tracks across the sky, the sensor gets a large number of slant path measurements of total water vapor. When such sensors are deployed in arrays, as they have been at the Department of Energy Cloud and Radiation Testbed (CART) site in Oklahoma, tomography can be used to infer three dimensional water vapor distributions.

The ideal method for fusion of such data is assimilation into a dynamical meteorological model in such a way that the measurements are required to be consistent with the physics of the atmosphere. Such models also have the advantage of prediction of future atmospheric states. A general method for statistically optimal data assimilation is the so-called 4 D (3 dimensions of space plus one for time) variational scheme. Implementation of such a scheme for the above sensors, or some approximation to it, is one possible method for addressing the problem of the current topic.

Technology such as that developed under this topic may be generalized to the weather web project in particular and the sensor web project in general. Because the problem of information fusion and information assimilation is central to future information technology, this topic is also directly applicable to the Information Technology for the Twenty-First Century (IT2) initiative.

PHASE I: The phase I effort should assemble a trial data set from an array of wind radar, microwave radiometers, and slant path GPS moisture systems and describe one or more assimilation techniques suitable to the problem and apply it to a portion of the trial data set.

PHASE II: Develop assimilation techniques and implement on a PC or other portable computer system. Test the data assimilation method on a full-scale data set such as the array of GPS, radar, and radiometric sensors in Oklahoma, and document effects on nowcast and forecast accuracy. Develop and demonstrate a prototype.

PHASE III DUAL USE APPLICATIONS: Development and delivery of turnkey systems will permit assimilation and use of these new data sources in models with important applications for other military and civilian applications. Examples include use for aviation, operation, prediction of the transport and diffusion of smoke, NBC, and pollutants. Another civilian application is

wildfire control. With wind radar, microwave radiometry and GPS slant path water vapor measurements, it is possible to infer the wind temperature, and moisture fields. This information should greatly improve the performance of transport and diffusion models used for modeling movement of pollutants, smoke, and haze.

In addition, these measurements can make crucial contributions to the prediction and monitoring of global climate change effects. We expect there to be a vast civilian demand for a product which provides assimilation of the Radar, radiometry, and GPS data into mesoscale and other models if it can be successfully developed.

REFERENCES: An extensive source of GPS meteorology information is : http://www.gst.ucar.edu

Anthes, R., M. Exner, C. Rocken, and R. Ware, 1997. Results from the GPS/MET Experiment and Potential Applications to GEWEX, GEWEX News, 7, 3-6.

Bar-Sever, Y.E., P.M. Kroger, and A.J. Borjesson, Estimating Horizontal Gradients of Tropospheric Path Delay with a Single GPS Receiver, JGR-Solid Earth, 1997.

Bevis M., S. Businger, T.A. Herring, C. Rocken, R.A. Anthes and R.H. Ware, 1992. GPS Meteorology: Remote Sensing of Atmospheric Water Vapor Using the Global Positioning System, Journal of Geophys. Research, Vol. 97, No. D14, pp 15,787-15,801.

Bevis, M., S. Businger, S. Chiswell, T.A. Herring, R.A. Anthes, C. Rocken and R.H. Ware, 1994. GPS Meteorology: Mapping zenith wet dealys onto precipitable water, Journal of Applied Meteorology, 379-386.

KEYWORDS: Radar, microwave radiometry, GPS slant measurement, moisture sensing, data assimilation, data fusion.

A00-014 TITLE: Non-Intrusive Gas Turbine Combustor Measurement Techniques

TECHNOLOGY AREAS: Air Platform, Materials/Processes

OBJECTIVE: Develop a rugged, cost-effective, non-intrusive system for measuring instantaneous velocity vectors, and temperatures and species concentrations in gas turbine combustors.

DESCRIPTION: The design of gas turbine combustors relies heavily on computer codes. Accurate experimental data needed to validate these codes (e.g. verifying scaling laws and providing closure to tubulence parameters) are not only difficult to obtain, but can only be measured in a loboratory or test cell setting. A simple, reliable system for obtaining the desired combustor properties (velocity, temperature, species) would not only benefit the design of gas turbine combustors, but, if capable of being used in the field, would be an excellent diagnostics tool to determine the health of an engine. Such a system could result in significant maintenance savings.

Currently used, non-intrusive systems for measuring the fluid flow velocity (e.g. Laser Doppler and Laser Transit Anemometry) are complex and expensive, and cannot be used in the field. Likewise, existing, non-intrusive temperature and species concentration measurement systems are even more complex and expensive, and rely on spectroscopic techniques such as absorption, laser induced fluorescence (LIF), and Raman scattering. These temperature and species measurement techniques require narrow laser line widths to excite a singel rotational vibrational state of the agent species. Laser tunability and restrictive line width requirements have thus hindered using these techniques in practical applications.

Laser diode technology has been expertimentally demonstrated to be able to measure fluid flow velocity. Further advances in laser diode technology promise to make the development of the desired laser temperature and species measurement techniques possible and practical, since laser diode techniques do not require narrow laser excitation line widths, but can derive the needed information from broad band excitation provided by suitable flash lamps.

Sources are sought to develop a laser diode fluorescence sensor (using broad band excitation sources) that eliminates the current complex imaging requirements for laser coherence. The sensor must enable the determination of temperature and species in a gaseous flow field. The sensor must be cost effective, accurate enough to be capable of verifying gas turbine combustor scaling laws, as well as rugged enough to be used as a potential diagnostics monitoring tool in the field.

PHASE I: Perform bench tests to demonstrate the feasibility of laser diode velocimetry (velocity measurements) for combustion applications. Perform analytical studies to determine the feasibility of a laser diode fluorescence technique using a broad band excitation source to detect tempertature and species concentration. Develop Phase II work plan.

PHASE II: Measure gas velocities in a combustor using laser diode velocimetry. Develop the laser diode fluorescence technique to measure temperature and species concentration in a gas turbine combustor environment. Demonstrate (in a laboratory setting) the ability to measure temperature and species concentration in a combustion environment.

PHASE III DUAL USE APPLICATIONS: An accurate, practical technique for real time measurement of combustion velocity, temperature and chemical species will benefit all applications that involve a combustion process. This includes all military and civilian gas turbines, as well as industrial and home furnaces. Knowing the details of the combustion process can lead to smaller and lighter combustors producing fewer emissions. In addition, such a technique would be an invaluable diagnostics tool that could provide early warning of combustor distress, resulting in significantly reduced maintenace costs.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: The ability to accurately monitor the performance of a combustor in the field could pinpoint combustor degradation long before significant damage occurs, thus resulting in large maintenance savings.

REFERENCES:
1.) Lee, M.P. and Hanson, R.K., "Calculations of O2 Absorption and Fluorescence at Elevated Temperatures for a Broadband Argon-Fluoride Laser Source at 193 nm," Journal of Quantitative Spectroscopy and Radiative Transfer, Vol. 36, No. 5, pp. 425-440, 1986.
2.) Dopheide, D., Strunck, V., and Faber, M., "Phased Diode Arrays for Velocity Measurements and Signal Processing," Proceedings of the IEEE Inst. in Aerospace Simulation Facilities, pp. 12-18, 1989.
3.) Dopheide, D., Rinker, M., and Strunck, V., "High-Frequency Pulsed Laser Diode Application in Multi-Component Laser Doppler Anemometry," Optics and Lasers in Engineering, pp. 135-143, Vol. 18, 1993.
4.) Grinstead, J.H., Laufer, G., and McDaniel, J.C. Jr., "Rotational Temperature Measurement of High-Temperature Air Using KrF Laser-Induced O2 Fluorescence," Applied Physics B, Vol. 57, pp. 393-396, 1993
5.) Potts, R.L., and Azzazy, M., "Simulation of Diode Array Velocimetry," AIAA 34th Aerospace Sciences Meeting, AIAA-96-0038, 1996.

KEYWORDS: Combustors, Non-Intrusive Measurements, Anemometry, Laser Diode, Fluorescence Spectrum

A00-015 TITLE: Compact Laser Igniter for Medium Caliber Cannon

TECHNOLOGY AREAS: Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Manager - Apache

OBJECTIVE: Conduct research to define the design characteristics of a laser igniter suitable for small and medium caliber weapons systems. This design must be very compact, light weight, and have low power consumption. It must fit in small form factor available on gun. It shall provide prompt and reliable ignition of charges using environmentally friendly energetic materials. It must be sufficiently rugged to withstand high shock/vibration levels. Build prototypes of design to demonstrate capability.

DESCRIPTION: The (Phase III) test bed for this project will be the M230 30-mm cannon. The design of the igniter should consider the following criteria:

1. Size: One possible design would have separate laser and power supply modules. The laser module would fit within the firing pin housing of the M230 cannon. However, this volume is very limited: two concentric, adjacent cylinders 14 mm diameter by 44 mm long and 5 mm diameter by 52 mm long. Thus a laser design external to the cannon (with energy directed to the charge by optical fiber or mirror) may be most suitable if all other criteria are satisfied. The total volume of the power supply and laser are not defined, but must be reasonably compact; a goal of this project will be to determine how small they can be made.

2. Power consumption: Power consumption must be compatible with the platforms on which these cannons are utilized such as Apache helicopters. Performance trade-off needs to be evaluated, but lower power consumption will be advantageous.

3. Weight: Weight must be minimized, especially in the power supply, to make the igniter system compatible with air platforms.

4. Performance: The igniter shall provide prompt, reliable ignition of the gun charge to provide full gun function (typically 4 msec) within the normal operating parameters. This requirement usually can be met with initiation of the first element of the charge ("primer") within 1 millisecond or less of the fire signal. Firing rate is 625 rounds/minute for up to 50 shots.

5. Environmental Limitations: The first stage energetic material in the gun charge (that which is impacted by the laser beam) can be modified to enhance performance with the laser. Any material used must meet normal sensitivity and safety standards. In addition materials considered must be lead and heavy metal free and environmentally friendly in production, use, and demilitarization. Consideration of next generation materials such as metastable intermolecular compounds is encouraged.

6. Shock and Vibration: The igniter shall survive the shock and vibration present on these platforms as well as that from the operation of the weapon system. Test firings will be provided by the government during the course of the research to validate mechanical survival of designs if desired by the contractor.

PHASE I: Establish the feasibility of a laser ignition system that will meet the six criteria above. Determine the fundamental properties of the elements of a system including laser, optical, power supply, and energetics components. Map out the research effort to develop these elements in Phase II.

PHASE II: Perform and consolidate the research required toward generating a working prototype.

PHASE III DUAL USE APPLICATIONS (a) Military - Generation of brassboard for testbed application. This technology will provide a major gain in the electromagnetic insensitivity of medium caliber weapons systems and a significant boost in environmental hazard reduction. (b) Commercial -Partner with domestic firearm manufacturer and modify to meet requirements of small-caliber weapons. Major impact possible in smart weapons technology (childproofing and non-owner gun firing) with electrically-controlled fire signal. Smart-weapon technology applied to handgun safety is a high-visibility political item that is being mandated in the near future in Maryland and other states.

References:

1. Laser Ignition In A Medium Caliber Gun: A Study Of Igniter Influence On Action Time, Richard A. Beyer and John M. Hirlinger, ARL Technical Report ARL-TR-1864, 1999.

2. "Medium Caliber Laser Ignition Demonstration," 31st Annual Guns and Ammunition Technical Symposium (ADPA), March 1996.

3. "Medium Caliber Laser Ignition: Burst Firing Demonstration," 32nd Annual Guns and Ammunition Symposium (NDIA), April 1998.

4. "Laser Ignition for Advanced Weapons Systems: Successes with the Crusader XM297 155 mm Howitzer and Transition to the M230 30 mm Chain Gun," Presented at the 21st Army Science Conference, June 1998

5. Patent Application "Cartridge Window for Laser Ignition," Docket Number ARL-99-01. Submitted to U. S. Patent Office December 1998.

6. Model Validation for High-Power Laser Ignition of JA2 Propellant, A. Cohen, R.A. Beyer, K. McNesby, A.J. Kotlar, A. Whren, J.E Newberry, ARL-TR-2044, 1999.

7. Laser Ignition of Standard and Modified 155-mm Howitzer Charges, R. A. Beyer, J.K. Boyd, S.L. Howard, G.P. Reeves, and M. Folsom, ARL-TR-1993, 1999.

8. Laser-Based Ignition for a Gunfire Simulator (GUFS): Thermal Transport Properties for Candidate Igniter Materials, M.J McQuaid, A.E Kinkennon, R.A. Pesce-Rodriguez, and R.A. Beyer, ARL-TR-2033, 1999.

9. Laser Ignition Times of MACS Charges, R. A. Beyer, ARL-TR-1939, 1999.

10. Direct Laser Ignition of Gun Propellants: Modular Charge Simulator Tests, S.L Howard, R.A. Beyer, and G.P. Reeves, ARL-TR-1873, 1999.

KEYWORDS: cannon, medium caliber, small caliber, laser, ignition

A00-016 TITLE: Synthesis and Functionalization of Quantum Dots for Bio Agent Detection

TECHNOLOGY AREAS: Biomedical

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Joint Program Office - Biological Defense

OBJECTIVE: To use nanometer sized, inorganic particles (quantum dots (QDs)) to replace current organic dyes for biosensor applications. The ideal QD nanoparticles should emit light outside the biomolecules, and exhibit high quantum efficiency without photobleaching.

DESCRIPTION: Current biological labelling methods primarily rely on organic dye-based molecules that tend to photobleach very rapidly. In addition, these dyes often emit at the same wavelength as many biomolecules. On the other hand, QDs (i.e.

cadmium selenide), are stable nanoparticles that do not exhibit photobleaching, and emit different wavelengths of light depending on their sizes. The need exists to produce extremely monodisperse QDs (ideally at 1-20 nm region) for biosensing applications. Synthetic methodologies that involve consistantly-producing uniform sized QDs (i.e. 2 and 5 nm QDs), as well as functionlizing them for biomolecule attachment are highly desired. The process has to be very reproducible, and the resulting QDs need to be soluble and stable in water. Capabilities for producing large scale QDs are also required. Demonstrations using an array of QDs for detection of multiple biothreat agents are a plus. The incorporation of QDs into any of the existing biodetection platforms will be highly considered.

PHASE I: Develop synthetic methodology, synthesize a variety of monodisperse QDs, and functionalize them using at least two bioreceptors. Compare their assay performance with that of traditional organic dyes.

PHASE II: Construct miniaturized sensor prototype(s) utilizing QD-bioreceptor conjugates. Demonstrate detection capability for a variety of bioagents.

PHASE III DUAL USE APPLICATIONS: Large scale production of miniaturized sensors. The sensors can be used for both military and domestic preparedness applications.

REFERENCES: 1) Bruchez, MP et. al., Semiconductor Nanocrystals as Fluorescent Biological Labels, Science 281, 2013 (1998). 2) Chan, WC et. al., Quantum Dot Bioconjugates for Ultrasensitive Nonisotopic Detection, Science 281, 2016 (1998).

KEYWORDS: Quantum Dots, Nanoparticles, Bioreceptors, Bio Agent Detection.

A00-017 TITLE: Flexible-Modular Body Armor For Armor Piercing Protection

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop a flexible body armor system, conformable to the wearer's torso, capable of providing NIJ Level IV protection (National Institute of Justice Standard 0101.03, 'Ballistic Resistance of Police Body Armor', Caliber .30 Armor Piercing, M2 @ muzzle velocity). The system should also provide multiple-hit protection (3-hit minimum) and knife protection, with a modular design to allow the user to adjust the protection level based on the tactical situation. This system should also increase the area of coverage and decrease the weight as compared to current systems.

DESCRIPTION: Recent developments in advanced personnel armor material systems have led to lighter weight body armor systems. The U.S. Army Natick Soldier Center has successfully lightened the load for front-line troops by introducing a body armor system that weighs 35-percent less than the current Personnel Armor System Ground Troop (PASGT) body armor system. This new system uses a ballistic fabric vest that provides fragment and handgun protection. Rigid ceramic plates inserted into the vest provide ballistic protection against 7.62-mm rifle ammunition (NIJ Level III). This system has a total weight of approximately 16.5 pounds.

These current designs, although an improvement, are still considered heavy, the insert plate is bulky, limits soldier mobility, increases soldier heat load and does not provide maximum ballistic protection to the entire torso or knife/stab protection. This effort will incorporate a new conformal body armor design to provide flexible full-torso ballistic protection and a material system to reduce system weight under 16.5 pounds for NIJ Level IV protection, while providing greater comfort and mobility to the soldier. A modular design is required to allow the ability to increase/decrease the ballistic protection level by adding/removing ballistic panels from the body armor. This will allow the soldier to tailor ballistic protection for the predicted threat, without carrying excess weight.

Applications include traditional maneuver warfare operations, urban warfare situations (MOUT), military law enforcement, peacekeeping missions and field-training exercises. Regardless of the situation, the system must provide effective defense against fragmentation rounds (mines, grenades, mortar shells, artillery fire), handgun and rifle projectiles (ball and armor piercing). The final system design will provide a flexible modular body armor system capable to defeating multiple levels of ballistic threats, with knife/stab protection and increased user comfort and mobility.

PHASE I: Identify leap-ahead technology for body armor design and materials, to provide improvements in ballistic performance, comfort and mobility over currently fielded body armor systems. This effort will determine materials and system design required to provide NIJ level IV protection with improved soldier comfort and mobility.

PHASE II: Fabricate body armor systems for testing and evaluation using selected materials and design identified and selected in the Phase I effort. Review and enhance manufacturing capabilities to enable efficient and cost effective production in sufficient quantities to modernize a large number of U.S. military forces.

PHASE III: DUAL USE APPLICATIONS: In addition to military applications, this technology also has applications for ballistic protection for foreign service personnel, federal law enforcement and security personnel, and civilian law enforcement body armor applications.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: The SBIR Topic could result in reduced OSCR in two ways; (1) one or more of the modular ballistic panels can be replaced as materials technology evolves, (2) soiled or damaged modular ballistic panels can be replaced as needed. This allows for reduced product improvement and maintenance costs since components can be replaced vice replacing the entire protection system.

REFERENCES:

U.S. Department of Justice, National Institute of Justice (NIJ), Standard 0101.03, Ballistic Resistance of Police Body Armor (Washington, DC: National Institute of Justice, April 1987).

U.S. Congress, Office of Technology Assessment, Police Body Armor standards and Testing: Volume I, OTA-ISC-534 (Washington, DC: U.S. Government Printing Office, August 1992).

U.S. Department of Justice, National Institute of Justice, Technology Assessment Program, selection and application Guide to Police Body Armor (Washington, DC: National Institute of Justice, February 1989).

KEYWORDS: protection, body armor, ballistics, armor

A00-018 TITLE: Silicon-Based Lasers

TECHNOLOGY AREAS: Information Systems, Electronics

OBJECTIVE: The goal of the research is to identify a processing approach that provides for direct integration of lasers into conventional silicon integrated circuits.

DESCRIPTION: Identify innovative concepts for integrating laser structures directly into silicon integrated circuits. Such a breakthrough will form the basis for future implementation of optical interconnects into high speed computer systems to provide for significant enhancements in overall computer performance. Research should address both material growth and device design issues associated with the direct growth of a laser structure on a silicon substrate. A direct integration capability does not currently exist, but would represent a major advance over the existing hybrid-circuit approaches. Emphasis of the research should focus on growing a low-power (100 mW) laser on a Si substrate, which is highly reliable and affordable. Approaches of specific interest include: 1) the heteroepitaxial growth of lattice-relaxed compound-semiconductor layers on silicon, or 2) novel engineering of silicon-silicon dioxide superlattice structures deposited on Si substrates.

PHASE I: Investigate and demonstrate feasibility of the proposed approach for growing a laser structure directly on a silicon substrate. Phase I should have the goal of demonstrating a lasing device that produces greater than 10 mW of visible-light output at room temperature and a lifetime in excess of 10 hours.

PHASE II: Continue to study and optimize the design and processing steps related to the innovation. This should include the design and testing of prototype lasers. Major cost and reliability issues associated with the innovation in the context of commercial viability should be explored. Phase II should have the goal of demonstrating a Si-based laser with greater than 100 mW of light output at room temperature and lifetimes in excess of 500 hours.

PHASE III DUAL USE COMMERCIALIZATION: Conventional computer interconnect technology will soon represent a major bottleneck to further increasing the rate of on- and off-chip data transfer. Optical interconnects provide a viable solution that can significantly alleviate this problem, and support continued advances in the technology. The development of a Si-based laser, which is be fully compatible with the conventional Si IC processing, would provide a major boost to the widespread introduction of the technology. This research is intended to provide this needed breakthrough.

KEY WORDS: Laser, silicon integrated circuits, compound semiconductors, heteroepitaxial growth, silicon-silicon dioxide superlattice

A00-019 TITLE: Supra-nonlinear Nano-particulate Liquid-crystalline Opto-electronics

TECHNOLOGY AREAS: Materials/Processes, Sensors, Electronics

OBJECTIVE: Recently, four-orders of magnitude higher optical nonlinearity than any known to date has been produced in new materials. This huge nonlinearity produces extreme sensitivity of photonic devices to external stimuli that has not been achievable prior to this discovery. Secondly, materials which have nanosized particles dispersed in them in a network structure have been produced that are reconfigurable and electronically switchable. The combination of these two capabilities will produce smart functions for image processing, memory, etc. and provide great contrast, high resolution. Furthermore, instead of the currently required milliwatts of optical power, we will be able to utilize very low power consumption levels, down to microwatt or even nanowatt levels. The objective is two-phased, first to develop such materials in Phase I, and in Phase II to apply such materials to the construction of specific photonics devices, including next generation image processing and sensing, holographic memory, switching and modulation, and optical limiting. These functions will be adapted to both civilian and DoD specific applications.

DESCRIPTION: Nematic Liquid crystals doped with certain dyes have shown to posses record-breaking optical nonlinearity, and furthermore a photosensitivity comparable to those of semiconductors that are used in present-day liquid crystal spatial light modulators. This makes it feasible, for example, to develop new tunable spatial light modulators (SLMs) where phase modulation and photosensitivity features are integrated in a single medium. This confluence in turn will result in reduced complexity in manufacturing, dramatically reduced cost, and higher reliability. One anticipates enhanced performance, specifically in relation to larger phase modulation, higher spatial resolution, faster response time, and very little power consumption. Specifically, for the example of the integrated SLM system, this translates into significantly improved performance as compared to the conventional split-function SLMs. The highly nonlinear and high sensitivity optical material can be combined with nanoparticle/matrix networks thereby producing "intelligent" nonlinear optical systems that they are reconfigurable, adaptive, have memory and can learn. This will lead us into a new fertile ground of photonics that will have demonstrable applicability for both civilian and DoD applications. The nanoparticle network could be dielectric, conductive, semiconductive, or even magnetic, and most importantly reconfigurable and electronically switchable. This will also ensure micro to nanowatt levels of power consumption.

Phase I: Materials with unique/versatile properties. This will be an exploratory phase where the main objectives are to synthesize and characterize supra-nonlinear optoelectronic materials in conjunction with nanoparticle networks with reconfigurable properties. The optical and nonlinear properties will be judged against their states of transparency, phase modulation properties, nonlinear optical constants, their response to external fields regarding reversible reconfigurablity, memory, and switching speed.

Phase II: Next generation prototype improved smart image processing and sensing, holographic memory, switching/limiting devices will be demonstrated of this Phase. The fundamental scientific and engineering design of the prototypes should allow the flexibility to easily reengineer the prototypes to make other photonic devices. The set of devices that will be so represented will include the following: a) high spatial (500 lines per mm) and temporal (microsecond) resolution optical phase and amplitude modulators; b) optical image memory and processing elements; c) reconfigurable lenses and diffraction gratings; d) electro-optic and all-optic shutters; f) high dynamic range optical limiters and anti-laser jamming devices; g) infrared laser beam sensors and image detectors. These new photonic devices will be made possible due to the unique nonlinear optical materials developed in Phase I.

PHASE III DUAL USE COMMERCIALIZATION: Civilian/commercial applications will naturally ensue. The prototype devices cited above will be explored for manufacturing and commercialization and commercializable prototypes demonstrated. There is a very large market for very low power and orders of magnitude lower cost optoelectronic and all-optical components that are intelligent, in that they are capable of learning, are multifunctional and adaptive, are very compact and compatible with the ongoing technology thrusts towards higher volume-density, high-information-throughput systems. The digitization of the battlefield will also be significantly helped via such frontier technology devices.

References:
"Extremely Nonlinear photosensitive liquid crystals for image sensing and sensor protection," I. C. Khoo, M. V. Wood, M. Y. Shih and P. H. Chen, Optics Express Vol.4, no. 11, pp 431-442 (1999).
Optically induced hydrodynamic reorientation of liquid crystals and its applications for infrared detection "and information storage," R. S. Akopyan, N. V. Tabiryan, and T. Tschudi, Physical Review E, Vol. 49, pp 3143-3149 (1994) and additional publications of Nelson Tabiryan if requested.

KEY WORDS: a) Supra-nonlinear optics; dye-doped liquid crystals; nanoparticle networks. b) Enhanced photosensitivity, combined high temporal and spatial resolution; adaptive memory, and switching, reconfigurability, learning /neural nets. c) Sensing and image processing, holographic memory, switching/limiting optics, reconfigurable lenses and diffraction gratings. d) Laser protection, anti-laser jamming, infrared laser beam sensor /detector, friend /foe identification, target acquisition and tracking, smart weapons e) Digitization of the battlefield, situation awareness, increased precision in performance.

A00-020 TITLE: Sterilization and Decontamination Systems Utilizing Cold Plasmas

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop a deployable chemical and biological sterilization/decontamination system, based on cold plasma technology, which would have the ability to effectively decontaminate the following: sensitive equipment; vehicle/shelter interiors; personnel; or personnel equipment, without adverse effects to the items being decontaminated and without presenting a significant health and safety risk to the operator.

DESCRIPTION: Plasmas are energetic, partially ionized gases capable of conducting electrical current. Exposure of stable gases to energetic electron impact in a plasma can result in excitation, dissociation, and ionization of the feedstock gas, producing chemically reactive metastables, radicals and ions as well as ultraviolet radiation and heat. Plasmas containing oxygen have the potential to readily oxidize toxic organic compounds, including chemical warfare agents, producing nontoxic volatile byproducts. The reactive chemical species produced by plasmas can also be used to kill biological warfare agents and biological pathogens. Thus plasma CB decon relies on agent detoxification and not just physical agent removal.

Cold plasmas offer a potential means for dry, nondestructive decontamination of high-value, or sensitive equipment, such as electronics and optics, for which there is currently no acceptable method of CB decon. Such a system may operate at either reduced or atmospheric pressure. In all cases, the exposure temperature must be maintained low enough to avoid thermal damage. A similar system might also be used for decon of personnel equipment, such as rifles and masks, with somewhat reduced temperature restrictions. This capability might be extended to in-situ decontamination of vehicle/shelter interiors containing sensitive equipment, provided that the reactive species can be produced at atmospheric pressure and be projected through a reasonable standoff range. The process must not consume unacceptably large quantities of containerized gases. The use of gases that can be easily generated in the field (e.g., air, nitrogen or steam) would be preferred. Adequate precautions must also be taken to protect against the risk of operator exposure to excessive heat, ozone and electrocution. If the exposure temperature can be further reduced to a level safe for people, one might also envision a plasma "shower" for decon of personnel and their equipment.

PHASE I: Define system requirements, evaluate feasibility of candidate systems and develop preliminary designs of a deployable system. The design studies must also address decon efficacy, system size and weight, power and gas requirements, maintenance requirements, deployability issues and developmental and operational cost as well as other pertinent factors.

PHASE II: Refine the preliminary design, develop a prototype system and demonstrate its operational effectiveness by conducting decontamination trials using simulated and, if possible, actual agents.

PHASE III DUAL-USE COMMERCIALIZATION: The current techniques used to decontaminate sensitive equipment are very limited. Cold plasma presents a viable method for sensitive equipment decontamination. The proposed system would be directly applicable to decontamination needs of the domestic preparedness market. Federal, state and local agencies, as well as other governments, could benefit from this technology in the event of either accidental or intentional contamination with CB warfare agents, or exposure to toxic industrial chemicals in legitimate use by industry. The system will also be pertinent to medical sterilization.

REFERENCES:
1. Y.C. Yang, J.A. Baker, J.R. Ward, "Decontamination of chemical warfare agents", Chem. Rev. 92, 1729 (1992).
2. G. Irving, T. McMurray, J. Herbold, Non-Medical Dispersed Biological Weapons Countermeasures (USAF Armstrong Laboratory AL/OE-TR-1997-0081, 1997, NTIS order # ADA327316).
3. R.E. Baier, J.M. Carter, S.E. Sorensen, et al., "Radiofrequency gas plasma (glow discharge) disinfection of dental operative instruments, including handpieces," J. Oral Implantology 18, 236 (1992).
4. H.W. Herrmann, G. S. Selwyn, et al., "Dry Decontamination of Chemical/Biological Warfare Agents using an Atmospheric Pressure Plasma Jet", Phys. Plasmas, 6 (1999) 2284
5. M. Laroussi, "Sterilization of Contaminated Matter with an Atmospheric Pressure Plasma". IEEE Trans. on Plasma Sci. 24, 1188 (1996).
6. K. Kelly-Wintenberg, T.C. Montie, C. Brickman, J.R. Roth, A.K. Carr, K. Sorge, L.C. Wadsworth, P.P.Y. Tsai, "Room temperature sterilization of surfaces and fabrics with a One Atmosphere Uniform Glow Discharge Plasma," Jrnl. Industrial Microbio. & Biotech. 20, 69 (1998).

KEY WORDS: decontamination, chemical/biological warfare agents, toxic industrial chemicals, plasma

A00-021 TITLE: Semiconductor-Based, Fully-Integrated, Terahertz, Transmit/Receive Modules

TECHNOLOGY AREAS: Electronics

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Manager, Nuclear, Bilogical, Chemical Defense

OBJECTIVE: To develop and demonstrate a robust semiconductor-based electronics technology suitable for providing cost-effective integration of sources, circuits and receiver elements across the THz frequency band (i.e., ~ 0.3 to 10 THz).

DESCRIPTION: There is presently a very important need to develop fully-integratable semiconductor-based electronic components that are capable of "effective" operation within the terahertz (THz) frequency band. While the THz regime, defined as frequencies between 0.3 - 10.0 THz, offers many technical advantages (e.g., wider bandwidth, improved spatial resolution, and compactness) the major motivation for the development of this submillimeter-wave region between microwaves and the infrared has been applications in molecular spectroscopy. In fact, in this final year of the twentieth century, the solid-state electronics capability within the THz frequency regime remains extremely limited from a basic signal source and systems perspective [1]. At the same time, many new potential applications of THz technology are rapidly emerging. While a number of novel commercial applications related to general spectroscopic probing have been demonstrated (e.g., polar materials, human tissue, flames, etc. [2, 3]), advances in nanotechnology, molecular chemistry and biological science have already begun to chart the course for new and important applications of THz electronics in the coming century. Specifically, new research has identified physical mechanisms within the THz regime that suggest advantages for the sensing of both chemical and biological agents [4,5]. The recent proliferation of chemical and biological (CB) agents as instruments of warfare and terrorism has lead the DoD to rank the development of early-warning systems for biological, and then chemical, as the highest priorities [6]. Hence these facts combine to compel the development of a THz electronics capability. An effective counter to the C/B threat will only be possible through the development of point and stand-off sensor technology. The key to realizing a militarily useful terahertz technology is to drastically increase the level of integration. Hence, a focused research and development (R&D) effort in an all solid-state circuit technology is required to effectively bridge the THz technology gap. Here, the most successful terahertz device technologies (e.g., Schottky and Heterostructure Barrier Varactors and Schottky mixers) should be applied to realize frequency agile and reliable components in a cost effective manner. This R&D effort will target new fabrication techniques and computer aided design tools appropriate for a planar, integrated, solid-state device/circuit technology. Performance goals must include milliwatt transmit power levels, high sensitivity, large bandwidth and, most importantly, suitability for use in military applications. The desired result will be a battery of transmit/receive module prototypes that will lay the foundation for a future generation of THz electronic systems. Once these initial goals are achieved, making additional progress in THz application areas such as remote

sensing, communications and imaging will be reduced to the realm of practical engineering and provide a great service both to the commercial and military sectors of the future.

PHASE I: Conduct a comprehensive analysis of semiconductor-based THz technology suitable for the cost-effective implementation as integrated transmit/receive modules. This will include detailed studies for fabrication process integration, demonstrations of highly accurate computer based device and circuit simulation tools, and the production of designs for sources and receivers that will provide acceptable performance at THz frequencies. Provide demonstrations of THz sub-components, where appropriate, to provide the foundation and feasibility criterion for final technology development.

PHASE II: Demonstrate an innovative, robust and repeatable process for integration of THz devices and circuits on a single substrate. Demonstrate Computer-Aided-Design (CAD) tools with the capability to optimize realistic THz devices and circuits in an integrated architecture. Develop and demonstrate prototype sources and receivers that function to reasonable performance standards at THz frequencies. Implement transmit/receive modules and apply toward a demonstration at THz frequencies that will provide performance and calibration standard results. An ideal demonstration of the prototype system will involve some spectroscopic or imaging application.

PHASE III DUAL USE COMMERCIALIZATION: The technologies developed under this topic will provide a foundation for a new class of remote sensors (i.e. for chemical and biological agents) and an enhanced satellite communication capability (e.g., integrated, cost-effective and wider bandwidth).

REFERENCES:

[1] D.L. Woolard et. al. "Terahertz Electronics for Chemical and Biological Warfare Agent Detection," 1999 International Microwave Symposium, Anaheim, CA, June 13-19.

[2] D.M. Mittleman, R. H. Jacobsen, and M. C. Nuss, "T-Ray Imaging," IEEE Journal of Quantum Electronics, 2, pp. 679-692 (1996).

[3] Z. Jiang and X.-C. Zhang, "Electro-optical Measurement of THz Pulses with a Chirped Optical Beam," Applied Physics Letters, 72, p. 1945 (1998).

[4] F.C. Delucia, "Detectability of Large Molecules in the Millimeter and Submillimeter Spectral Region," ARO Technical Report (1997).

[5] D.L. Woolard et. al. "Feasibility of Submillimeter-wave Technology for the Identification of Biological Warfare Agents," The 4th Joint Workshop on Standoff Detection, Williamsburg, VA, Oct. 26-30 (1998)

[6] K. Phelps, "DoD Chem/Bio Detection Program," presented at the ARO Workshop on Nanostructures, Ga Tech, Atlanta, GA, Oct. 14-16 (1998).

KEY WORDS: Terahertz electronics, semiconductor-based components, chemical and biological sensors.

A00-022 TITLE: High Performance, Multifunctional Fibers Containing Carbon Nanotubes

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop light-weight, multifunctional FIBERS containing carbon nanotubes, that have enhanced mechanical properties and/or unique multifunctional properties compared to conventional fiber materials. What is desired is a multi-component FIBER including carbon nanotubes in the structure of the fiber itself.

DESCRIPTION: Present-day synthesis of carbon nanotube structures is undergoing an explosive growth, fueled by theoretical studies and the promise of unique applications1,2. Highly unusual properties and devices have been predicted and/or observed, including extremely high strength fibers for high performance textiles and composites, nanoscale electronic devices, cold cathode field emission and other effects. The unusual properties of carbon nanotubes suggest that lightweight, continuous fibers incorporating carbon nanotubes will have enhanced strength, elasticity, strength/weight ratios, thermal and electrical properties, compared to currently available long fibers. For example, recent experimental results obtained at the University of Kentucky demonstrated a 150% increase in elastic modulus, 90% increase tensile strength and 350% increase in electrical conductivity when 5% carbon nanotubes were incorporated into pitch-based carbon fiber3. Ultra-high performance fibers are expected to be suitable for a variety of DoD and private sector applications, including personnel and vehicle armor, aerospace materials, high performance textiles and multifunctional materials for advanced device applications, including photovoltaics, thermal management and data transmission.

PHASE I: Demonstrate synthesis and processing of FIBERS containing carbon nanotubes in the fiber structure. Research may focus on carbon-based fibers (i.e. carbon fiber from PAN), ceramic fibers like SiC or B4C (possibly from suitable polymer precursors) or polymer fibers. It is desirable to consider materials and processes that will facilitate interaction between the base material of the fiber and the nanotubes in the fiber structure, which is critical to good fiber mechanical properties. Other properties, including enhanced electrical and/or thermal conductivity should be realized in these materials as well. High-temperature stabilization of nanotubes in processing ceramic-based fibers must be considered. Issues such as dispersion and orientation of nanotubes are important and should be addressed in the context of enhancing or optimizing fiber properties4. Phase I should focus on the synthesis and processing of continuous FIBERS in lab scale quantities, characterization of structure and measurement of properties. Properties should be compared to conventional fibers (without nanotubes) of the same base material prepared as a control. A projection of material costs and the technology needed to reduce costs should be undertaken.

PHASE II: Optimize performance (strength, elasticity, conductivity, environmental stability, etc.) of fibers containing carbon nanotubes and produce in suitable quantities for forming into textiles, fiber reinforced composites or other forms that can be utilized as components for structural or device applications, depending on the properties exhibited by the fibers and the appropriate application. Demonstrate enhanced or unique properties that can be achieved with the new materials in applications, compared to applications using conventional fibers. Components or systems of interest for development in Phase II will be identified by the Army in collaboration with the contractor, based on the properties exhibited by the novel fibers and their applications potential.

PHASE III Dual Use Applications: High performance multifunctional fibers can be used in a variety of applications such as multifunctional composites for structural applications and ballistic protection for law enforcement and security personnel. Fibers with a combination of electrical conductivity, thermal stability and mechanical strength also have potential applications in device technology such as photovoltaics and electromechanical devices and could provide conductive pathways for data or power transmission through structural materials.

REFERENCE:

1. Treacy, et al., Nature, 381, 678, (1996).
2. Sinnott, et al., Carbon, 36(1-2), 1, (1998).
3. Dagani, Chem. and Eng. News, 77(23), 25, (1999).
4. Calvert, Nature, 399, 210, (1999).
5. Windle, et al., Carbon, 36(11), 1603, (1998).

KEY WORDS: Ballistic protection, carbon nanotubes, fibers, nanotechnology, composites, conductivity, nanoparticles, nanocomposites, polymers, materials, textiles.

A00-023 TITLE: Micromachined Integration of RF and Optoelectronic Multi-mode Components

TECHNOLOGY AREAS: Electronics

OBJECTIVE: The objective is the demonstration and development of small, rugged, light-weight, low cost RF and optoelectronic components, with high functionality, using micromachined circuit integration techniques.

DESCRIPTION: Recent research into micromachining circuit integration techniques has demonstrated self-packaged, self-shielded microwave millimeter circuits of very high density and low cost. Very small tunable high Q filters, very low loss power distribution and combining circuits, high Q integrated inductors and capacitors, high efficiency antenna arrays, and other passive circuit elements have been demonstrated. The capability of this technology to provide three dimensional circuit integration, with the potential for flip chip introduction of circuit chips of diverse substrate material has been established. These techniques offer the opportunity for an overarching circuit integration technology capable of integrating planar semiconductor circuits based on different materials into a near monolithic, layered three dimensional, self-packaged component. The resulting components offer the promise of all weather multi-mode integrated sensor components and multi-level signal circuits to reduce the size, weight, and cost of military communications and radar systems, while increasing their functionality.

PHASE I: Demonstrate the design of a micromachined component exploiting the capability for the integration of circuits based on different materials to provide a new capability for communications, surveillance, or guidance, or to perform a sub-system function with lower cost, size, or weight than existing components. Provide modeling, analysis, and/or experimental evidence to support the design.

PHASE II: Fabricate an optimized component. Perform experimental tests to confirm achievement of design specifications. Demonstrate the capability for economical production of large quantities. Develop a commercialization plan for military and commercial markets.

PHASE III DUAL USE COMMERCIALIZATION: At the component level the same kind of applications as in military communications, radar, and guidance systems, will apply to the commercial market place. Many small companies exist to fill these niche applications. Components developed under this SBIR topic will be viable product lines in these markets.

REFERENCES:
T.M. Weller, L.P.B. Katehi, and G.M. Rebeiz, "High-Performance Microshield Line Com-ponents," IEEE Transactions on Microwave Theory and Techniques 43, pp. 534-544, March 1995.

KEY WORDS: micromachining, RF components, photonic components, optoelectronic components

A00-024 TITLE: Wavefront Control and Sensing System based on an Opto-Silicon-Integrated Phase-Contrast Technique

TECHNOLOGY AREAS: Electronics

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Manager, Smart Weapons

OBJECTIVE: Develop a high-resolution wavefront control and sensing system based on VLSI circuits and high-resolution liquid crystal (LC) or micro-machined (MEMS) spatial light modulator technologies. The desired wavefront control system, consisting of an on a chip, pixelated, high-resolution spatial light modulator and an optically and electronically matched photoarray, will be used as a smart phase/amplitude plate in phase-contrast type wavefront sensing and control systems. This integrated controllable phase/amplitude system should utilize on-the-fly analog computation and control to provide high-resolution wavefront control and measurements.

DESCRIPTION: There is an emerging need for inexpensive, small, high-resolution wavefront control and sensing systems capable of real-time wavefront aberration analysis and correction for advanced military adaptive imaging, laser communication and designator systems, and for a number of industrial applications such as visualization of phase objects in micro-technology and medicine, measurements of turbulent air flows and laser beam aberrations. The integrated opto-electronic wavefront control systems developed under this program should implement adaptive and nonlinear functions and provide both compensation of wavefront phase aberrations and high-resolution precision wavefront measurements based on a phase contrast technique. A phase spatial light modulator (SLM) and a photosensitive array should be coupled to provide programmable feedback between the input wave spectrum intensity and phase distributions. Basically, the chip should create a local nonlinearity of the input signal and feed it back to an output through the spatial light modulator. The nonlinearity to be implemented consists of a combination of programmable gains and thresholds at each pixel, identical for all pixels. Because conventional phase-contrast wavefront sensing techniques cannot provide one-to-one mapping of wavefront phase into the output intensity modulation, additional parallel out-of-focal-plane-processing and 2D feedback control may be required to provide linear transformation of the input wavefront phase to a high-resolution wavefront sensor output.

PHASE I: Design and develop prototype integrated opto-electronic wavefront control systems linking a high-resolution phase modulator with a photoarray that uses a smart phase/amplitude structure in a phase-contrast technique that is insensitive to wavefront tilts. Assess performance of chips for adaptive optics and nonlinear information processing.

PHASE II: Integrate the designs. Optimize the interface with the optics and provide linear phase-intensity mapping and wavefront distortion compensation. Develop and demonstrate commercial and military applications, and leverage market opportunities.

PHASE III DUAL USE COMMERCIALIZATION: MILITARY: These opto-silicon-integrated elements will allow future integration of optical elements, digital interfaces, and computer and driving electronics into a single unit. This will result in small, wireless, low-power, high-performance intelligent devices suitable for applications including real-time small target tracking and recognition, aberration-free imaging (adaptive binoculars, sniperscopes, etc), long range laser communication, reconnaissance imaging, and military robots. NON-MILITARY: Recognition and identification systems for medical and industrial applications, free-space communication, and industrial robots.

REFERENCES:
1. R.K. Tyson, Principles of Adaptive Optics, Academic, Boston (1991);
2. M.C. Roggemann, B.M. Welsh, Imaging Through Turbulence, CRC Press, Boca Raton, Florida (1996).
3. D. Malacara, Optical Shop Testing, Wiley-Interscience, New York (1978).
4. V. Yu. Ivanov, V. P. Sivokon and M. A. Vorontsov, "Phase retrieval from a set of intensity measurements: theory and experiment," J. Opt. Soc. Am. A 9(9), 1515-1524 (1992).

KEY WORDS: wavefront control, imaging, opto-silicon integrated systems, smart structures.

A00-025 TITLE: Enhanced Computer Analysis and Computer Aided Design (CAD) of Active Radio Frequency Antenna Arrays

TECHNOLOGY AREAS: Information Systems, Electronics

OBJECTIVE: The objective of this topic is the capability to analyze, optimize, and design very large arrays of active antennas and complex circuits of planar, active components.

DESCRIPTION: The design and optimization of very large arrays of active antenna elements, ie. an antenna element with an active device integrated directly into the structure, simulating the nonlinear devices self-consistently with the electromagnetic analysis, is beyond the capabilities of current commercial CAD software. Recent research results on the computer simulation of large active arrays, on the integration of nonlinear device analysis with linear electromagnetic analysis, on multi-resolution and other techniques to make significant increases in simulation speed, on the parallelization of these models, and on hybrid simulation techniques to exploit different aspect of geometry regularity, provide the opportunity for large increases in the capability to analyze very complex planar circuit structures with active devices in the frequency domain and to optimize them. Multi-resolution time domain techniques provide the opportunity to utilize finite difference time domain techniques for the analysis of large, complex circuits in the time domain. Advances have been made in the modeling of thermal effects of active devices in arrays and the integration of these models with the device and EM models. Thermal effects are proving very important for arrays of active devices and their effects must be considered in circuit analysis and design. CAD software taking advantage of these new techniques will provide the capability for first pass design of packaged microwave and millimeter wave circuits, with a resulting reduction in design cost. Improved CAD is expected to provide denser and therefor smaller integrated circuits, and better performance through better optimization. This is important for commercial communications, radar, and guidance systems, but it is especially important for military systems with low market volume components, where the design cost is a significant fraction of the total cost. This topic proposes the formulation of a CAD capability able to treat much larger and more complex structures than current commercial CAD routines using these newer techniques. References are given below as examples of newer computational techniques, global modeling techniques, and hybrid techniques. These are meant to be examples only. Successful proposals will be expected to be innovative and to provide new capability to commercially available CAD.

PHASE I: Formulate a CAD architecture to treat very large and highly complex circuits. Demonstrate the optimization and design for a reduced level computation of active antenna arrays using only the nonlinear device and EM analysis. Justify the scalability of the architecture to very large arrays and very complex circuits. Provide a concept for a user friendly graphical user interface (GUI).

PHASE II: Scale the architecture developed under phase I to very large problems. Develop the GUI. Provide the capability to self-consistently include thermal effects. Provide a commercialization plan.

PHASE III DUAL USE COMMERCIALIZATION: There has been strong industry interest recently in the capability to design large, complex circuits with a single computer analysis, rather than treating the problem as small pieces to be analyzed separately and integrated in the mind of the designer. Small companies are active in this market, as well as the established CAD companies. This product would exceed current commercial CAD capability and would have a viable market for both commercial and military systems.

REFERENCES:
M.A.G. de Aza, J.A. Encinar, J. Zapata, and M. Lanbea, "Full-Wave Analysis of Cavity-Backed and Probe-Fed Microstrip Patch Arrays by a Hybrid Mode-Matching Generalized Scattering Matrix and Finite-Element Method," IEEE Transactions on Antennas and Propagation 46, pp. 234-242 (February, 1998).

K. Sabet, J.-C. Chen, and L.P.B. Katehi, "Efficient Wavelet Based Modeling of Printed Circuit Antennas and Arrays," IEE Proceedings on Microwave Antennas and Propagation 146, pp. 298-304 (August, 1999).

M.B. Steer, J.F. Harvey, J.W. Mink, M.N. Abdulla, C.E. Christoffersen, H.M. Gutierrez, P.L. Heron, C.W. Hicks, A.I. Khalil, U.A. Mughal, S.B. Nakazawa, T.W. Nuteson, J. Patwardhan, S.G. Skaggs, M.A. Summers, S. Wang, and A.B. Yakovlev, "Global Modeling of Spatially Distributed Microwave and Millimeter-Wave Systems, IEEE Transactions on Microwave Theory and Techniques 47, pp.830-839 (June, 1999).

Special Issue on Global Modeling of Millimeter-Wave Circuits and Devices, IEEE Transactions on Microwave Theory and Techniques 47 (June, 1999).

L.P.B. Katehi, J.F. Harvey, and E. Tentzeris, "Chapter 3: Time-Domain Analysis Using Multiresolution Expansions," in Advances in Computational Electrodynamics, The Finite-Difference Time-Domain Method," ed. by A. Taflove (Artech House, Boston, 1998).

KEY WORDS: CAD, global modeling, circuit optimization, active antenna arrays

A00-026 TITLE: Blast Resistant Glass Facades for Structural Applications

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: To develop and demonstrate new methodologies and technologies for new and significantly improved cost-effective blast-resistant glass facades for structural applications to withstand overpressure effects due to blast loading. Lamination, particulate reinforcement, and other intrinsic and extrinsic strengthening components and mechanisms are sought to control failure, such that glass facades remain anchored, for as long as possible, under large blast pressures, and once failure initiates, that the glass facade break up into harmless fragments or powder. Successful low-cost methodologies and technologies will result in the development of new and significantly improved blast-resistant facades, such that failure can be controlled to withstand and mitigate large-blast pressure effects.

DESCRIPTION: Windows and glass facades are essential elements in building design. However, they are the weak link in facade design, as they will typically fail before any structural element, when the structure is subjected to blast overpressure loading. For workspace and structural protection, windows must be able to resist blast overloads, and then if and when failure initiates, it must be in a controlled manner such that flying glass shards and glass debris do not form. Glass debris and shards have been shown to be one of the major sources of fatalities in structures subjected to blast loading conditions. Furthermore, windows have to be anchored as long as possible, since the amount of blast pressures that enters an occupied space is directly proportional to the fenestration space. Limiting the amount of fenestration will limit the blast effects. Standard annealed glass behaves poorly under blast conditions. Not only are the peak allowable pressures low, but this type of glazing breaks into sharp shards. Several other types of glazing are available for large-scale structures, such as thermally tempered glazing (TTG) and polycorbonate glazing (bullet resistant glass). TTG, under blast loading breaks up into small pieces, which would limit injuries and fatalities. Polycorbonate glazings also have favorable behavior under blast loading conditions. Instead of breaking up into small pieces, it develops small cracks that do not beak up into shards. However, it remains as one piece, which after dislodgment from structural attachments, could be an extremely hazardous large flying object. Furthermore, these glazings, which can be designed to withstand higher pressure loading than annealed glass are prohibitively expensive for large-scale structural applications. In addition, to fail properly, their support and attachment interfacial systems must be properly designed. This has been proven to be extremely difficult and current ad hoc attachment methods are structurally unreliable and expensive.

PHASE I: Demonstrate feasibility by the development of methodologies and technologies for low-cost blast resistant glass. In Phase I, tangible designs of at least one prototype is expected. It should be shown that proposed designs can be scalable and easily integrated and attached within large structural elements. Mechanical behavior and response should be determined and

verified by a combination of impact and blast experiments and computations. It should also be shown that the proposed design has superior blast behavior and is cost-effective in comparison with current glass facade designs and technologies.

PHASE II: Develop a fully integrated design and test environment such that commercially viable facades and windows can be retrofitted and attached into large-scale structures. It is expected that final designs should withstand blast pressures that are higher than those currently in use, and that once attached to structural elements that failure can be controlled to result into breakup of harmless fragments or powder.

PHASE III DUAL USE COMMERCIALIZATION: There are expected to be a large number of dual use applications. New and significantly improved window facades and glazings are needed for blast protection due to explosives, earthquakes, strong winds, and other severe environmental conditions for both military structures and commercial structures. These new glass facades may find applications for secure large-scale commercial and governmental structures, for commercial and military vehicles, transparent armor, aircraft canopies, atrium like designs, and hardened shelters.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Can significantly reduce operational costs due to lower maintenance requirements and significantly improved life-cycle reliability

REFERENCES

Combined AFM/XPS Study of the Failure Surfaces in the PVC Film/Adhesive/Glass System, Vabrik, R. Bertoti, I., Kalman, E., Journal of Adhesion Science and Technology, 1999, 13, p. 97.

On the Origin of Failure Waves in Glass, Bourne, N. Millett, J. Rosenberg, Z., Journal of Applied Physics, 1997 81, p. 6670.

Reliability Analysis of Window Glass Failure Pressure Data, Behr, R.A., Karson, M.J. Minor, J.E.
Journal of Structural Safety, 1991, 11, p. 43.

KEYWORDS: Overpressure blast protection, glazed structures, facade attachments, fenestration, large-scale structures

A00-027 TITLE: Broadband Focused Radar at Ground Penetrating Frequencies for Detecting Mines, Unexploded Ordnance, or Mobility Related Surface Layers

TECHNOLOGY AREAS: Weapons

OBJECTIVE: To produce a fully-mobile, broadband radar system with focused planar beam over approximately 10Mhz to 1000 MHz for the detection of frozen or thawed soil layers and buried objects.

DESCRIPTION: At present, above-ground penetrating radar systems for close-up surveying of terrain are inadequate for the detection of (i) frozen or thawed soil layers, which is important for mobility determination, and (ii) for locating near-surface buried objects such as pipes, waste containers, mines, or unexploded ordnance. Current and emerging horn systems are insufficient for a number of reasons. The frequencies at which the illuminated spot is sufficiently small are too high to penetrate wet soil. Alternatively, unwieldy lower frequency horns are not suitable for coherent signal processing and accurate ranging under the near-field conditions at small standoff distances. Even in the intermediate or far field, their non-planar wave fronts make it difficult to establish unambiguous look direction and timing. The use off-normal incidence is an essential surveying mode. This applies both to subsurface incidence and aboveground incidence angle in the case of elevated antennas. Current imaging systems offer both too much and too little. The processing requirements of tomography or inversion for dielectric content are excessive. The system proposed should offer the option that data can be collected from a substantial standoff distance with off- normal incidence, a mode not seen in subsurface imaging radars. This mode allows innovative signal processing to achieve, in effect, greater resolution and signature detection than current radar systems offer.

Required is a radar system that offers as an option a safe standoff distance of at least 1-2 of meters (i.e. not require contact of antenna with ground). It should accommodate off-normal incidence with crosshair, laser, or other means for locating the illuminated spot, with video record. Minimum reflector or array size is desired, with side lobes ideally more than 20 dB below main beam. The incident beam should be focused at or slightly below ground surface with platform elevation of about 2 meters; 3 dB beamwidth at ground surface should not be greater than approximately 0.5 meter. At the ground surface, the beam should be approximately planar. The system should also offer the option of ground contact or near-contact surveying, for maximum ground penetration, frequency range, and discrimination potential. The system need not consist of only one antenna, but can include a reasonably small number of antennas, each optimized for parts of the frequency range and discrimination task, as long as these can operate in close concert with one another and not unduly impede mobility.

The final radar system should be mobile, with some manner of position determination and/or distance tracking capability. The distance or position information should be co-registered with the radar and video records for mutual coordination. A single

person should be able to move the system smoothly over a surveying transect. A re-orientable antenna support structure should allow an operator to survey to the side of the direction of platform motion. It would be desirable to have the ability to change between horizontal and vertical polarizations (i.e. measuring VV or HH returns) and an ability to measure cross-polarized returns. Transmitted power and dynamic range of the system should be such that (i) a 6cm thick frozen soil layer is discernable at a depth of 30 cm and (ii) a bright reflector (e.g. 30 cm plate or corner reflector) should be discernible beneath at least 30 cm of wet silty soil. Measured data should feature, either directly or by equivalence, amplitude and phase of reflected signal at each frequency relative to known or calibratable transmission amplitudes and phases. Data should be recorded in digital format and be downloadable onto standard storage devices or in such a way that information is easily translatable thereto.

PHASE I: The Phase I work will develop and demonstrate a laboratory prototype broadband radar system featuring at least broadband focusing capability for measurement over a single spot (i.e. non-mobile) on a layered dielectric, with and without representative buried metallic objects such as UXO, successfully discriminating both the layers and the objects.

PHASE II: The Phase II work will develop, test, and demonstrate in the field at selected Army installations, a fully mobile broadband radar system capable of (i) the detection of frozen or thawed soil layers, and (ii) the discrimination of a variety of objects buried in the shallow sub-surface.

PHASE III: DUAL USE APPLICATIONS: This broadband radar system will have broad applicability in the discrimination of buried objects of both military and civilian significance. The usefulness of the system could easily be enhanced by deployment on other, more diverse platforms.

U.S. Army Test and Evaluation Command (ATEC)

A00-028 TITLE: Device to Extract Biological Organisms from Contaminated Surfaces

TECHNOLOGY AREAS:

OBJECTIVE: Design a sampling device to quantitatively recover microbiological contamination deposited on common surfaces.

DESCRIPTION: Testing of equipment, materials and operational procedures to assess the quantity of contamination/decontamination on surfaces requires reliable sampling methods. Currently, certain commercially available devices such as contact slide (Ref.1), culturette (Ref. 2) have shown satisfactory reproducibility when used on smooth surfaces. However, their practical application for uneven surfaces has been inconsistent. Swabbing the contaminated area using a wet swab has shown comparatively better consistency (3). However, individual variation frequently causes inconsistency. Often, minute changes in the size of the swab area create faulty results. In general there is no standardized sampling technique available. This makes comparison of the results very difficult.

The need for a mechanical device to collect samples is therefore warranted. The device should be capable of extracting the samples from a variety of uneven contaminated surfaces like concrete, carpet, office panels, or upholstery. It should be able to remove bacterial contamination when the suspected material is dried up on the surface. The device should be able to collect contamination from a typical area of 2" X2" and suspend it in a 5-10 ml buffer for further processing. Extraction of the contaminated surface using a liquid simultaneously with mechanical force is a suggested method for quantitative removal of the contamination. This device should work on both vertical and horizontal and should be suitable for use in the field. It must have easily-determined collection efficiency ( 90%) and maintain the viability of microorganisms collected.

PHASE I: Design a device to extract the bacterial spores from an approximate area of 2- 4 square inches. The bacteria should be viable in the extracted sample. Fabricate a prototype and perform bench level testing to define and validate the performance of the sampling device.
PHASE II: Once Phase I is completed, the performance and reliability of the device will be tested under expected field use conditions to determine the applicability of the device to supporting biological defense system testing programs.

COMMERCIAL POTENTIAL: This device may have commercial application for sample collection in chem/bio-terrorism scenes, sweat sample from body surface for clinical studies, crime scenes etc.

References:

1. Contact Slide TC (Art.No. 931050): for determination of total counts on surfaces
Biotest AG., Landsteinerstr.5, D-633303 Dreieich, Germany

2. Culturette(R) Becton Dickinson Microbiology Systems, Sparks, MD 21152

3. SWIPE Surface Bio-Sampling Kit, work in progress at U. S. Army Edgewood Chemical Biological Center by Dr. Peter Emmanuel.

KEYWORDS: Chemical/biological sampler, extraction, sampling device

A00-029 TITLE: Remote Detection of Hazardous Chemicals

TECHNOLOGY AREAS:

OBJECTIVE: Design and build a man portable, active optical device for the remote detection of hazardous chemical vapors and residues from clandestine laboratory operations

DESCRIPTION: Clandestine laboratories produce illegal drugs through the chemical synthesis of precursors, reagents and solvents. These illicit laboratories are extremely dangerous because of the hazardous chemicals used for the extraction of the finished product. Strong acids such as muriatic, sulfuric and hydriodic are usually present along with strong bases including sodium hydroxide and ammonia. Volatile elements such as sodium, lithium metal and red phosphorus are also sometimes used. Organic solvents such as ether, chloroform, acetone and alcohols are almost always used.

Occupational Safety and Health Administration (OSHA) and Environmental Protection Agency (EPA) regulations require that clandestine lab investigators be fully certified as hazardous waste responders. Entry into a clandestine lab to asses the area for chemical hazard requires full personal chemical protection. These areas are extremely dangerous and potentially deadly to criminal investigators. The dangers after fire or explosion are compounded since containers have been destroyed and chemical agents dispersed. Processing chemicals with vapors heavier than air settle in depressed areas making them difficult to detect. This environment is even more hazardous for canines trained to alert on fire accelerants.

Volatile hydrocarbon solvents will fluoresce when exposed to ultraviolet radiation. The remote detection of these compounds via their fluorescing properties and other potential fluorescing by-products of clandestine labs such as Phospine gas will greatly assist in initial hazard assessment, thus helping to ensure the safety and personal health of the investigators.

PHASE I: Characterize fluorescence phenomena in materials under laboratory and field conditions that are used in clandestine laboratory operations; develop prototype design concepts and evaluate key system components.

PHASE II: Develop and demonstrate a prototype unit

PHASE III: Downsize to man portable unit. The development of this technology will be advantageous in both military and law enforcement applications. It will allow for the remote detection of hazardous reagents, thereby identifying clandestine narcotics operations and preventing unnecessary contamination and increased safety for civilian law enforcement and National Guardsmen assigned to counterdrug task forces. Use of this technology can be expanded to chemical agent verification on the battlefield, tracking of airborne toxins from chemical weapons disposal or destruction, and identification of petroleum spills and leaks.

REFERENCES: Office of National Drug Control Policy, National Methamphetamine Conference, Omaha, Neb; May 28-30, 1997

Regional Counterdrug Training Academy, Naval Air Station, Meridian, MS "Clandestine Laboratory Investigations" November 2-6, 1998

Encyclopedia of Analytical Instrumentation, "Laser Induced Fluorescence", 1996-97; Science Hypermedia, Inc.

KEYWORDS: Fluorescence, Biological, Chemical Agent, Remote Detection, Clandestine Laboratories, Airborne Toxins

U.S. Army Aviation Research, Development, and Engineering Center (AVRDEC)

A00-030 TITLE: Low Conductivity for Thermal Barrier Coatings (TBCs)

TECHNOLOGY AREAS: Air Platform, Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Manager, Utility Helicopters

OBJECTIVE: The objective of this effort is to develop a new generation low conductivity Thermal Barrier Coating (TBC) that enables a higher allowable gas temperature, to 2800 deg. F , without increasing the component's requirement for cooling air. This technology which will increase rotor inlet temperature, reduce specific fuel consumption (SFC) and increase engine horsepower will have a positive impact on reducing Operating & Support (O&S) costs for future helicopters.

DESCRIPTION: Under the IHPTET program the phase III turbine system objectives address increases in efficiency and rotor inlet temperature, and decreases in cooling flow and weight requirements. In order to meet performance requirements increased turbine-operating temperatures are necessary. Turbine components are already operating in a variety of aggressive environments making them susceptible to surface and mechanical property degradation. Current TBCs that are being used in engine applications commonly fail due to premature spall of the ceramic coating during thermal or thermomechanical load cycling which a coated component experiences during engine operation. For successful operation of engine components at even higher temperatures, new and improved TBCs must be developed. A new generation low conductivity TBC will allow higher turbine inlet temperatures to be employed providing improvements in SFC and Power for the engine.

PHASE I: Working with a gas turbine engine manufacturer, identify and demonstrate the feasibility of a new generation low conductivity TBC that enable gas temperatures to reach 2800 deg. F with a specific conductivity goal of 0.25 to 0.5 W/MK.

PHASE II: In conjunction with a gas turbine engine manufacturer and utilizing the results from Phase I, further develop and demonstrate the new TBC on an engine component for the hot section.

PHASE III DUAL USE APPLICATIONS: The resulting technology will be beneficial to both the military and commercial sectors, being applicable to a wide variety of applications such as the tank, automotive, aircraft, as well as, any other market using engines.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Technologies which provide increases in rotor inlet temperature, reductions in SFC and increases in engine horsepower have a positive impact on reducing O&S costs for future helicopters.

REFERENCES:
(1) Strangman, T.E., 1985, "Thermal Barrier Coatings for Turbine Airfoils", Thin Solid Films, Vol. 127, pp. 93-105.
(2) Herman, H. and Shanker, N.R., 1987, "Survivability of Thermal Barrier Coatings", Materials Science and Engineering, Vol. 88, pp69-74.
(3) Andersson, C.A., et al., 1982, "Advanced Ceramic Coating Development for Industrial/Utility Gas Turbine Applications", NASA CR-165619.

KEYWORDS: TBC, Coatings, Low Conductivity

A00-031 TITLE: Comanche Tactics and Survivability Expert Planner

TECHNOLOGY AREAS: Information Systems, Human Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Assistant Project Manager, Comanche Program Managers Office

OBJECTIVE: The objectives of the Comanche Tactics and Survivability Expert planner are to provide the pilot with identification, rapid prototype development and assessment of information system/AI technologies to support Comanche tactics training, planning, and informed weapon system employment.

DESCRIPTION: The development of Cognitive Decision Aiding processes for the Comanche are critical to the mission effectiveness of the platform. With multiple sensors, RF information, and accurate navigation systems the pilot's ability to accurately correlate multiply sets of data and make correct decisions will be difficult without the use of a Tactics Expert Function. The Comanche Tactics and Survivability Expert Planner will enable the weapon system in achieving enhanced survivability and target lethality. The Comanche weapon system incorporates significant technical advances in virtually all its major subsystems. To fully exploit the potential of this advanced, multi-mission weapon system there is a need for effective planners and decision aids to support mission planning and tactical employment.

A Tactics Expert system is needed to identify aircraft vulnerability to threat detection and indicate/recommend courses of action that maximize target detection/kill while minimizing own-ship vulnerability. Of particular interest are technologies that can support real-time/near real-time operations. Research is needed to identify integrated solutions that provide a linkage between training/planning and real-time decision support.

In addition, approaches are needed that foster cognitive readiness of the crews through consistent and reinforcing tools and methods that transition from training and planning to tactical decision support. The sought after solution will incorporate the effects of significant battlefield conditions including environments, threat capabilities and weapon system operational modes and

expected performance. The approach should also provide for learning and adaptation of the model based on actual experience; for example during the course of a campaign the system should be capable of self-update based on the current conditions and mission results. The cockpit implementation must be capable of rapid execution to support real-time/near real-time crew interaction. Therefore, the research effort should emphasize rapid prototyping and assessment environments to support investigation of alternative tactical display and decision aid approaches with particular emphasis on crew/weapon system interaction and decision support needs and processes.

PHASE I: Technology survey and assessment vs. the need. Develop demonstration level applications of promising technologies.

PHASE II: Rapid prototype development and assessment of technologies identified in Phase I. The focus of Phase II will be on key planning functions.

PHASE III DUAL USE APPICATIONS: Phase III will implement the Tactics Expert Planner developed in Phase II, and will assess real-time application of the Tactics Expert for Comanche deployment. Potential military applications for the Tactics Expert (beyond Comanche) include other Army aviation platforms, Air and Missile Defense Deployment and Fire Control, and MLRS re-supply planning. Decision support technology (including near real-time capability) resulting from this effort would have significant commercial potential. For example, e-commerce is a strong candidate. In this application rapid decisions that generate tailored proposals to the specific business conditions is a critical need. Data Mining is a second major area for spin-off applications. Relevant data mining applications include Credit Experts, Inventory Expert Planners and Logistics Expert Planners.

REFERENCES:

1. Dawid, P. 1992, "Applications of a general propagation algorithm for probabilistic expert systems", Statistics and Computing, 2: 25-36.

2. Heckerman, D. 1997, "Bayesian Networks for Data Mining", Data Mining and Knowledge Discovery, 1: 79-119

3. Musman, S., Chang, L.W., Booker, L. 1993, "Application of a Real-Time Control Strategy for Bayesian Networks to Ship Classification Problem Solving", International Journal of Pattern Recognition and Artificial intelligence, Vol. 7, No. 3.

4. Oliver, R., and Smith, J., Influence Diagrams, Belief Nets, and Decision Analysis, Wiley, 1990.

5. Pearl, J. 1986, "Fusion, propagation and structuring in Belief Networks", Artificial Intelligence", 29: 241-288.

6. Spiegelhalter, D., and Lauritzen, S., and Cowell, R. 1993, "Bayesian analysis in Expert Systems", statistical Science, 8: 219-282.

KEYWORDS:
Expert system, decision aid, tactics expert, survivability planner, cognitive readiness, information system (IT), AI

A00-032 TITLE: Wing-Store Unmanned Aerial Vehicle

TECHNOLOGY AREAS: Air Platform

OBJECTIVE: The objective of this program is to develop and demonstrate an air-launch, wing-store unmanned aerial vehicle (UAV) for target acquisition and battle damage assessment (BDA) to improve helicopter aircrew situational awareness, effectiveness, and survivability.

DESCRIPTION: Current UAV systems rely on Ground Control Stations and nearby launch/landing sites to conduct teaming operations (UAV working with helicopter). Furthermore, for the UAV and manned helicopter to work together, in-depth coordination and communication must take place between the GCS and the aircrew. A UAV that can be carried, launched and controlled by the air platform itself will greatly increase the aircrew's autonomy and reduce communication and coordination with range limiting GCS's.

The wing-store UAV will provide the attack/reconnaissance/surveillance aircrew with an expendable, off-aircraft sensor that they can use at their discretion when they need to. Situations may include: identifying enemy locations, assessing safe ingress/egress routes, acquiring targets, acting as a decoy or communications relay platform, and performing battle damage assessment. The wing-store UAV would be programmed by the aircrew and then launched. During the programmed route/loiter the UAV would transmit video images to the aircrew and to ground forces, as required. The UAV will incorporate an in-flight, re-programmable capability so that the aircrew can redirect the UAV for follow-on tasking. Helicopters that the wing-store UAV are envisioned to team with include: AH-64 Apache, RAH-66 Comanche, UH-60 Blackhawk, and SOF platforms.

GOALS: Cost goal is under $20k. Other goals include: flight programmable, range of 50 km, weight less than 75 lbs, flight time greater than 60 minutes with time to target at 25km under 6 minutes (~ 135 kts), and loiter time at least 45 minutes.

PHASE I: The Contractor would be expected to perform a preliminary design study of the wing-store UAV, propose a vehicle design that would meet the concept, and provide a preliminary cost estimate (per unit) for production quantities of 100, 500, and 1,000 units. Proposals would be expected to address the air vehicle, sensor package, data transmission, method of launch, and issues that would effect air-launch such as movement of launching aircraft (hover/forward flight) and helicopter downwash.

PHASE II: The Contractor would be expected to develop the wing-store UAV based on the preliminary design from phase I, integrate the hardware and software into a prototype vehicle, refine the per unit cost estimate, test and demonstrate the vehicle. Demonstration would be expected to include flight of the UAV with preprogrammed waypoints, sensor demonstration with video link to a ground station, and in-flight retask.

PHASE III: The Contractor would be expected to further develop the wing-store UAV and perform a flight demonstration of the system with air-launch from a manned helicopter. Launch and mission accomplishment would be assessed. Commercial applications such as search & rescue and aerial police surveillance would be explored.

REFERENCES:

Herrick, Katrina, Highlights of Trends and Growth in Civil UAV Markets, December 1998
http://www.auvsi.org/auvsicc/faaisg/ppt/markets.htm

Hewish, Mark. "A Bird in the Hand", Jane's International Defense Review, Nov 99, pp. 22-28.

Kumar, Rajesh. Tactical Reconnaissance: UAVs Versus Manned Aircraft, March 1997
http://www.au.af.mil/au/database/projects/ay1997/acsc/97-0349.pdf

Peterson, Maj Allen L. and Kuck, Kristopher F. "Teaming Airborne Manned and Unmanned Systems", Army Research Development and Acquisition, Jan-Feb 99, PB 70-99-1, pp. 39-40.

SWB Turbines, Inc. http://www.swbturbines.com

Wullenjohn, Chuck. "Unmanned Aerial Vehicles Demonstrated Where They're Tested", Army Research, Development and Acquisition, Nov-Dec 98, PB 70-98-6, pp. 30-31.

KEYWORDS: Sensors, UAV, wing-store, air-launch, manned-unmanned, teaming.

U.S. Army Communications and Electronics Command (CECOM)

A00-033 TITLE: Retrofit Antijam Applique for Handheld GPS Receivers

TECHNOLOGY AREAS: Electronics

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Manager Global Positioning System

OBJECTIVE: Develop a low-cost Global Positioning System (GPS) antijam applique that retrofits into the antenna subassembly of handheld GPS receivers and provides cancellation of narrowband and wideband interference in L1 and L2 bands using minimal power.

DESCRIPTION: In the modern battlefield the land warrior has become increasingly dependent on GPS for providing location information for Situation Awareness. There is a need for robust GPS reception in high interference environments. Current legacy handheld GPS receivers like the Precise Lightweight GPS Receiver (PLGR) AN/PSN-11 offer limited antijam provisions, and restrict size and battery power drain making most adaptive spatial, spectral, analog and temporal nulling techniques difficult to implement as handheld appliques. To extend the service life and expand the operational capabilities of the large number of legacy GPS receivers there is a requirement that relatively inexpensive, smart antenna appliques be developed. The smart antenna applique should be a direct replacement for the current antenna. Power should be obtained from existing batteries where operation is manually activated only when jamming is detected. A jam indicator and interference signal level measurement can be provided in combination with directional capability. Jammer direction can be operator determined and nulled upon manual activation or performed automatically. The low-cost design is expected to process GPS P-code, provide cancellation for continuous-wave (CW), narrowband and wideband interference up to 100% of the band, and preserve the GPS signal information content and carrier delay in jamming and non-jamming environments. Antijam performance shall cover a limited sector around

the jammer direction with minimal effect on GPS reception. The applique should be approximately the same size as the current built-in antenna subassembly.

PHASE I: Define an innovative smart antenna antijam applique that provides a attenuation of jamming in the P-code bandwidth for L1 and L2 bands. The design should be suitable for legacy handheld GPS receivers, operate in the military environment and dissipate minimal power in operate and standby modes. The design will mechanically and electronically interface with legacy handheld GPS receivers and require no change to the receiver. As a goal in standby mode, provide a positive indication of interference. Phase I will demonstrate the feasibility of the design through analysis, modeling or breadboard hardware.

PHASE II: Conduct the design, fabrication, and test of the smart antenna applique concept defined in Phase I. Testing and demonstration should include effectiveness against CW, narrowband and wideband noise jamming, and characterization of GPS performance in a simulated environment. Address the transition of the design to low-cost, high-volume, production.

PHASE III DUAL USE APPLICATIONS: There is significant interest in GPS interference at the Federal Aviation Administration due to safety of flight issues. General aviation is becoming increasing dependant on GPS. Private pilots typically use handheld receivers. Integrated, low-cost A/J solutions suitable for dismounted military applications would be ideal for civilian use.

KEYWORDS: GPS; Antijam; Applique; Handheld Receivers; PLGR, DAGR.

A00-034 TITLE: Interoperability between Modeling and Simulation Applications and Army Command and Control (C2) Systems for Planning/Decision Support

TECHNOLOGY AREAS: Information Systems, Human Systems

OBJECTIVE: To develop approaches for interoperability standards between M&S applications such as constructive force-on-force simulations with live Army Tactical Command and Control Systems (ATCCS) for planning/decision support. This will enhance the Army's capability in creating a realistic simulation/ stimulation environment to rapidly train the medium bigade with the introduction of new C2 technology.

DESCRIPTION: The overall objective of the proposed research is to demonstrate the utility of the Department of Defense (DoD) High-Level Architecture (HLA) or alternatives for Modeling and Simulation (M&S) to support battlefield interoperability in Command and Control (C2) operations and to allow warfighters to "train as they fight." This approach will leverage Government investment in simulation technology by integrating it with fielded systems to provide capabilities for mission planning, execution monitoring, replanning, and embedded training. The project will investigate the use HLA or other alternatives as a means of seamless information exchange between battlefield functional areas and for integrating constructive simulations in a collaborative, virtual Tactical Operations Center (TOC). The integration of live and virtual components will create a realistic simulation/stimulation environment to support the refinement/development of tactics, techniques and procedures (TTPs) and warfighter training allowing forces worldwide to train in their command posts (CPs) using organizational equipment, with a minimum of overhead. This modeling & simulation capability is essential for the rapid introduction of new C2 technology, the development of advanced concepts and the means to rapidly train the medium brigade.
The use of HLA, as a DoD mandated standard, will first be investigated to facilitate the interoperability of C2 systems and constructive force-on-force simulations that will result in an integrated environment to support Course of Action (COA) Analysis, mission planning and rehearsal, and commanders decision support. Since the development paradigm used in the implementation of Army tactical C2 systems software and the HLA Run Time Infrastructure (RTI) distributed processing software are inherently different, a seamless integration that will be non-intrusive to the warfighter's tactical C2 application may not be feasible. In this case, alternative simulation software architectures will be investigated to meet the objectives.

PHASE I: The results of requirements capture will be documented in the form of a technical report. This report will provide insight into the C2 systems, their capabilities, and processes within the context of the problem space. In addition, this report will include an analysis of the potential impact of warfighter simulations from a mission rehearsal and training perspective. The second deliverable will be a prototype C2 Object Model and its accompanying class hierarchy representation. The C2 Object Model will provide an initial look at standardization of information exchange among C2 systems within the context of the HLA. In the event that a mapping to HLA services does not seem feasible, alternative software architectures will be investigated and reported.

PHASE II: A prototype environment will be developed to demonstrate the feasibility of the Object Model developed in Phase I. This will include the scenario developed to facilitate demonstration of this capability. This prototype will serve as the primary means of showing the applicability of the HLA to the problem area. The prototype will serve as a testbed for incorporating the results of further research in this area.

PHASE III DUAL USE APPLICATIONS: Distributed modeling and simulation environments have immediate application to many commercial industries, which could benefit from distributed development environments. One primary example is the use of distributed simulation techniques by the entertainment industry for distributed on-line interactive games.

REFERENCES: Department of Defense Modeling and Simulation Master Plan, October 1995

Medium Brigade - Commerce Business Daily, Posted in DBDNet on November 5, 1999 (Printed Issue Date: November 9, 1999), From the Commerce Business Daily Online via GPO Access (cbdnet.access.gpo.gov), Subject: Modification to Special Notice on Systems to Equip a New Brigade Organization

KEYWORDS: Modeling and Simulation, High-Level Architecture, Command and control, Course of Action Analysis, Decision Support, Simulation, Software Architecture, Object Model

A00-035 TITLE: Photovoltaic (PV) Solar Panel Camouflaging

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Electronics

OBJECTIVE: Low-visibility solar panels for remote battery recharging.

DESCRIPTION: Investigate and select approach to modify the reflective properties of phtovoltaic (PV) silicon cells to obtain solar cells of different colors (black, green, brown, etc.). Colors to be investigated should be specified in MIL-C-46168D, with emphasis on black 383, green 383, brown 383, and tan 686A. In addition, the special reflectivity in the near infrared (700-900 nm) should be characterised. The cells will be used for the development of PV solar panels with minimal visual detectability for battery recharging in forward area special missions. The development of comouflaged solar cells is particularly important with the advent of the fielding of significant numbers of rechargeable batteries.
In addition, the technology could be applied to flexible PV solar panels to be mounted on tent tops and vehicle roofs and covers. This would be of particular applicability to the Medium Brigade, since it could provide a source of silent auxiliary power.

PHASE I: Investigate techniques and select the most viable approach to produce PV silicon cell of different colors for primary use in military applications (consideration should be given to durability of cell performance). Apply the selected approach to produce sample cells of at least the four difference colors (black, green, brown and tan) to demonstrate the feasibility of the approach. Test and evaluate the sample cells to determine and quantify the effect of the modified spectral reflectance on the cell power generation and conversion efficiency under 1 sun normal illumination condition. (It is expected that the camouflage technique could produce solar cell panels with conversion efficiency approximately 85-90% as high as the standard AR coated panel modules.)

PHASE II: Prototype camouflaged solar panel using combination of cells of different colors. Design camouflaged solar panel with a peak power output of 20 watts. Fabricate 20 fieldable devices for test and evaluation.

PHASE III DUAL USE APPLICATIONS: Architects consider solar cell modules often unaestetical. From their point of view solar cells can only be an integral part of the building, as a whole if, besides the typical blue colored panels, there are also different colors available. The technique investigated and selected for military panels camouflaging with minimal losses in conversion efficiency can be utilized in the private sector. This will result in a larger production and lower cost of colored silicon cells..

REFERENCES: National Renewable Energy Laboratory

Medium Brigade – Commerce Business Daily, Posted in DBDNet on November 5, 1999 (Printed Issue Date: November 9, 1999), From the Commerce Business Daily Online via GPO Access (cbdnet.access.gpo.gov), Subject: Modification to Special Notice on Systems to Equip a New Brigade Organization

KEYWORDS: Photovoltaic (PV) Solar Cell

A00-036 TITLE: Rapidly Deployable Shelter Extension Module System

TECHNOLOGY AREAS: Ground/Sea Vehicles

OBJECTIVE: The objective of this task is to design, develop, prototype, and demonstrate an extension module system for a military tactical shelter assemblage to replace/augment the current tentage in order to decrease the setup/breakdown timeline of Tactical Operations Centers (TOCs) and command posts (CPs), therefore increasing field mobility and troop productivity.

DESCRIPTION: Shelter extension concepts such as those of interest here will be essential elements of integrated command, control, and communications (C3) within the Transition (Medium) Brigade planned for the future. In being part of a more deployable force, C3 shelter extension concepts will be key contributors to enhanced battle zone mobility. The complexity of the systems and number of shelter assemblages that comprise TOCs and CPs on the battlefield today has resulted in a setup/breakdown time that is unacceptably long. One of the driving factors in this regard is the number of tent systems that must be erected and the number of computer and communications systems that are remoted to the tent area from out of the shelters, with their corresponding power and data cable runs. This effort shall develop an extension module system for a military tactical shelter assemblage composed of rigid or semi-rigid panels, which shall replace the Standardized Command Post System (SICPS) tent system currently used and shall create a workspace comparable in size to the SICPS tent. For the purpose of this topic, a shelter assemblage will consist of a SICPS shelter mounted on a HMMWV, although it is desired that the module system be capable of installation on varying shelter sizes and types. The extension system shall be designed so as to be permanently installed on the shelter assemblage and shall be retracted when the system is on the move and deployed when the system is on the halt. The system shall incorporate integral AC and DC power receptacles and data ports for the deployment of tactical computer and communications systems in the extension workspace area. The system shall be designed to comply with current transportability and safety standards of tactical shelter/vehicle assemblages, and shall be designed with a minimum impact upon vehicle payload as possible. In addition to these size and weight considerations, the system shall be designed so as to facilitate deployment and stowage, as system setup/breakdown time is the driving factor of this topic. Desired deployment and stowage times are less than ten minutes. It is also desirable that the current SICPS tentage currently used be able to work with this new system in order to increase the size of the workspace available in a TOC or CP area where several shelter assemblages are collocated. The system developed must be capable of being installed on new shelters as well as retrofit onto existing shelters.

PHASE I: The contractor shall design a Rapidly Deployable Shelter Extension Module System as described above that shall be easy to operate and require minimal troop involvement. The contractor shall then generate the detailed design of the system with special emphasis on components deemed to be critical, including but not limited to, the deployment/stowage mechanisms, shelter assemblage interfaces, materials and integration issues. The offeror shall develop a virtual prototype (CAD model) showing the operation of this design and formulate a comprehensive parts list.

PHASE II: The contractor will develop, fabricate, and demonstrate the fully operational Rapidly Deployable Modular Shelter Extension Module System designed in Phase I. The contractor will provide two prototype systems installed on contractor provided SICPS shelter assemblages. These modified shelter assemblages shall be tested in accordance with current Army practice, and their performance and operational effectiveness shall be evaluated.

PHASE III DUAL USE APPLICATIONS: While increased operational tempo is not typically a requirement for dual-use applications, it is envisioned that a similar system would be marketed commercially based on its simplicity of use and ease of deployment, as it is these features that allow for the increased OPTEMPO in the tactical environment. This simplicity and convenience would be the driving interests for other agencies that use mobile facilities (police/fire/rescue departments, municipal governments, environmental testing agencies) and by other parties such as users of recreational vehicles, and mobile catering or vending facilities.

REFERENCES: Medium Brigade - Commerce Business Daily, Posted in DBDNet on November 5, 1999 (Printed Issue Date: November 9, 1999), From the Commerce Business Daily Online via GPO Access (cbdnet.access.gpo.gov), Subject: Modification to Special Notice on Systems to Equip a New Brigade Organization

KEYWORDS: Shelter, TOC, Command Post, HMMWV, SICPS

A00-037 TITLE: Individual Profile Centered Interactive Tailored Information Visualization for Semi-Autonomous Command Post (CP)

TECHNOLOGY AREAS: Information Systems, Human Systems

OBJECTIVE: Develop an interactive profiling and custom tailored information visualization technique to build a semi-autonomous Command Post (CP) which can rapidly and intuitively provide critical information to the commander based upon his individual profile preference.

DESCRIPTION: Effective information visualization is key to the warfighter's decision-making process. It is highly individual dependant as each commander reacts to the same information quite differently for the similar mission based upon his/her past experience, personal preference, or priority. The effective CP should accommodate this individual profile. Utilization of this profile technology in information visualization and processing can solve the infamous information overload syndrome. The goal is to provide the commander critical information in the most commander relevant and intuitive manner. Profiling technology, including custom tailored visualization coupled with multi-modal technology, will provide the decision makers ability to interact and interface intuitively with the information space. The Tactical Operations Center (TOCs) or CPs are not simply a physical structure, but more of temporal and spatial space which can be defined only when commander and information interface. This would significantly enhance the commander's cognitive readiness and decision-making process. The desired information technology will be totally portable, modular and scalable, supporting various echelons and mission.

The specific goal of this program is to develop efficient profiling technology, and apply it to custom tailored visualization.

The CP XXI and Medium Brigade concept would be the primary platform to implement this technology. This information technology also will have strong Dual Use application ranging from Smart home to individual workstation.

PHASE I: Select remote sensing technology suitable for remote identification. Investigate and develop profiling technique including profile information collection and process algorithm, and database. Develop methodology to incorporate the profile information in custom tailoring information visualization, and couple them with multi-modal technology to interface with the CP. Conduct the concept feasibility demonstration.

PHASE II: Refine and expand profiling technique including database and interface to visualization application tools. Experiment information visualization customization by using various profiles. Integrate them with multi-modal systems. Fabricate and demonstrate an interactive functional prototype. Expand the capability for multi-user environment.

PHASE III DUAL USE APPLICATIONS: The outcome of this program has extremely wide applications for both military and commercial areas such as smart home, smart information presentation, autonomous information filtering and dissemination based upon profile.

OPERATING AND SUPPORT COST (OSCR) REDUCTION:

KEYWORDS: Semi-Autonomous TOC, Profiling, Smart Database, Remote Sensing.

REFERENCES:

1. http://cself27.leeds.ac.uk:8010/jason/Thesis/Chapter4.html - Collaborative Visualization

2. http://www.ausinfo.com/Products/Software/Cidrs/overview.html - The Commander's Information Display and Retrieval System (CIDRS)

3. http://www2.covis.nwu.edu/papers/CoVis_PDF/PeaAAAS94.pdf - Distributed collaborative science learning using scientific visualization and wideband telecommunications

4. http://www.covis.nwu.edu - Learning through Collaborative Visualization (CoVis)

5. http://yezdi.www.media.mit.edu/people/yezdi/AGENTS-SUMMARY.HTML - Agents, infobots, knowbots, etc

6. http://www.almaden.ibm.com/almaden/npuc97/1996/selker96.htm - Dr. Ted Selker

7. http://www.cs.umbc.edu/kqml/papers/kqml-acl-html/section3.4.html - KQML Software Architectures and language

8. http://www.agentbuilder.com/AgentTools - IA tools and technology update

9. http://ai.about.com/compute/software/ai/msubsoftware.htm - software agent tools and languages

10. http://www.cs.umbc.edu/kqml - KQML

11. http://www.ausinfo.com/kbdt - CECOM, C2SID Phase II SBIR. Austin Info Systems and EER Systems have combined their Battlefield systems programming..(Ref: Dr. Israel Mayk)

12. http://www.cyc.com/publications.html - Knowledge bases, upper CYC ontology, CYCL language.

13. http://www.wil.utoronto.ca/profiles/foxpro.html - Constraint-based Retrieval of Engineering Design Cases: Context as constraints Taner Bilgic and Mark S Fox

14. http://www.aaai.org - A Generic Knowledge-Base Browser and Editor, S. Paley, J.D. Lowrance and P. D. Karp, SRI International, 1997 proceedings AAAI-97/IAAI-97, American Association for Artificial Intelligence.

15. http://www.ftc.gov/bcp/profiling/991108agenda.htm - Public Workshop on On-line Profiling technology

16. http://www.neurometric.com - performance profiling

Medium Brigade – Commerce Business Daily, Posted in DBDNet on November 5, 1999 (Printed Issue Date: November 9, 1999), From the Commerce Business Daily Online via GPO Access (cbdnet.access.gpo.gov), Subject: Modification to Special Notice on Systems to Equip a New Brigade Organization

A00-038 TITLE: Integrated Computer Mouse (ICM) For On-The-Move Operations

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Develop a computer mouse integrated within the soldier, such as a soldier's glove, to allow the soldier on-the-move to accurately pick software icons while in tactical situations. This integrated mouse will reduce any difficulties in computer operations due to relative motion between the soldier and the computer interface from a bumpy, vibratory tactical environment.

DESCRIPTION: The increased use of computers within the Armed Forces has put a strain on the soldiers in the field concerning the ease of use of these systems. Moreover, the harsh tactical environment seen in the battlefield creates an additional computer operation problem due to the relative motion differences between the soldier's hands and the computer interface (i.e., touch screen, mouse, etc.). This problem will become increasingly apparent as future battlefield concepts become a reality, such as the Transition (Medium) Brigade, where the "lighter and more lethal" doctrine requires significantly higher mobility. It is a difficult task to accurately navigate a computer mouse that is attached to the vehicle when the soldier is experiencing a separate random motion from the movement of the vehicle. As an example approach, the soldier can simply operate the Integrated Computer Mouse (ICM) between his thumb and index finger, where relative motion between the soldier and the computer is eliminated. The soldier can then more accurately operate the computer software while being bounced around in harsh terrain. Any ICM approach must be: removable; have a connector to unplug the glove/device with a safety release if the glove/device is ripped from the cable in the event of egress; capable of withstanding the harsh tactical environment (vibration, high temperature, low temperature, humidity, cable pull, rain, salt fog); and must not interfere with the soldier's ability to perform his duties (i.e., gripping if a glove approach is used). If a glove is used, it must be DOD issue gloves and all types must be considered.

PHASE I: The contractor shall define the preliminary design of the ICM, identify the key components, and validate the design with computer modeling. In addition during Phase I, the contractor shall develop the mechanical design of the system concept considering the environmental concerns and the safety of the soldier. In addition, a study concerning the compatibility of the ICM with existing and future DOD computer systems must be performed. The contractor must also develop a test plan to test all operational, mechanical, electrical, and human factors issues during Phase II.

PHASE II: Phase I design work will be refined and advanced, working toward the design of an initial prototype. Electrical and mechanical design work will be completed and the contractor shall fabricate a minimum of 10 fully functional prototypes and demonstrate them with contractor supplied military computers or surrogates. These prototypes will be rigorously tested and evaluated by the contractor based upon the test plan previously developed during Phase I.

PHASE III DUAL USE APPLICATIONS: This type of computer hardware may have potential for use in manufacturing businesses involving excessive vibration to enable the operator to accurately control computer operations. Additionally, remote equipment operations, where the computer operator must repeatedly return to the computer from his workstation, can now be remotely operated with a mouse to increase the worker's production rate.

REFERENCES: Medium Brigade - Commerce Business Daily, Posted in DBDNet on November 5, 1999 (Printed Issue Date: November 9, 1999), From the Commerce Business Daily Online via GPO Access (cbdnet.access.gpo.gov), Subject: Modification to Special Notice on Systems to Equip a New Brigade Organization

KEYWORDS: Integrated, Mouse, Glove, Tactical

A00-039 TITLE: Truth Maintenance /Belief Revision in Data Fusion Systems for Enhanced Information Trustworthiness

TECHNOLOGY AREAS: Information Systems, Human Systems

OBJECTIVE: Develop a Truth maintenance / Belief Revision (TM/BR) tool which increases the trustworthiness of data base information in a data fusion environment. Provide a realistic demonstration of the tool's ability to increase tactical information trustworthiness.

DESCRIPTION: The goal of this project is research and development that will lead to an enhanced tool supporting automated reliability improvement of the battlefield tactical picture in Situation Awareness (SA)/Data Fusion (DF) systems. TM/BR is a scientific technology area that maintains logical consistency of dynamically changing databases. The problem is that current SA/DF are implemented in systems having no capability for data base veracity, in which the data bases are populated by sources which often provide conflicting and illogical information. Once an operator attempts to fuse and understand data base information with conflicts, this can easily misdirect SA reasoning processes to completely incorrect results within a SA system, without the operator ever knowing what is happening.
This effort will attack this problem by advancing the state of the art in automated truth maintenance/belief revision systems to SA databases in data fusion systems. Focus will be on the management of uncertain, fuzzy truth and belief in military data fusion systems for SA.
These systems contain two components: a data fusion engine to reason with spatial, temporal, and operational data, and a TM/BR system to detect logical inconsistencies in the supporting database for the data fusion engine.

PHASE I: Research TM/BR methods which can be practically exploited to increase the reliability of an existing tactical SA application databases using a simplified data fusion model. Provide for the measurement of the database information integrity, and demonstrate it.

PHASE II: Extend the reseach into other areas for improving the information trustworthiness and demonstrate the degree of database improvement in a realistic demonstration.

PHASE III DUAL USE APPLICATIONS: Implement the Phase II methods in a realistic SA/threat system using a realistic implementation of the JDL data fusion model. Deliver source code to government. Include the TM/BR in commercial database products such as Oracle, Sybase, and others.

REFERENCES: Forbus, K.D., and deKleer, J., "Building Problem-Solvers", The MIT Press, Cambridge, MA, 1993.
Gardenfors, P., "Belief Revision: An Introduction", Cognitive Science, Dept. of Philosophy, Lund University, Lund, Sweden.

KEYWORDS: Truth maintenance, belief revision, information trustworthiness, data fusion, data fusion model

A00-040 TITLE: Geolocations with Distributed SIGINT Sensors

TECHNOLOGY AREAS: Information Systems, Sensors

OBJECTIVE: Research and develop new high accuracy/performance geolocation algorithm that optimally processes a set of signals/information from many different/separate SIGINT sensors distributed over wide areas around the target emitters in order to have accurate geolocations and wide detection coverage.

DESCRIPTION: This project will investigate and develop a new algorithm of a high geolocation-performance by exploiting advantages associated with many SIGINT platforms/sensors. These platforms/sensors distributed over various terrain and air space can collect a set of common emitter signals in different location aspects and noise environments. New algorithm will utilize all these signals in an optimally coordinated way for geolocation accuracy improvement. These participating platforms will have different channels, number of sensors, performances, and signal/platform dynamics. The target algorithm should not only properly deal with their differences but also take advantage by integrating their shared aperture and signals/information for optimally higher performance than that of the geolocation algorithm with the case of a separate individual SIGINT platform. The information and net-synchronization signals shared among platforms as well as the means of transmission/reception have to be judiciously selected in order to maximize their individual and collective covertness. A wide range of platforms should be considered in this development and the algorithm has to be flexible enough in order to be suitable for the various processing capacities of different platforms. The platforms may range from small and expendable remote sensors or portable software radios to large and high performance airborne or ground SIGINT systems. The algorithm should be flexible for working with varying number of sensors or platforms. The main sub-topics under this development may include space-time-frequency processing with random array for near and far sights, accurate time synchronization among sensor platforms, and various geolocation techniques (such as Angle-of-Arrival (AOA), Time-Difference-of Arrival (TDOA), Frequency-Difference-of- Arrival (FDOA)) with various static/dynamic sensor platforms.

PHASE I: Research and explore the geolocation system principles and concept by models, analyses, and simulations. Estimate achievable performances and computational complexity in relationship to physical parameters. Compare the system performance improvement over the currently existing discrete or semi-discrete SIGINT geolocation systems. Develop a system model on which design of the software/hardware can be based during the subsequent phase. Develop the test of demonstration configurations and plan for the phase II.

PHASE II: Develop algorithm and integrate its software in a set of prototype hardware for operating in an environment of JTRS-like (refer to Joint Program Office for the Joint Tactical Radio Systems) software radios or Force XXI Battle Command Brigade and Below (FBCB2) computers in US Army Future Scout reconnaissance vehicles. Refine the previously developed plan and test/demonstrate in laboratory and demonstrate in field. Analyze and validate the test data in reference to the analytically predicted performances.

PHASE III DUAL USE APPLICATIONS: This new synchronized diversity combining or space-time beamforming processing technique can be used in commercial/military PCS basestations and other communication systems in order to enhance communication performances/robustness/range, the flexibility of antenna locations and user capacity. The geolocation technique can be directly applicable to law enforcement and emergency services for locating multiple target radios. Malfunctioning or modified radios may not work cooperatively for PCS built-in location system and requires external geolocation system in order to reduce undesirable disruption which may include inadvertent jamming due to radio malfunction.

REFERENCES: 1. http://abop.monmouth.army.mil, Broad Agency Announcement DAAB07-00-R-K501; 2. Radio Direction Finding and Superesolution, IEE Electromagnetic Waves Series 33, Peter Peregrinus Ltd., P.J.D Gething; 3. Principles of Apperture and Array System Design, John Wiley and Sons, Bernard D. Steinberg
4. Cyclostatiionarity in Communications and Signal Processing, William A. Gardner; 5. A PSP Antenna Array Receiver for Joint Angle, Multipath and Data Estimation, GLOBECOM'97, Nov. 97, G. Paparisto, K. M. Chugg, N. E. Lay, and A. Polydoros; 6. Higher-Order Spectra Analysis, Prentice Hall, Chrysostomos L. Nikias; 7. Other references on topics of geolocations, software radios, direction finding

KEYWORDS: SIGINT, JTRS, Space-Time Adaptive Processing, Geolocation, Random Array, Beamforming, Diversity Combining, Net Time Synchronization, Distributed SIGINT

A00-041 TITLE: Architectures and Enabling Technologies for Intelligent Information Operations/Information Warfare (IO/IW) Decision Aids

TECHNOLOGY AREAS: Information Systems, Human Systems

OBJECTIVE: Investigate decision-aiding software and/or hardware architectures, and intelligent inferencing technologies, to be used to develop effective decision aids for supporting Information Operations (IO) / Information Warfare (IW) .

BACKGROUND: From the mid-forties to the early-to-mid-nineties, covert, or overt, data collection on adversarial leadership has been performed by a dedicated group of individuals at select government organizations. “Data collection” here does NOT mean “bits and bytes” or measurements from test equipment. “Data collection” as used in this SBIR topic is about information on human beings: personality styles; cognitive mental processes; relationships with peers and subordinates; and historical problem-solving approaches and solutions.

This is an enormous, complex, time-consuming, task. Individuals who performed data collection did so against adversaries over the years. The data was mostly on paper and filled boxes, and often, literally, rooms. Constant monitoring was performed over the long-term, the idea being that should conflict occur at any time, the US would hopefully be able to posture itself in the best way possible.

The situation today is different. Resources, monetary and personnel, are less abundant so there are less people doing these data collection tasks. Even if resources were still plentiful, the international dynamic state-of-affairs today and the US involvement in Operations Other Than War (OOTW) require hours-to-days response times. Where might our forces deploy next? It is not possible to obtain the detailed long-term data of the past. Additionally, even if there were some time period to collect enormous amounts of data, there is not time to sort, collate and analyze the information to any usable degree.

What can be done to solve this situation? Following are some ideas which will tie-in to the objective of this SBIR topic:

(1) Psychological research continues to examine human behavior, and increasingly, research about the interaction among groups of people. This topic's reserach is about analyzing this information to determine potential predictive outcomes of individual decision-making. What type of behavior might be expected of an individual as a member of a particular nation? A culture? A religion? A peer group? Then, what individual characteristics might cause a departure from "normal" behavior?

(2) On-going technological advances include improvements in highly-complex algorithms being translated and transformed to computer software. Combining these advances with advances in increased computer processor speed is helping to allow a vast amount of data to be analyzed more quickly and with greater accuracy.

(3) Summary. The key focus of this topic is to enable solutions to #1. Then consideration must be given to implementation of this research per examples in #2 (automation, computer algorithms, statistics, inferring-techniques).

(4) One single solution to this topic may not exist. It is possible more than one SBIR proposal may be awarded, which collectively, will achieve the goals of this topic. Therefore, it is imperative that any response to this topic must clearly articulate what the offeror has in research, or is “working”, and provide detailed approaches as to how to solve the goals of this SBIR.

IMPORTANT QUESTIONS TO BE ANSWERED, TOPICS TO INCLUDED, FOR RESEARCH: dealing effectively with varying levels of data uncertainty; handling potentially contradictory data from multiple information sources; providing mechanisms to integrate diverse methods available for individual and group behavior prediction; and support of inferencing mechanisms that both parallel and complement human analytic capabilities.

DESCRIPTION: IO/IW is characterized by a unique constellation of knowledge and inferencing requirements, specifically: a fundamental lack of knowledge about human decision making and behavior, particularly in modern asymmetric warfare (AW) environments; inadequate understanding of the interaction between individual and social and organizational decision making behavior; lack of knowledge of adversary characteristics, both individual and organizational; and a need to provide timely decision aiding in high-value environments given incomplete and uncertain knowledge bases and data sources.

While progress is being made on a number of theoretical fronts in understanding individual and social behavior (Pew and Mavor, 1998), there exists a need for parallel development of decision aiding architectures that incorporate emerging theoretical research and technologies which enable examination and correlation of the theoretical research.

A variety of artificial intelligence representational and inferencing mechanisms are potentially applicable to the development of IO/IW decision aids, including expert systems, fuzzy logic, machine learning, and belief networks. However, no data are available to provide a solid empirical basis for a principled selection of the most appropriate inferencing technique (or group of techniques) for a given IO/IW objective and scenario.

This effort will focus on identifying candidate architectures and technologies to support the diverse information and inferencing requirements of modern warfare IO/IW decision aiding. Particular emphasis will be placed on flexibility of the overall design to accommodate concurrent advances in understanding human and organization behavior, and in meeting evolving needs of IO/IW operations over the next decade.

PHASE I: Phase I will result in a comprehensive characterization of existing IO/IW knowledge and inferencing requirements; systematic evaluation of the appropriateness of existing AI representational and inferencing approaches to address these problems; and recommendations for an architecture that integrates the most appropriate technologies within a computational, real-time, intelligent IO/IW decision aid.

PHASE II: Phase II will implement the architecture designed under Phase I, and will evaluate its effectiveness as a real-time decision aid to support IO/IW commanders and analysts. The evaluation must pay particular attention to addressing the unique IO/IW issues discussed above.

PHASE III DUAL USE APPLICATIONS: The decision aid resulting from the Phase II development will be applicable across a broad range of commercial areas, including strategic planning for business applications, economic modeling and forecasting, assisting in selection of employees for project teams, and organizational policy decision making.

KEYWORDS: IO IW, decision support systems, artificial intelligence techniques, human behavior modeling, computational intelligence, individual and organizational decision making, information dominance, human situation assessment and decision making

A00-042 TITLE: Data Sonification

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: To develop a Data Sonification (DS) application that increases the Situation Awareness (SA) of a commander, analyst, planner, or battle captain through intelligently audio-encoded information.

BACKGROUND: The terms “Data Sonification (DS)” and “DS grammar” are used in this topic write-up. This section provides a basic overview of these terms. The references provide both DS tutorial information and more DS examples.

Sound display capabilities are almost a standard feature on most computers. While these features are largely promoted as a means of putting music, speech audio, and other sounds into a multimedia presentation or display, these capabilities may also be useful in allowing sound to serve as medium for symbolic representation of data, i.e., as a substitute for, or a supplement to, other data presentation methods.

This idea of using sound in this manner is termed “Data Sonification.” The use of a variety of sounds, the methods to use sound to represent data, and the rules governing the consistent use of these sounds relative to the data represented, can together be considered "DS grammar."

This SBIR topic is NOT about trying to augment existing workstations via some audio “quick-fix” or “patchwork” solutions. This topic is about using various user-feedback modalities, such as visual, aural and tactile, working in concert, to provide pertinent information.

Some potential military examples: (a) Use of stereo, or 360 degrees, of sound. Let an audio cue, for example, be heard from behind a listener’s right ear. In conjunction with a view of a point-of-reference on a map, this audio cue could represent some enemy activity to the southeast of the point-of-reference; (b) Correlation of sound to volume-of-data. There may be interest in determining some single sources of information such as a report that a key terrorist has been captured or an anti-aircraft missile signature has been detected, or there may be interest in a brigade command post in which many voice communication signals might be detected. The DS solution could be a higher volume of a specific sound when the command post was detected or perhaps an increased frequency of sound pulses might be a solution, as in the phone company providing twice as many busy-signal tones per second for circuits-busy, versus the busy tone when the individual being called is using the phone. (c) Use of sounds to provide status updates. Suppose an enemy is moving toward a friendly location and the commander surmises the enemy would most likely use route number three out of four potential avenues-of-approach. If the enemy is detected advancing via route three, perhaps a harmonious sound may be heard, indicating “all is going as planned.” Conversely, some displeasing sound would indicate the enemy is advancing through a route other than number three.

DESCRIPTION: Information overload confronts current staff analysts and planners in today's command posts. Using today's visualizations, there is significantly more information available for analysis at any one time than the user can absorb. However, the audio channel from the computer to the human is a relatively uninvestigated mode of information presentation. A Data Sonification (DS) application would identify very large amounts of robust, multi-dimensional, pertinent information not

presented within active visualization windows. Using a DS grammar, the DS system would then semantically encode this information into an audio signal. This rich “music of a thousnad subtle and not-so-subtle alarms” would enable the user to maintain strong situation awareness without having to rotate background processes into foreground visualizations. Much like a babysitting monitor allows parents to tend to other tasks while keeping an "ear" on a sleeping infant; the DS application would allow an analyst to work on a separate task while keeping an ear on large amounts of data in the unit's area of interest. This technology is the logical evolution of the old military technique of using bugles, fifes, and drums to send command information to deployed forces.

PHASE I: Conduct a technical feasibility study, identify the scope and general approach for a DS grammar, and produce a detailed report clearly identifying the scope and general approach for a DS grammar.

PHASE II: Develop a detailed military DS grammar, build a military DS application for use in a command post, and conduct a more detailed proof of concept demonstration, or in other words, working prototype software. It will NOT be acceptable to have as a result of the Phase II effort, just another report.

PHASE III DUAL USE APPLICATIONS: DS applications for medical SA for surgery and intensive care monitoring systems; as well as aviation DS SA applications for pilots and air traffic controllers. Also, there is an excellent potential to develop generalized data-mining and data-harvesting DS applications that complement more traditional visualization technologies.

OPERATING AND SUPPORT COST (OSCR) REDUCTION:

REFERENCES: The first two references provide tutorial information on data sonification and ideas on implementation. The third reference provides military-relevant problems involved with sorting-through, and analyzing, large amounts of data; data sonification is addressed as one of the solutions.

Kramer, G., ed. Auditory Display: Sonification, Audification, and Auditory Interfaces. Santa Fe Institute Studies in the Sciences of Complexity, Proc. Vol. XVIII. Reading, MA: Addison-Wesley, 1994.

Data Sonification: Do You See What I Hear? Tara M. Madhyastha and Daniel A. Reed University of Illinois at Urbana-Champaign IEEE Software, Vol. 12, No. 2, March 1995 Copyright (c) 1995 Institute of Electrical and Electronics Engineers, Inc.

CoRAVEN: Modeling and Design of a Multimedia Intelligent Infrastructure for Collaborative Intelligence Analysis, Jones, P. M., Hayes, C. C., Wilkins, D. C., Bargar, R., Sniezek, J., Asaro, P., Mengshoel, O., Kessler, D. and Lucenti, M. (1998). CoRaven, Proceedings of the 1998 IEEE International Conference on Systems, Man, and Cybernetics, San Diego CA, October 1998.

KEYWORDS: Situation Awareness, Audio, Data Sonification, Information Overload

A00-043 TITLE: Digitally-Based Phase-Coherent Radar Environment Simulator

TECHNOLOGY AREAS: Air Platform, Information Systems

OBJECTIVE: To develop a Radar Environment Simulator based on digital frequency synthesis and modulation technologies. The simulator system should have a wide operating bandwidth, fast switching speed, pulse-to-pulse phase coherency, and should be small and lightweight for airborne applications.

DESCRIPTION: Radar Environment Simulators are used to exercise communication, sensor, and electronic warfare (EW) systems and evaluate their performance. Most environment simulators are large, extremely expensive, and do not provide phase-coherent waveform capabilities. Recent innovations in direct digital synthesis (DDS) technology have resulted in the development of a DDS-based phase coherent microwave synthesizer architecture having the characteristics of a wide 0.5 - 18 GHz operating bandwidth, sub-microsecond switching speed, good spectral purity, small size and weight, and high reliability.

Expanding on this DDS-based microwave synthesis capability by adding a digital timebase, scheduling software, and digital modulation capabilities (pulse, frequency, amplitude) this synthesizer system will evolve into a small, inexpensive, and capable radar environment simulator. A radar environment simulator based on this technology would overcome limitations of high cost and large size that current high-performance radar simulators suffer from.

This simulator system should be able to simulate any radar or communications system in its frequency range, including those with complex emitter characteristics such as stagger, agile, jitter, pulse Doppler, and other scan types. It should be capable of creating scenarios where many different emitters separated by frequency, time, and other parameters are simulated. The system should retain the major beneficial operating characteristics of the core DDS-based synthesizer; low cost, sub-microsecond response time, phase coherence, low phase noise and spurious content, high reliability, small size and weight for airborne or man-portable applications.

PHASE I: Design the key components for a wideband phase coherent DDS-based radar environment simulator. Determine required parameters and system performance specifications.

PHASE II: Develop and demonstrate a fully functional prototype system comprised of the key components designed in the Phase I effort.

PHASE III DUAL USE APPLICATIONS: A wide range of commercial and military applications exist for a small, man-portable, highly versatile RF environment simulator ranging from basic test equipment to complete complex environment generation. Commercial test and evaluation applications exist for any microwave receiving system that must operate in the presence of interfering RF systems such as cellular telephone, line-of-sight microwave links, paging systems, PDA networks, satellite communications system, or aviation. Test and evaluation applications also exist for satellite systems and various aviation navigation and collision avoidance systems. Military applications include flightline test and evaluation of aircraft radar and EW systems, or use as an UAV-based or expendable ECM decoy.

REFERENCES: Dave Adamy, "Electronic Warfare Simulation", Journal of Electronic Defense, Vol 22, No. 4, April 1999, pp 60-61.
David A. Brown, "Electronic Threats Fall Prey to Fast Moving Simulation Laboratory", SIGNAL, Vol 53, No. 10, June 1999, pp 79-85.
"Simulators", Supplement to the Journal of Electronic Defense, January, 1994, pp 30-39.
Navy Simulator Program guidelines: www.ailtso.com/simval/capabilities.htm
Overall capabilities at Edwards Air Force Base - afftc.edwards.af.mil:80/pcapable/atic.html
Basic simulator systems (single systems): www.stricom.army.mil/STRICOM/PM-ITTS/TSMO/

KEYWORDS: Electronic Warfare, Radar Simulator, Digital Frequency Synthesizer (DDS), Frequency Modulation, Bandwidth, Fast Switching Speed, Pulse-to-pulse Coherency

A00-044 TITLE: Low Noise, Narrow Gate-Width 640x512 Short Wavelength Infrared (SWIR) Mini-Camera for Low Light Level Imaging Applications

TECHNOLOGY AREAS: Sensors, Electronics

OBJECTIVE: Develop gateable, low input-referred noise complementary metal oxide semiconductor (CMOS) readout integrated circuits (ROICs) for use in very small, low power 640x512 short wavelength infrared (SWIR) imaging cameras, enabling passive low light level imaging (f/1, 30Hz) under night sky illumination less than overcast starlight and pulse-gated imaging at 1.5 ?m using gate widths less than 5 microseconds and laser power less than 10mJ/pulse.

DESCRIPTION: Recent advances in InGaAs and HgCdTe SWIR focal plane array technology have enabled demonstration of portable solid state imagers operating at room temperature with signal-to-noise ratios of 10 under starlight conditions. In many cases, these SWIR imagers have leveraged existing CMOS ROICs developed for focal planes operating in the medium wavelength infrared (MWIR) and long wavelength infrared (LWIR) with readout noise floors in excess of 400 electrons. In the photon-starved SWIR regime, where the source of photons is the natural luminance of the night sky, input-referred readout noise floors less than 20 electrons may be required to fully exploit the potential of the technology for many passive low light level imaging applications. In a pulse-gated configuration, where the source of photons is a low power eye-safe laser, very low readout noise floors are also required given the readout noise-limited condition at gate widths less than 5 microseconds.

PHASE I: Design innovative low noise input circuits and build small format, gateable CMOS ROICs with input-referred readout noise less than 20 electrons. The ROIC shall support gate widths of 5 microseconds or less and permit external control of the imaging focal plane exposure time and region of interest (ROI). The circuits shall be hybridized to small detector arrays responsive in the SWIR and the focal plane noise floor fully characterized as a function of integration time and operating temperature. Innovative input circuits that demonstrate significant noise floor and gate width advances are highly desirable. A minimum of 2 input circuit designs shall be explored by each participant in phase I. Given the array format requirements in Phase II, the proposed circuitry shall be compatible with the 640x512 unit cell dimensions.

PHASE II: Design, build and demonstrate an all solid state 640x512 SWIR video camera based on the selected low noise, narrow gate-width CMOS ROIC architecture demonstrated in phase I. The signal-to-noise ratio of the video camera shall be greater than 10 under overcast starlight illumination at 30 Hz frame rate. The operating temperature of the camera shall not be less than 250K and the camera shall weigh less than 2 pounds excluding lens. In addition to the passive imaging scenario outlined above, the camera shall be gateable to less than 5 microseconds and permit external control/sync of the integration period.

PHASE III DUAL USE APPLICATIONS: The phase III commercialization of this technology includes night driving aid, search and rescue, security, low light level surveillance and medical diagnostic adjunct for diffusing light fields in tissue. It is anticipated that the cost of this technology will be low, enabling a wide range of reflected light imaging applications currently impractical and supporting the OSCR goals of the Army.

REFERENCES: 1. E. Fossum and B. Pain, "Infrared Readout Electronics for Space Science Sensors: State of the Art and Future Directions", Proceedings of the SPIE, vol. 2020, Infrared Technology XLX (1993)
2. L. Kozlowski, et al, "Attainment of high D* at Room Temperature via Gate-Modulated Detector Interface", Proceedings of the SPIE, vol. 2745, 1996

KEYWORDS: HgCdTe, InGaAs, Focal Plane Arrays (FPAs), Readout Integrated Circuits (ROICs), Noise, Signal-to-Noise Ratio, Short Wavelength Infrared (SWIR)

A00-045 TITLE: Real-Time Image Restoration for Generation 3 Forwarde Looking Infrared Systems

TECHNOLOGY AREAS: Sensors

OBJECTIVE: The objective of this effort is to demonstrate the ability to significantly increase the range of Third Generation Forward Looking Infrared (FLIR) sensors through the use of real time image restoration ("super resolution") technology. Specialized high speed signal processing, when coupled with advanced large format low noise IR focal plane arrays (FPA), can produce a 50% increase in target acquisition range without increasing the aperture of the sensors. These capabilities have been demonstrated for strategic systems and by NASA, and can be adapted to tactical military and commercial use.

DESCRIPTION: Recent improvements in large format staring IR focal plane arrays have made possible a new class of mega-pixel imaging sensors. The US Army is considering the development of a Third Generation of FLIR systems based on the large scale, low noise FPAs. Modeling has demonstrated that image restoration algorithms (so-called "super-resolution") should dramatically improve image fidelity by reducing diffraction induced optical blur, taking advantage of the geometric oversampling provided by these large format cameras. To establish the performance advantages of this technology with field users, it is necessary to develop a real time system that can process imagery from a large format FPA camera and demonstrate an enhanced image to the operator. Innovative research is required to determine the best processing and algorithm approach to adapt these techniques to real time, tactical sensors.

PHASE I: Evaluate the different classes of image restoration algorithms that are suitable for real time implementation (not greater than 2 frame lag) using a 1K x 1K long or mid wave IR sensor that can operate at either 30 or 60 Hz (non-interlaced).

PHASE II: Perform research to adapt the optimal approach discovered under Phase I for real time implementation. Perform a laboratory demonstration of a processor module that can perform execute the restoration algorithm using a mega-pixel FLIR as an input source. The demonstration will have the ability to lead to a final system that fits on a single processor card that can be inserted into a FLIR, will operate at 60 or 30 Hz, and will have less that 2 frames of delay from input of image to output of restored image.

PHASE III DUAL USE APPLICATIONS: The Phase III commercialization of this technology is expected to provide a major enhancement to future video cameras, digital cameras, and PC based image processing software. It is anticipated that the small size, weight and cost of this technology will enable implementation in a wide variety of consumer based product, providing enhanced resolution while minimizing the need for heavy and expensive optics and larger format camera chips.

REFERENCES: "Deconvolution of Images and Spectra," edited by Peter A. Jansson, Academic Press, NY, 1984
"Restoring with Maximum Likelihood and Maximum Entropy," B. Roy Frieden, JOSA Vol 62, No 4, April 72

KEYWORDS: Image Restoration, Optical Super-Resolution, Focal Plane Arrays (FPAs), Forward Looking Infrared (FLIR)

A00-046 TITLE: Electromagnetic-Based Computer Aided Design (CAD) for Wavelength Scale Optics

TECHNOLOGY AREAS: Information Systems, Sensors, Electronics

OBJECTIVE: Develop an Electromagnetic-Based Computer Aided Design Software package to allow the general design of Wavelength Scale Optics on a personal computer. The innovative research element is to develop the capability to accurately design Wavelength Scale Optics with aperiodic structures, finite substrate thicknesses, and non-planar wavefronts.

DESCRIPTION: Diffractive optical elements are passive components that redistribute light through the propagation and mutual interference of a wavefront. As such these elements offer the ability to incorporate unconventional functionality, such as off-axis

focusing, aberration correction, and beam forming elements, into conventional optical systems. For the Army, incorporation of Diffractive Optical Elements within optical systems can offer the advantages of a reduced number of optical elements, reduced weight, and reduced cost. These are key factors, especially in applications such as Unmanned Air Vehicles, and Unmanned Ground Vehicles, where miniaturization is critical. Whereas Diffractive Optical Element technology is being commercialized at a fast rate, its full potential has not yet been realized. Historically, this was due to the lack of suitable fabrication and replication methods; however, today it is clearly due to the lack of complete and general Diffractive Optical Element Computer Aided Design tools. For instance modern fabrication methods, such as e-beam lithography, can currently produce Diffractive Optical Element profiles that cannot be analyzed or designed using conventional analysis methods. However, recent advances in the electromagnetic modeling of Diffractive Optical Elements overcome this limitation. In fact these new tools place no limitation on the size, number of levels, material properties, or aperiodicity of the Diffractive Optical Element . Therefore it is the intent of this topic to solicit proposals to combine these tools in combination with conventional scalar methods into an integrated, complete, and general, Diffractive Optical Element Computer Aided Design program. This program should be designed with a graphical user interface and suitable output fabrication formats, this tool will provide a capability that is in critical need and has the potential to serve many Department of Defense and commercial uses.

PHASE I: 1) Identify electromagnetic methods that are amenable to aperiodic Diffractive Optical Element analysis that can be easily implemented on Personal Computers. Show initial results. (Scalar and periodic Electromagnetic analysis packages already exist, so this work must address aperiodic applications.)
2) Identify scalar diffraction methods and periodic methods that will be integrated with the electromagnetic methods. Show initial results. (Although not novel these methods shall be included for completeness.)
3) Design a graphical user interface that will be capable of incorporating all of the above models and various output features, like fabrication file formats and data on the analyzed fields.

PHASE II: 1) Implement and demonstrate the electromagnetic models and show that their computational requirements are manageable by a Personal Computer.
2) Integrate all of the models under one Graphical User Interface and demonstrate the operation of each component (Electromagnetic, scalar, periodic, and output formats) as operational.
3) Supply a copy of the finished product for evaluation.

PHASE III DUAL USE APPLICATIONS: Possible commercialization includes the incorporation of this tool in to optical design programs like, CODE V, OSLO, and ZEMAX for incorporation of diffraction analysis in these codes. The application of these codes to photographic mask evaluation and proximity correction in photolithography. And the obvious, application of this tool to the design of wavelength scale optical components for IR detectors, VCSEL collimation and fan-out, photonic band gaps, and VLSI-scale optics.

REFERENCES: For information on a similar (but non-electromagnetic based) optical design program, see www.focus-software.com
For information on a similar electromagnetic-based design program (but which cannot address non-periodic structures and finite substrate thicknesses), see www.gsolver.com

KEYWORDS: Electromagnetic, Computer Aided Design, Diffractive Optical Elements, Graphical User Interface, Aperiodic, Personal Computer, Optical Design

A00-047 TITLE: Micro Air Vehicle and Weapon Sight Infrared (IR) Camera

TECHNOLOGY AREAS: Sensors, Electronics, Weapons

OBJECTIVE: To develop a miniature infrared camera that can be used as an electronically stabilized sensor for a miniature unmanned aerial vehicle (UAV) and transmit imagery to the command and control site, and as a wireless sensor on a rifle/pistol to transmit imagery of targets to the warfighter's helmet display. Integrated electronic stabilization will be incorporated in the camera electronics to enable clear picture framing of high dynamic scenes which is the current technical limit of this technology.

DESCRIPTION: Uncooled infrared cameras have been developed that weigh several ounces. This has opened up a whole new class of applications. One application is to develop a miniature sensor that will be used in a micro UAV (15-56 cm wing span). The sensor will have a 25 micron pitch, an noise equivalent delta temperature (NEDT) of less than 25 millikelvin for an F1 optical system, instant on capability (full image performance in less than 1/3 of a second), and an array size of 320X240. The sensor will be electronically stabilized as much as possible to take out the dynamics of the air vehicle. The weight of the camera excluding housing shall be less than 2.5 ounces. The second application is a wireless weapon sight infrared (IR) camera. This camera shall have the same size and sensitivity as the air vehicle, but must also have a miniature transmitter to transmit target images to the warfighter's display. Integrated in this package is an aiming light in the 8-12 micron band to accurately mark targets.

PHASE I: Develop the design for the weapon/air vehicle sensor and identify components. This sensor will have instant on and electronic stabilization capability. A trade off will be made as to sensor array size as it relates to the two applications.

PHASE II: Demonstrate a camera with instant on that is lightweight, low power, small size, electronically stabilized, and can transmit imagery to the warfighter.

PHASE III DUAL USE APPLICATIONS: Firefighters helmet sights, driving aids, networked security sensors, highway surveillance cameras

REFERENCES: Technical Overview of the UL3 Uncooled Cameras," J. Heath, SPIE Orlando 99 Conf #37-13, paper 12

KEYWORDS: Infrared, micro sensor

A00-048 TITLE: Adaptable Packet-Switched, Battle Command Information

TECHNOLOGY AREAS: Information Systems, Human Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Manager Warfighter Informatio Network - Terrestrial

OBJECTIVE: The commander's critical information requirements (CCIR) requires the battle command system deliver extremely, time-sensitive information at the right place and at the right time for the few key decisions he/she will make on the battlefield. The commander's critical information, therefore, must be supported by whatever the immediate means available to the commander including mobile (e.g., wireline and wireless), packet-switched (e.g., IETF IP Internet) communications.

The objective is to adapt packet switching (e.g., IETF IP Internet) capabilities to support information exchanges between Battle Command and commercial interactive applications and simulations over mobile packet-switched communications. The objective capabilities include dynamic allocation of network capacity to high, data-rate users with congestion control minimizing potential network overload. Prioritization of resources matching QoS requirements will support the lowest level of system capacity and degradation. Other capabilities include being reactive to variations in data rate requirements, but unaffected by varying channel error rate characteristics. The packet-switched support of information exchanges will consist of varying the data rates to scale Battle Command interactive applications and simulations from 30 frames per second (fps), with audio, to 10 fps, with audio, and a minimum capability for audio-to-audio only, if required. Bandwidth is allocated, as required, and in real-time, to establish and maintain pre-defined quality of service (QoS). The latter implication is to adapt packet switching capabilities (e.g., IETF IP Internet) to support mobile communications networks capable of pre-defined QoS {i.e., rhyme testing > 90%, latency < 250 milliseconds, delay jitter < 150 milliseconds, and bit error rate (BER) < 10–4)} for IP voice and video during transmission. The packet-switched enabled mobile communications networks should appear “lossless” during communications between Battle Command and commercial interactive applications and simulations supporting as close to, as possible, real-time capabilities.

The Topic's objective is to develop and test a prototype platform, possibly utilizing a single digital, multimedia workstation, that is linked to a wide area network (WAN) and/or Intranet/Internet capable of transmitting a commander's critical information. The prototype product will be used to demonstrate the realistic impact of a packet-switched type of communications system on the battle command interactive applications and simulations or equivalent. The Topic's other objective is to gain subject matter experts (SMEs) and the student experience in a packet-switched communications architecture, that is also capable of predefined QoS features, when called upon to support the delivery of a commander's critical information. The product's capabilities potentially could also support military or commercial, on-demand education, if required.

DESCRIPTION: The Topic requirement is to design (Phase 1) and develop and test (Phase II) the prototype software/hardware platform, preferably a single, digital multimedia workstation, linked to a wide area network (WAN) and/or Intranet/Internet to test its capabilities. Another Topic requirement is the proposed use of contractor recommended commercial and/or government products. The prototype platform must demonstrate in Phase II the required QoS features required of packet-switched type of communications capable of supporting to the delivery of real-time, voice, data and video (multimedia) applications. The prototype platform is also required support the high fidelity, 2-D and 3-D, battle command and simulation applications typically being developed at BCBL-L Futures Lab, Fort Leavenworth KS. The BCBL-L technical objectives include the enhancement of the quality of training by making it more compelling for the instructor and the student. The contractor will not have access to the BCBL-L Futures Lab's battle command system capabilities. The Phase 1 and Phase II program must, therefore, support the emulation of interactive simulation features typical of the Government (e.g., BCBL-L) or commercial products (e.g., surgical, etc.) of like capability to demonstrate prototype platform feasibility.

PHASE I: Design the prototype software/hardware platform, including the required design documentation, addressing mobile packet-switched communications features, capable of the pre-defined QoS, required to support delivery of battle command and simulation applications, or found commercially.

PHASE II: Develop, test, integrate and demonstrate the prototype software/hardware platform, supporting pre-defined QoS features, required to support delivery battle command and simulation applications, or found commercially. Demonstration will first be performed at the contractors plant and then at a Government installation (e.g., CECOM).

PHASE III DUAL USE APPLICATIONS: The Phase III software/hardware platform brings advanced technology experience in a packet-switched type of communications to deliver commander's critical information. The primary military application will bring mobile packet-switched communications experience directly to the military commander's and industry manager's, real-time multimedia products used in the delivery of his/her critical information. The resulting capability may also support government and commercial instruction in or out of the "school house" supporting individual self-paced training. The final product, therefore, could also be designed as an intelligent/ interactive experience that could exercise instruction drills using commercial based-training techniques and computer surveys for user feedback.

REFERENCES: 1.Battle Command Handbook found on the WWW Site: http://cacfs.army.mil/index1.htm.)

2.Joint Tactical Architecture (JTA) available at http://www-jta.itsi.disa.mil/jta/jtav3-final-19991115/finalv3.html

KEYWORDS: Battle Command, CPXXI, IETF, QoS, Warfighters Information Network, WAN, Intranet, Internet, Mobile IP, Applications, Simulations

A00-049 TITLE: Soldier Antenna

TECHNOLOGY AREAS: Electronics, Weapons

OBJECTIVE: Develop and demonstrate an effective rugged and efficient, Very High Frequency (VHF)/Ultra High Frequency (UHF) body borne antenna for the Soldier and commercial applications.

DESCRIPTION: Present VHF/UHF antennas use effective, but high profile designs that in many instances inhibit the ability of the soldier to effectively perform his mission. These antennas when properly deployed (fully extended) tend to get caught in underbrush and tree branches. There is a need to provide the warfighter with a body borne VHF/UHF antenna that will enhance his warfighting capabilities. Efficiency and range of the antenna must be compatible or greater then legacy VHF/UHF antennas currently borne by the soldier. Nominal ranges are for: VHF 8Km; lower UHF 4Km; and upper UHF 2 Km. Principle communications are peer-to-peer voice, message data, video, and GPS. Future requirements are to communicate with sensors, robotics and micro Unmanned Arial Vehicles. Techniques to extend range, and enhance anti-jam and low probability of detection (e.g. electronically steerable antennas) are relevant. Consideration of emerging materials, coating, and antenna switching technologies, as well as, adaptiveness, efficiency in all warfighter positions, and the ability of the antenna to communicate in rapidly changing warfighter scenarios are critical requirements of the antenna. Successful proposals will explore and develop an innovative VHF/UHF body borne antenna system that will address these objectives and descriptions.

PHASE I: Perform a study of this requirement and develop a set of alternatives, and present to the government. The contractor and the government will make a joint decision on the most promising techniques to pursue in Phase II.

PHASE II: The most promising techniques, emerging from the Phase I study, will be further developed and modeled. A performance description, specification, and antenna prototype will be developed.

PHASE III DUAL USE APPLICATIONS: Soldier Antenna will be used by the infantry soldier to eliminate the need for a large antenna hanging off the soldier. Commercial applications include law enforcement (FBI, DEA, Coast Guard), Firefighting, oil or construction industries.

REFERENCES: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3khz to 300ghz,IEEE C95.1-1991,1992.

KEYWORDS: Communications, antennas, VHF/UHF

A00-050 TITLE: Single Chip, Low Cost, Very Short Range RF Systems for Military Applications

TECHNOLOGY AREAS: Information Systems, Electronics, and Weapons

OBJECTIVE: Development of a low cost integrated system that will provide hands-free, wireless (cable-free) control of dismounted soldier communications, and wireless data links for Command Post weapons systems, enhancing reliability and human factors engineering of these systems. System requirements are for a short-range (less than 10 meters), low RF power (0 dbm. or less) voice and data link operating in the 2.4 GHz. Industrial, Scientific & Medical (ISM) band. Spread Spectrum radio technologies shall be used that can self-configure to form ad-hoc networks when like devices are brought into close proximity (less than 10 meters). Data throughput requirements are less than 1 Mb/s for soldier radio links and up to 10 Mb/s for Command Post cable replacement implementations. System design shall make maximum use of new Personal Area Network (PAN) radio technologies such as Bluetooth and Home RF (See description below) that are now emerging from the commercial sector. The system shall include commercial grade security and authentication for both voice and data.

DESCRIPTION: The need for wireless control of individual soldier-borne radio equipment has been documented at numerous urban warfighting experiments at Fort Benning, Ga. under the Military Operations in Urban Terrain Advanced Concept Technology Demonstration (MOUT ACTD). The need for cable-free links in Army Tactical Operations Centers (TOC) has been identified at numerous Advanced Warfighting Experiments (AWE) at Ft. Hood, TX. The emergence of a new class of commercial single chip, short range cable replacement radio technologies from the computer and telecommunications industries provides a unique opportunity to leverage these technologies to the above military applications at very low cost. Bluetooth and Home RF are prime examples of the technologies currently being developed in the private sector. Emerging standards for both these technologies employ a frequency hopping spread spectrum (FHSS) radio interface in the 2.4 GHz frequency band that enables portable electronic devices to connect and communicate wirelessly via short-range radio. Both systems provide for ad-hoc networking of devices when brought in close proximity. Future tactical applications for this technology are the Army's Military Operation In Urban Terrain (MOUT), Small Unit Operations/Situational Awareness System (SUO/SAS) programs, and connection of shelter mounted computer workstations in a Tactical Operations Center (TOC).

PHASE I: Analyze the current state-of-the-art and availability of Bluetooth, Home RF or equivalent single chip, low cost, short range components and select the best chip for integration into an end-to-end system. Assess Army tactical system needs and select system for appropriate development of a product to perform wireless function. Show potential of approach with selected lab brassboard of component sub-element.

PHASE II: The selected system of Phase I will be further developed by completing a specific design plan, fabrication and carrying out prototype demonstration. Prototype should incorporate Single Chip Radio (e.g. Bluetooth or Home RF) or equivalent into a functioning operation of a wireless interconnect to an actual Army hosted system need. Example: Wireless interconnects of computer workstations, cable free controls to radio. Results documented in final report.

PHASE III DUAL USE APPLICATIONS: The end-to-end system capability will be further refined and optimized for both commercial and military use. Possible applications include law enforcement, very short range telecommunications or applications in the Personal Computer industry as well as the military environment such as using un-tethered radios (wireless antenna connection or wireless radio controls). This would require direct application of the chip system to the peripheral devices in a user transparent approach.

KEYWORDS: Bluetooth, Home RF, short range RF system, spread spectrum waveform, low cost, single chip design.

A00-051 TITLE: Malicious Mobile Code Detection Using Artificial Intelligence Methods

TECHNOLOGY AREAS: Information Systems, Weapons

OBJECTIVE: Perform research into advanced malicious mobile code detection techniques that would utilize artificial intelligence methods beyond the traditional detection techniques currently in use. The new techniques should detect malicious Mobile Code in the form of plug-ins, Java Applets, Visual Basic scripts and macros downloaded through browsers, e-mail or other internet clients.

DESCRIPTION: In both the commercial world and military world, computer network security is being recognized as a major emerging problem. It is vital to protect computer networks from hacker and foreign power threats. There are a number of commercially available malicious mobile code detection software packages currently available. These products use three basic malicious mobile code detection techniques including code inspection (examination of the imported code and identification of characteristics associated with malicious intent), heuristic or expert system techniques (a malicious or benign determination is made based on possible code behavior during a program emulation) and a sandbox technique (all imminent behavior is monitored and any prohibited activity is blocked before it reaches the operating system). This research will investigate new and innovative approaches to malicious mobile code detection utilizing artificial intelligence and neural networks. The goal is to develop a self-learning software application that will automatically build a data base containing correlations between characteristics and behavior based on experience and will thus adapt over time.

PHASE I: Perform a study into the application of artificial intelligence and neural networking and other innovative techniques towards malicious mobile code detection. A final technical report would be delivered that would present a set of design alternatives. The contractor and the government would make a joint decision on the most promising techniques to pursue in Phase II.

PHASE II: The most promising techniques emerging from the Phase II study would be further developed and modeled. A performance description or specification would be developed. A prototype software working model will be delivered.

PHASE III DUAL USE APPLICATIONS: The performance description or specification would be further refined and optimized for both commercial and military use. Product developed from this SBIR will have a wide variety of commercial applications for any organization that performs financial transactions over the internet, that has a web site or an intranet.

KEYWORDS: malicious mobile code detection, artificial intelligence, neural networking

A00-052 TITLE: Mobile Agents for Tactical Communication Networks

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: The objective of this SBIR is to investigate and determine the applicability of the emerging mobile agent technology to enhance the functionality of and performance of tactical, wireless, mobile packet networks, and to provide a high level design for prototype implementation of such a mobile enhanced capability in a laboratory environment.

DESCRIPTION: The use of mobile agents and mobile agent technology in tactical, wireless packet networks remains an unexplored frontier. The tactical mobile, wireless networks are characterized by frequent topology changes, link/node destructions or temporary outages, as well as fluctuating available bandwidths. In the tactical environment, BOTH the user access point as well as the radio based backbone are subject to frequent, unplanned, and sometimes extensive relocation moves. The mobile agent technology, through its migration capability, offers some potential to increase performance, enhance functionality, and increase survivability of tactical, wireless, mobile networks. Some of the major issues are, but not limited to: agent/network security, low bandwidth/high delay links, frequent unplanned topology changes, node outages, both temporary and permanent, as well as integration with existing/planned tactical systems such as the Joint Tactical Radio System (JTRS) and Warfighters Information Network - Terrestrial (WIN - T) .

PHASE I: In Phase I, the following shall be accomplished:
a. A complete assessment of the capabilities and current limitations of mobile agent technology in a static, commercial environment. Specific commercially available (or nearly so) or research packages shall be assessed and analyzed for applicability to this effort.
b. A determination of those tactical, mobile, wireless network functions that may use mobile agent technology to improve performance or enhance functionality. The mobile agent technology shall be consistent with the use of
Internet Protocol, version 4 (IPv4), Internet Protocol, version 6 (IPv6) , and other standard or emerging Internet Engineering Task Force (IETF) supporting protocols. Emphasis shall be placed on those functions that DIRECTLY support mobile operation and/or survivable operation. Network management for fault detection, configuration control, performance monitoring may also be considered as they relate to the tactical environment, but mobility support, survivability support, and configuration/reconfiguration support must be emphasized.
c. A detailed technical assessment of the expected gains to be achieved using the mobile agent technology in tactical networks. This should be quantifiable and be used to determine bounds of performance enhancements. Any/all overhead
(for the mobility of the agent as well as any potential increased traffic loading, etc) shall clearly be indicated.
d. A complete, detailed high level system and software design that can be implemented in Phase II, with a set of scenarios that fully demonstrate and exercise to mobile agent capabilities. It is required that the demonstration can be performed in a set of wireless connected laptops. If a existing mobile agent package is proposed, the selection of that package must be justified.
e. A complete set of documentation regarding the software design, and implementation shall be delivered with the prototype software to assist in the transition process to PEO/PM programs.

PHASE II: In Phase II,
a. The design developed in Phase I shall be implemented in prototype fashion. The software development shall make maximum use of the Commercial off the Shelf (COTS) software and hardware, and use an object-oriented language such as C++ or Java. The software developed shall also be consistent with and complementary to the Space and Terrestrial Communication Directorate (STCD) Wideband Radio Network (WRN) program and the Joint Tactical Radio System (JTRS) programs to provide a smooth transition path. The use of software design tools, such as Rational Rose and others, in strongly encouraged.
b. The prototype software shall be used to experimentally determine and demonstrate the expected performance gains provided by the use of the mobile agent technology in a number of scenarios. The effects of any/all overhead on reduced user bandwidth availability, or increased end-to-end delay, shall also be measured and any discrepancies fully explained. The demonstration must consist of two components, one showing the functionality by means of laptops interconnected by a wireless LAN, and also a demonstration using the STCD WRN Testbed facility at Ft. Monmouth, NJ.

PHASE III DUAL USE APPLICATIONS: A fully supportable commercial product using the mobile agent technology may be applied to the use of IP in the commercial digital cellular and other radio based networks. This is an increasing area of interest and is expected to continue in the years to come, thus providing a ready base upon which to deploy and integrate the products of this SBIR. Possible applications include any area where devices are used in remote areas and are highly mobile (e.g. Law Enforcement, Forestry, etc.), or any corporate wireless network that is not tied to the local communications network.

REFERENCES:
1. GreenBerg, M., et. al., "Mobile Agents and Security", IEEE Communications Magazine, Vol. 36, No. 7, pages 76-85. July 1998.
2. Spyrou, C., et. al., "Wireless Computational Models: Mobile Agents to the Rescue", Proceedings of 1999, Tenth Annual InternationalWorkshop on DataBase and Expert Systems Applications, 1-3 Sept 1999, page 127-133.
3. Barbeau, M., "Implementation of Two Approaches for the Reliable Multicast of Mobile Agents over Witeless Networks", Proceedings of the Fourth International Symposium on Parallel Architectures, Algorithms, and Networks, June 23-25 1999, pages 414-419.
4. Bandyopadhyay, S., et. al., "Using Mobile Agents for Off-Line Communication Among Mobile Hosts in a Large, Highly Mobile Dynamic Network", Proceedings of the 1999 International Conference on Personal Wireless Communication, 17-19 Feb. 1999, pages 88-92.
5. Kujimara, K., "A model of Reactive Planning for Multiple Mobile Agents", Proceedings of the 1999 IEEE International Conference on Robitics and Automation, 9-11 April 1991, pages 1503-1509, Vol. 2.
6. Di Caro, G., et. al., "Mobile Agents for Adaptive Routing", Proceedings of 31st Annual Hawaii International Conference of System Sciences, pages 74-83, July, 1998.

7. Camarinha-Matos, L. M., et. al., "Mobile Agents and Remote Operation", Proceedings of the 10th Annual IEEE International Workshop on Enabling Technologies: Infrastructure for Collabotative Enterprises, 1998, pages 110-115.
8. Fussel, T., etc. al., Dynamic Propagation and Linking of Information Metadata using Mobile Agents", Proceedings of 1999 Tenth Annual International Workshop on Database and Expert Systems, 1-3 Sept. 1998, pages 750-754.
9.Joint Tactical Architecture (JTA) available at http://www-jta.itsi.disa.mil/jta/jtav3-final-19991115/finalv3.html

KEYWORDS: mobile agents, radio based communication using packet networks, mobile networks, survivable networks

U.S. Army Construction Engineering Research Laboratory (CERL)

A00-053 TITLE: Electro-Osmotic Pulse Technology to Control Leaching and Groundwater Intrusion in Containment Sites

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: To develop an economically feasible prototype seepage prevention system based on electro-osmotic pulse technology to be used primarily in landfill and hazardous waste containment applications.

DESCRIPTION: Electro-osmosis is the transport of cations due to the application of an external electric field. Because of the molecular binding nature of water molecules, water molecules are transported along with the cations. This technique has been used in civil engineering to dewater dredgings and other high-water content waste solids, consolidate clays, strengthen soft sensitive clays, and increase the capacity of pile foundations. Electro-osmosis has received significant attention in the last 5 years as a method to remove hazardous contaminants from groundwater or to arrest water flow. Although results have shown the technique to be feasible, they have not been remarkable. One limitation of the present application is the use of a constant direct current, not a pulsating current. Currently, electro-osmotic pulse (EOP) technology is being applied to concrete structures. A system has been developed that uses a pulsating direct electric field. The system consists of an electronic control unit that delivers electric pulses to positive electrodes (anodes) inserted into the concrete structure. The negative electrode (cathode) is driven into the exterior soil or buried within the concrete structure outside of the protected area. The pulsating electro-osmosis system consists of a pulse of positive voltage (as seen from the dry side of the concrete wall) and a period of rest when no voltage is applied. The pulse of positive voltage has the greatest duration and amplitude. The electrical pulse causes cations (e.g., Ca++) and associated water molecules to move from the structure's dry side towards the wet side, counter to the direction of flow induced by the hydraulic gradient, thus preventing water penetration through buried concrete structures. By using a pulsating excitation; electrode polarization, cation depletion, and overdrying of the concrete are prevented. The application of pulsating electro-osmosis and semi-conductive anodes to soils may overcome some of the limitations of the present direct current method.

PHASE I: A theoretical model detailing the similarities and differences in the application of the EOP system to soil compared to those previously used in concrete would be developed. The theoretical developments would be complemented by small and large scale laboratory testing. Some issues to be addressed are: optimization of the pulse pattern for various soils and contaminants, e.g. number of cations available, and; selection of anode and cathode materials based on soil and contaminant type.

PHASE II: The design construction and installation of three full scale prototype systems would be completed, based on the previous phase I design work. The test sites would include a normal landfill, a hazardous waste containment site, and a remediation barrier site. Prior to system installation, guidelines would be developed for applicable sites, operating procedure and monitoring, installation methodology and technical specifications, and reliability monitoring.

PHASE III DUAL USE APPLICATIONS: The technology for seepage prevention system is applicable to landfills and hazardous waste containment applications within the DoD, other Federal agencies, State agencies and private sector foundations. There are extremely high benefits in terms of cost savings through this environmental technology.

REFERENCES:
K. Utklev, "Method and Apparatus for Controlling the Relative Humidity in Concrete and Masonry Structures," U.S. Patent No. 5,368,709.

V.F. Hock, M.K. McInerney, and E. Kirstein, "Demonstration of Electro-Osmotic Pulse Technology for Groundwater Intrusion Control in Concrete Structures," FEAP Technical Report 98/68, U.S. Army Center for Public Works, April 1998.

M.K. McInerney and V.F. Hock, "Electroosmotic Pulse Technology for Groundwater Intrusion Control in Concrete Structures, presented at the 21st Army Science Conference held 15-17 June, 1998 in Norfolk, Virginia.

KEYWORDS: electro-kinetics, historic, masonry, moisture, structures, water

A00-054 TITLE: Advance Anode Materials for Electro-Osmotic-Pulse Technology to Control Water Intrusion in Porous Structures

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: To develop new anode technology and materials that can be used on non-homogeneous structures such as masonry block, brick and stone.

DESCRIPTION: Electro-osmosis is the transport of cations due to an external electric field. Because of the molecular binding nature of water molecules, water molecules are transported along with the cations. Currently, electro-osmotic pulse (EOP) technology is being commercially applied to concrete structures. A system has been developed that uses a pulsating direct electric field. The system consists of an electronic control unit that delivers electric pulses to positive electrodes (anodes) inserted into the concrete structure. The negative electrode (cathode) is driven into the exterior soil or buried within the concrete structure outside of the protected area.
The pulsating electro-osmosis system consists of pulses of positive voltage (referenced to the dry side of the concrete wall), negative voltage, and zero voltage. The positive voltage pulse, which has the greatest duration and amplitude, causes cations (e.g., Ca++) and associated water molecules to move from the structure's dry side towards the wet side, counter to the direction of flow induced by the hydraulic gradient, thus preventing water penetration through the concrete structure. By using a pulsating excitation; electrode polarization, cation depletion, and overdrying of the concrete are prevented. EOP technology provides installation cost savings of over 40% compared to conventional methods. Additionally EOP has a much longer lifetime. Unfortunately, present technology limits its use to poured concrete structures, which comprise less than 30% of the basements. Development of new anode technology can extend EOP application to virtually all below-grade structures by including masonry block, brick and stone.

PHASE I: Develop a methodology to apply EOP technology to non-homogenous structures. The methodology may include anodes in the form of a wall coating, which, in order to function as a reliable anode, must have excellent adhesion and good electrical conductivity. Tests will be performed in the laboratory on scale-model systems. Base materials of masonry block, brick and stone will be used.

PHASE II: Develop an economically feasible prototype for efficient field application of the new anode materials. Tests will be conducted on full size structures.

PHASE III DUAL USE APPLICATIONS: The anode technology will serve to improve the efficiency and use of EOP technology. EOP technology will offer cost savings of over $500 million to the DoD. These cost savings can be drastically increased by applying EOP technology to below-grade structures constructed of masonry block, brick and stone. Since water intrusion in buildings is not limited to DoD facilities, the market for this technology is worldwide. EOP technology can be applied to any below-grade structure constructed of standard building materials (e.g., concrete or masonry) regardless of use or ownership.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: In 1999 a cost comparison was done using two adjacent and identical buildings at Ft. Bragg. The cost per lineal foot for EOP treatment of water intrusion was $133.53/foot and the cost per lineal foot for conventional waterproofing was $262.60/foot - an up front cost savings of 49%. These savings will be further increased through the development of new anode materials. The Honorable Tommy G. Thompson, Governor of Wisconsin expressed his appreciation to LTG Ballard, Commander, Corps of Engineers, for the Corps of Engineers' role in developing EOP technology. In this letter, he estimates that cost savings resulting from the use of EOP technology will be in excess of $100 million nationwide.

REFERENCES:

V.F. Hock, M.K. McInerney, and E. Kirstein, "Demonstration of Electro-Osmotic Pulse Technology for Groundwater Intrusion Control in Concrete Structures," FEAP Technical Report 98/68, U.S. Army Center for Public Works, April 1998.

M.K. McInerney and V.F. Hock, "Electroosmotic Pulse Technology for Groundwater Intrusion Control in Concrete Structures, presented at the 21st Army Science Conference held 15-17 June, 1998 in Norfolk, Virginia.

KEYWORDS: electro-kinetics, anode, masonry, moisture, structures, water

Edgewood Chemical Biological Center (ECBC)

A00-055 TITLE: Combinatorial Screening of Synthetic Nanomaterials for Chem/Bio Agent Detection

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Joint Program Office- Bio Defense

OBJECTIVE: To use a combinatorial strategy to screen a large number of synthetic nanomaterials produced from either biotic or non-biotic approaches. The ideal nanomaterials should contain well-defined receptors or receptor arrays (incorporated into nanofims or nanocomposites), and be able to detect both Chemical (CW), and Biological (BW) Warfare agents, as well as Toxic Industrial Chemicals (TICs).
Companies

DESCRIPTION: Current CW, BW, and TIC detection primarily relys on bulky detectors such as Mass Spectrometer, or antibody, DNA, or enzyme based instruments. These instruments are often too heavy for individual soldiers in the battlefield. In addition, logistics associated with these instruments (i.e. instrument maintenance, stability of consumable bioreagents, and extensive personal training requirements) have reduced the operational capability dramatically. Therefore, the need exists to develop novel nanomaterials that can detect CW, BW, and TICs simultaneously. These synthetic receptor based nanomaterials have to be stable in both air and water under conditions such as extreme temperatures (i.e. from -30ºC to 60ºC) and pHs (i.e. from 1 to 12). The ideal sensing mechanism is a reversible or regenerative process. Real-time sensing (simultanueous recognition and signal transduction) is highly desired. Low cost materials are preferred, but not required. The target CW and BW agents are mustard (desired), G- and V-type agents, as well as spores, viruses, bacteria, and toxins. The resulting sensor should be humidity insensitive and require very low power (i.e. battery).

PHASE I: Combinatorial screening of leading nanomaterial families that could detect CW, BW, and TICs. Appropriate signal transduction method(s) should also be tested during the screening process. The main goal of Phase I will be a proof of principle demonstration. The proof of principle system does not have to be miniaturized.

PHASE II: Combining nanomaterials or nanomaterial arrays in a sensor prototype, and miniaturization of the final sensor to handheld size. The prototype should be able to identify at least two types of CW simulants (i.e. 2-chloroethyl ethyl sulfide (blister agent simulant) and diisopropyl fluorophosphate (DFP, nerve agent simulant) and four different types of BW simulants (i.e. ovalbumin (toxin simulant), BG spores (spore simulant), EH (bacteria simulant), and MS2 (virus simulant).

PHASE III DUAL USE APPLICATIONS: Large scale production of miniaturized sensors. The contractor has to demonstrate the efficiency of the device in the Joint Field Trial (JFT) environment utilizing live agents. The proposed handheld sensors can be used for both military and domestic preparedness applications.

REFERENCES: 1) Lonergan, M. C.; Severin, E. J.; Doleman, B. J.; Beaber, S. A.; Grubbs, R. H.; Lewis, N. S. Chem. Mater. 1996, 8, 2298-2312. 2) Walt, D. Accounts of Chemical Research 1998, 31, 267-278. 3) Jenkins, A. L.; Uy, O. M.; Murray, G. M. Analytical Chemistry 1999, 71, 373-378.

U.S. Army Missile Research, Development, and Engineering Center (MRDEC)

A00-056 TITLE: Breakthrough Advances in Non-Hermetic Electronic Encapsulant Materials

TECHNOLOGY AREAS: Materials/Processes, Electronics

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Executive Officer, Air and Missile Defense

OBJECTIVE: Develop organic material formulations and application/molding processes that significantly advance the state-of-the-art in current encapsulation material performance for non-hermetic integrated circuits (ICs).

DESCRIPTION: Military electronics have historically used mil-spec hermetic packaging to protect integrated circuits from corrosion-causing moisture and contaminants. With the mandate to utilize commercial components as much as possible to lower acquisition costs, non-hermetic, plastic encapsulated microcircuits (PEMs) are quickly being designed into new weapon systems and spare/redesigned electronics. To reduce the chances of corrosion on the surface of the IC within a PEM, the Army has initiated a Manufacturing Technology program to provide near-hermetic protection to ICs while they are still in the wafer form. The protection this coating provides will more readily allow the use of PEMs in weapon systems by eliminating moisture susceptibility concerns with off-the-shelf PEMs. This protective coating enables the development of new material formulations and processes that can focus on packaging requirements other than hermetic protection. The primary purpose of the encapsulant will now be to provide mechanical, thermal, and material compatibility between the mounting substrate (printed circuit board)

and the IC contained within the encapsulation. This topic solicits innovative and unique packaging methods, materials, and processes that exploit elimination of moisture protection requirements.

PHASE I: Investigate recently developed and previous existing polymer formulations for optimum electronic packaging characteristics. Material characteristics should allow rapid escape of moisture during thermal assembly operations to minimize pressure buildup that may lead to package fracturing (popcorning). Materials should also have coefficient of thermal expansion (CTE) and modulus of elasticity properties that minimize stress between the printed circuit board (PCB) substrate and integrated circuit. Polymers are inherently poor thermal conductors, so the material may need to contain compatible fillers that increase thermal conductivity. Other additives may include adhesion promoters and integral shielding to protect new low-voltage devices from induced transients. The proposer is encouraged to investigate all potential enhancements that may improve the performance and reliability of standard encapsulated microcircuits. Based on limited benchtop testing, a small family of materials should be selected during this phase for further investigation in Phase II. Material synthesis and packaging costs should be considered in the downselect.

PHASE II: Low cost, efficient methods of applying the selected materials to the integrated circuit package frame shall be investigated. This should include radical methods as well as standard and developmental methods such as molding, glob-top, spray, mass bonding of pre-fabricated packages, wafer level packaging, etc. The material formulations should be refined to optimize electrical/mechanical characteristics and enhance compatibility with selected processing methods. Processing costs for packaging shall be estimated and compared to industry standard costs. Design and fabricate test vehicles to prove electrical/mechanical/reliability/cost benefits of the new packaging materials and processes. The new materials and processes shall be demonstrated in a beta-line fashion. Document changes required for standard packaging lines and develop a performance/cost benefits business case.

PHASE III DUAL-USE APPLICATIONS: This topic will improve the performance, lower the cost, and improve reliability of nearly all electronic components used in weapon systems. Materials that need not provide significant moisture protection can be optimized for better thermal and mechanical characteristics, leading to increased operational cycles before failure, lowering replacement costs in the field. The commercial value of this topic is primarily in the potential for lower cost and more easily processable materials for high volume consumer electronics manufacturing (computers, cell phones, personal digital assistants, etc.) The increased thermal conductivity provided by these new materials should also allow further integration and density of integrated circuits, increasing functionality and reducing volume.

REFERENCES:
1. C. Reusnow, S. Purwin, "PEM Coating Program", Proceedings from the 1999 Military/Aerospace COTS Conference, 25-27 Aug 99, Berkeley, CA. (conference contacts listed at http://rac.iitri.org/cots_conf.html)

2. M. Loboda, R. Camilletti, et al, "Manufacturing Semiconductor Integrated Circuits with Built-In Hermetic Reliability", Proceedings of the 1996 Electronic Components and Technology Conference, May 96, Orlando, Florida.

KEYWORDS: electronic packaging, plastic encapsulated microcircuit PEM), encapsulants,polymers non-hermetic

A00-057 TITLE: Transient Jet-Interaction Combustion Modeling

TECHNOLOGY AREAS: Air Platform, Information Systems, Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Executive Officer, Air and Missle Defense

OBJECTIVE: To develop innovative models for the basic physical and thermochemical processes describing transient, three-dimensional, two-phase(gas-particle), chemically reacting jet-interaction flows which can replace the existing but inadequate models that inhibit development of the technology.

DESCRIPTION: Simulation and analysis of the detailed physics and thermochemistry associated with jet-interaction thrusters for missile control require high fidelity models for two-phase(gas-particle), chemically reacting jets in cross flows. Computational fluid dynamic (CFD) models are available which account for the two-phase and finite-rate chemical kinetics processes in solid propellant rocket combustors, nozzles and exhaust plumes; however, these models have proven to be largely inadequate for complex three-dimensional, two-phase (gas-particle), chemically reacting, transient lateral jet interactions with body flowfields. For example:

1. Transient flow phenomena has been shown in recent tests to be of utmost importance to jet-interaction modeling; yet, achieving even quasi-steady state solutions requires completely unacceptable computational times. Furthermore, domain decomposition on multiprocessor machines does not solve the run time dilemma because of the ever continuing need for greater grid resolution.

2. Achieving adequate grid resolution to capture the flowfield features becomes an unacceptably difficult task using structured grids.

3. Fluid and chemistry time scales are incompatible with consequent stiff matrices and small solution time steps.

4. Jet induced flow separation is not adequately modeled with two-equation, Reynolds averaged, turbulence models.

5. Current flowfield chemistry is laminar, not turbulent.

6. The solution methodology is fixed for the entire flowfield regardless of the dominant local physical processes, i.e. there is no intelligent solution methodology.

New, innovative, and improved approaches are needed to overcome these key limitations or problem areas with research directed towards:

1. Unstructured numerics using adaptive grid embedding to resolve critical scales.

2. An advanced nonlinear turbulence framework with compressibility and temperature/species fluctuation capabilities.

3. Strongly coupled particulate interaction effects including turbulence dispersion and modulation.

4. PDF (probability density function) methodology for turbulence/chemistry interactions.

5. Intelligent processor control for domain decomposition among multiprocessors coupled with flowfield interrogation to identify the dominant physical processes at the local level and apply the most applicable solution methodology to each domain.

6. Innovative solution techniques such that the required transient physical processes can be modeled while achieving solutions in a reasonable time period.

PHASE I:

Phase I proposals must demonstrate (1) a thorough understanding of the Topic area, (2) technical comprehension of key jet-interaction problem areas, and (3) previous computational fluid dynamics experience in modeling two-phase (nonequilibrium gas-particle), chemically reacting flows with a CFD code possessing those capabilities.
Technical approaches will be formulated in Phase I to address each of the above key problem areas for inclusion into computational fluid dynamic models utilized by the exhaust plume community. At least one innovative model will be coded and implemented during Phase I to assess the potential for Phase II success.

PHASE II:

The additional model improvements formulated in Phase I will be finalized, documented, coded, and incorporated into an existing Government computational fluid dynamics code. The improved computational fluid dynamics model will be run blind for a series of high-speed jet-interaction test cases for which detailed flowfield and body force/moment data is available to demonstrate the advanced capabilities for analyzing and modeling jet-interactions.

PHASE III: DUAL-USE APPLICATIONS:

For military applications, this technology is directly applicable to all guided missile systems. For commercial applications, this technology is directly applicable to advanced propulsion techniques for commercial applications such as high speed supersonic transports and single stage to orbit launch systems.

OPERATING AND SUPPORT COST (OSCAR) REDUCTION:

The SBIR research topic entitled "Transient Jet-Interaction Combustion Modeling" is oriented toward fundamental research of basic physical phenomena with direct application to mission objectives and any association with OSCR issues will be incidental.

REFERENCES:
1. Srivastava, B., "Lateral Jet Control of a Supersonic Missile: CFD Predictions and Comparison to Force and Moment Measurements," AIAA Journal of Spacecraft and Rockets, 33(2):140-146 (1998)

2. Srivastava, B., "Aerodynamic Performance of Supersonic Missile Body- and Wing Tip-Mounted Lateral Jets," AIAA Journal of Spacecraft and Rockets, 35(23):278-286 (1998)

3. Brandeis, J., and Gill, J., "Experimental Investigation of Super- and Hypersonic Jet Interaction on Missile Configurations," AIAA Journal of Spacecraft and Rockets, 35(3):296-302 (1998).

4. Praharaj, S.C., et.al., "CFD Computations to Scale Jet Interaction Effects from Tunnel to Flight," AIAA 97-0406, presented at the35th Aerospace Sciences Meeting and Exhibit, Reno, Nevada, 6-10 January 1997.

KEYWORDS: Jet-interaction, Turbulence models, Computational fluid dynamics, Separated flows, Two-phase (gas-particle) flow, Unstructured grids, Finite-rate chemistry, Numerical methods

A00-058 TITLE: Wave Equation Conduction Thermal Analysis Software Development

TECHNOLOGY AREAS: Information Systems, Materials/Processes

OBJECTIVE: The objective of this topic is to
1. Determine the mathematical relevancy of utilizing the wave equation for modeling in-depth heat conduction.
2. Identify specific systems in which use of the wave equation is required to accurately model in-depth thermal response of structures.
3. Develop analytical software for integration into existing tools to facilitate thermostructural analysis efforts involving design of laser systems, nozzle configurations, and radiation systems.

DESCRIPTION: The present method of predicting in-depth temperature response in thermostructural design and analysis is to use the Fourier's heat conduction equation. This approach expresses the conduction heat flux as a product of the conductivity of the material and local temperature gradient. Thus it implies that the conduction speed is infinite in any medium regardless of its temperature and composition. This assumption is generally acceptable in the majority of heat transfer problems. However, at extremely low temperatures and transient heat transfer at very short duration, heat flux is controlled not only by diffusion but also by a finite thermal wave speed. This proposed research topic is to examine the hyperbolic conduction equation through numerical analysis and experimental verification. The potential areas of application include biomedical, space and defense industry. The particular areas of applicability include laser technology, nozzle heating, and cryogenics. Commercialization of this research includes the development of commercially available software tools to be used by the medical industry for cryogenics and laser surgery, laser metal processing, space and defense industry for nozzle design and analysis as well as laser weaponry design and analysis. Additionally, with current interest in irradiating food products for safety, this analysis technique can be used to accurately define levels of irradiance. This technology represents a revolutionary change to modeling thermal response for the identified applications.

PHASE I: Phase I efforts would involve initial analytical evaluations of the importance and relative effects of using the hyperbolic equation (wave equation) as compared to the diffusion equation. Current state-of-the-art techniques of modeling pulse heat conduction will be assessed and compared to approaches using the wave equation. Based on these evaluations, novel methods will be identified to provide a more accurate prediction of highly transient heat conduction. Preliminary analytical tools will be generated and provided for in-house evaluation of relative effects in high temperature environments such as nozzle and laser heating.

PHASE II: Under Phase II, the analytical models developed under Phase I would be further enhanced through model validation and verification. A preliminary graphical user interface will be generated to facilitate the model validation and verification effort. This interface will serve as a pre- and post processor to assist in quantifying the thermal response of materials when exposed to a variety of thermal environments. A test and evaluation program will be defined and implemented to assess and enhance the analytical model accuracy for a variety of thermal environments and material behavior. These environments will include high performance nozzle heating, laser heating, cryogenics, and electronic chip fabrication. The material behavior will include conductive and charring materials typical of nozzle inserts, external composite airframes, and silicon used in the electronics industry. Following the validation and verification effort, the graphical user interface will be further enhanced through the coupling with existing in-house analytical tools and finite element analysis software in the prediction of heat transfer behavior for applicable environments and materials. The results of this effort will significantly enhance the state-of-the-art in conduction modeling for use in current military and commercial technologies such as nozzle systems, laser weapons and metal processing, cryogenics in electronics as well as biomedical and food applications using lasers and irradiation of food products.

PHASE III DUAL-USE APPLICATIONS: Particular defense programs that might benefit from this research include any system having nozzle heating and laser weaponry and damage modeling. Additionally, modeling of heat shield materials in high heat flux environments such as arc heaters, plume impingement, and hypersonics could potentially utilize the software development to more accurately design optimized systems. Systems designed with a removable shroud that is released near end game experience thermal pulse heating on structural and window materials that potentially require thermal modeling using the wave equation. The commercial applications are extensive for analyzing laser, cryogenics, and superconductor thermostructural response. With the increase use of laser surgery techniques, the requirement to more accurately model thermal response of skin and internal organ tissues is more demanding. The development of the proposed software will provide a means of performing analytical predictions prior to surgery. Additionally, the superconductor technology requires specific thermal analysis on a micro scale. This

incorporates Micro-Electro Mechanical Systems and corresponding analysis requirements. The National Science Foundation has provided funding in previous years directly supporting the preliminary research for Biomedical applications.

REFERENCES:
1. D.Y. Tzou, A Unified Field Approach for Heat Conduction from Macro- to Micro-Scales, Journal of Heat Transfer, Transactions of the American Society of Mechanical Engineers, February 1995, Vol. 117, p 8.

2. K. Mitra, et al, Experimental Evidence of Hyperbolic Heat Conduction in Processed Meat, Journal of Heat Transfer, Transactions of the American Society of Mechanical Engineers, August 1995, Vol. 117 p 568.

3. Yun-Sheng Xu and Zeng-Yuan Guo, Heat Wave Phenomena in IC Chips, International Journal of Heat and Mass Transfer, Vol. 38, No 15, pp 2919-2922, 1995.

4. D.Y. Tzou, Macro- to Microscale Heat Transfer, Taylor & Francis, Washington, DC, 1997.

KEYWORDS: Laser Weapons, Wave Equation, Heat Conduction, Super-conductors, Laser Surgery, Cryogenics, Nozzle Heating

A00-059 TITLE: High Resolution Precise Doppler Light Detection and Ranging (LIDAR)

TECHNOLOGY AREAS: Materials/Processes, Sensors

OBJECTIVE: The objective of this effort is to develop and build a reduced eye-hazard Doppler light detection and ranging (LIDAR) for detecting and determining wind velocity and turbulence above helicopters at greater than 5 kilometers. The spatial resolution of the LIDAR should be on the order of 1 meter and a velocity resolution on the order of 10-20 cm/s. The purpose of this system would be to aid in the detection of masked targets (i.e. helicopter) or atmospheric disturbances from signatures due to exhaust, debris particles displaced by the target(s), and/or disturbances caused by natural environmental phenomena.

DESCRIPTION: The LIDAR system should consist primarily of an eye-safe laser, telescope, receiving and transmitting optics, receiver, receiver(s), and a data collection and reduction mechanism which should include data processing, software, computer, etc. The system shall be portable and eye-safe, and have a performance range of 5 plus kilometers. The masked target will either create its own wind or turbulence, disturb the natural wind currents, and/or cause vibrations, thus making a detectable signature(s) for a Doppler LIDAR.

PHASE I: Phase I should consist of research and studies that lead to a design that will meet the needs as described in the Description above. This research and studies shall determine what components are required, the cost of the components, conceptual design based upon findings (including form, fit, and function), growth potential, risk factors (both technical and phenomenological) and their relevance, propagation at the selected wavelength as influenced by environments, data processing assessments, establishing LIDAR performance tradeoffs with range, scan times, optic size, and weight; a model of the performance of the system, and a final report.

PHASE II: Phase II should culminate in the demonstration of a prototype for evaluation. Phase II should be the building of the LIDAR system, performing signature tests with the system against objective targets, provide a complete system for evaluation and data collection purposes to the Optics and Laser Technology Area of Aviation and Missile Command's (AMCOM's) Research, Engineering and Development Center, and a final report documenting the LIDAR operation procedures and the results of the system tests. The SBIR contractor will retain the intellectual property rights of the prototype being evaluated.

PHASE III DUAL-USE APPLICATIONS: There is a need for a device that remotely determines the wind velocity in aviation. Aircraft must avoid vortices that are created by other aircraft, clear air turbulence avoidance and micro burst weather conditions that may lead to unstable or upsetting flight conditions. This system has the potential to be sufficiently sensitive that it may provide threshold signatures that may act as a precursor for adverse atmospheric conditions. Pending successful outcome of the prototype evaluation in Phase II, acquisition of this system may be accomplished during a Phase III effort.

REFERENCES:
1. Fundamentals of Photonics by Bahaa E. A. Saleh and Malvin Carl Teich; John Wiley and Sons, Inc. 1991

2. Laser Radar Systems by Albert V. Jelalian; Artech House, 1992

3. The Laser Guide Book by Jeff Hecht, McGraw-Hill, Inc, 1992

4. Edge technique for high-accuracy Doppler velocimetry, by Gentry and Korb; 'Applied Optics', 20 August 1994, Vol. 33, No.24

KEYWORDS:Laser Remote Sensing, Doppler LIDAR, Wind Velocity

A00-060 TITLE: Missile Aero-Acoustic Response Modeling

TECHNOLOGY AREAS: Information Systems, Materials/Processes, Sensors

OBJECTIVE:To develop an acoustic forcing function for computational fluid dynamics models which can be coupled to computational aero-acoustics and structural propagation models. The resultant comprehensive technology product will be used to predict the structural requirements for the sensitive electronic components in advanced missile designs.

DESCRIPTION: Continuing efforts to reduce cost have forced designers to forego the use of mil standard electronic components in sensitive missile sub-systems. This shift to commercially available hardware has and will continue to result in lower per-unit cost missiles; however, this implementation requires a sharpened design process to insure that these components will withstand the harsh environments experienced by missiles in flight and preclude costly post-production modifications. The development of a comprehensive technology product to predict the structural requirements for the sensitive electronic components in advanced missile designs will require the integration of the fluid dynamics, aero-acoustics, and structural mechanics models to produce a reliable, high-fidelity design tool. Existing state-of-the-art computational fluid dynamics (CFD) capabilities to model missiles in flight will be used as the starting point for this effort. Capabilities exist to account for the time-dependent prediction of missile aerodynamics; however an acoustics driver must be added to feed the aero- acoustics or external wave propagation model. Methodology for propagation of the acoustic waves is in hand but the application of this methodology is in its infancy. Additionally, an advanced structural wave propagation model must be developed for application to specific missile designs. This effort will focus on the initial step in comprehensive model development, the formulation and addition of an acoustics driver to a state-of-the-art computational fluid dynamics model.

PHASE I: Phase I proposals must demonstrate a thorough understanding of the Topic area and previous computational fluid dynamics experience in modeling multi-phase, nonequilibrium gas-particle, chemically reacting flows with a CFD code possessing those capabilities. Technical comprehension of key acoustic-aerodynamic interaction problem areas will be conveyed through detailed descriptions with proposed technical approaches for problem resolution. Technical approaches will be formulated in Phase I to address the key problem areas for inclusion into computational fluid dynamic models. At least one innovative model will be coded and implemented during Phase I to assess the potential for Phase II success.

PHASE II: The additional model improvements formulated in Phase I will be finalized, documented, coded, and incorporated into an existing Government computational fluid dynamics code AMCOM-2000. The improved computational fluid dynamics model will be run blind for a hypersonic vehicle with jet-interaction control for which detailed flowfield and body force/moment data will be available to demonstrate the advanced capabilities for modeling and analyzing the acoustics driving potential.

PHASE III: DUAL-USE APPLICATIONS: For military applications, this technology is directly applicable to all missile applications.
For commercial applications, this technology is directly applicable to advanced propulsion techniques for commercial applications such as high speed supersonic transports and single stage to orbit launch systems.

REFERENCES:
1. Hixon, R. and Turkel, E., "High-Accuracy Compact MacCormak- type Schemes for Computational Aeroacoustics", AIAA Aerospace Sciences Meeting and Exhibit, 13-15 Jan 1998, Paper No. AIAA-98-0365.
2. Tam, C., "Advances in Numerical Boundary Conditions for Computational Aeroacoustics", AIAA Computational Fluid Dynamics Conference, 29 Jun-2 Jul 1997, Paper No. AIAA-97-1774
3. Goodrich, J., "High Accuracy Finite Difference Algorithms for Computational Aeroacoustics," AIAA Aeroacoustics Conference, 14-14 Maqy 1997, Paper No. AIAA-97-1584.

KEYWORDS: Acoustics, missile, Aerodynamics, Computational fluid dynamics, Wave propagation, Driving

A00-061 TITLE: Polarization Laser Detection and Ranging (LADAR)

TECHNOLOGY AREAS: Materials/Processes, Sensors, Weapons

OBJECTIVE: Develop and build an imaging polarization portable laser detection and ranging (LADAR) sensor using polarized output beam(s) and detectors to see the difference in the polarization returns. The outputs of the LADAR should provide the Mueller Matrix elements. At a minimum the system should be able to give the Stokes Vectors. The system shall have a range of 1 to 5 plus kilometers, a range resolution of less than 3 inches (variable resolution desired), and a pointing/steering capability necessary to meet imaging LADAR performance objectives.

DESCRIPTION: The LADAR system shall consist primarily of an eye-safe laser, receiving and transmitting optics, receiver(s), precision pointing and steering capability (scanner), and data collection and reduction mechanisms to include software,

algorithms, and hardware. The system should also be portable. The system should be capable meeting less that 3 inches of spatial resolution over a range of from 500 meters to 5+ kilometers. This effort is not to develop polarization algorithms.

PHASE I: Phase I shall consist of research and studies to define the LADAR system design and performance. The research and study shall determine and include the following: the method of collecting the polarized data values that correspond to the Mueller Matrix elements, what components are required, cost of the components, a conceptual design based upon the findings (including form, fit, function), growth potential, risk factors and their relevance, data processing assessments, a performance model of the system, a weight optimization prediction, and a final report detailing the factors determined with supporting rationale.

PHASE II: Phase II should culminate in the demonstration of a prototype for evaluation. Phase II should be the building of the LADAR system, performing tests with the system against objective targets, provide a complete system for evaluation and data collection purposes to the Infrared and Optics Technology Area of Aviation and Missile Command's (AMCOM's) Aviation and Missile Research, Development and Engineering Center, and a final report documenting the LADAR operation procedures and the results of the system tests. The SBIR contractor will retain the intellectual property rights of the hardware being evaluated.

PHASE III DUAL-USE APPLICATIONS: There is a need for meteorologists to be able to determine if clouds are a formation of rain, fog, or ice to help determine the cloud/storm development. This technique may provide an approach that can resolve ice from rain; therefore, would aid the weather bureau in weather assessments and forecasting storm developments. There is possibly a large market in aviation. Polarization could be used for object avoidance; i.e. power lines, towers, and buildings. The amount of ice build up on objects such as aircraft, roads, etc. may also be determined using polarization. Polarization may also be used to help determine the amount of stress on vegetation to aid in irrigation and fertilization. Polarization LADAR sensors could also aid the auto industry in the detection and avoidance of black ice. Pending successful outcome of the prototype evaluation in Phase II, acquisition of this system may be accomplished during a Phase III effort.

REFERENCES:
1. Predicted Performance of Counter-Air Target ID Using IR Polarimetry, by F. Iannarilli and M. LeCompte; "Critical Technology", 25 January 1994, Restricted to DOD and DOD contractors

2. Simulated polarization diversity lidar returns from water and precipitating mixed phase clouds, by K. Sassen et.al; "Applied Optics", 20 May 1992, Vol. 31, No. 15

3. Remote sensing of crop parameters with a polarized, frequency-doubled Nd:YAG laser, by J. Kalshoven, Jr., et.al; 'Applied Optics', 20 May 1995, Vol. 34, No. 15

KEYWORDS:
Laser Remote Sensing, LADAR, Polarization

U.S. Army Medical Research and Materiel Command (MRMC)

A00-062 TITLE: Improvements in Generation of High-Density Microarrays

TECHNOLOGY AREAS: Biomedical, Electronics, Human Systems

OBJECTIVE: The objective of this SBIR topic is to support antimalarial drug discovery efforts by capitalizing on recent innovations in DNA de novo microarray technology. Specifically, we seek improvements in synthesis of microarrays and surface attachment chemistries. Enhancements in microarray technology supports the DoD's Biomedical Technology Area program in Infectious Diseases of Military Importance, and more specifically, the DTO MD12 Anti-Parasitic Drug Program.

DESCRIPTION: The focus of this effort will be to improve or replace the existing technology for the photolithographic synthesis or mechanical deposition (i.e., printing) of DNA sequences in silico. We seek an automated, alternative that will generate high-density oligonucleotide arrays or DNA de novo arrays with the following minimum characteristics: for oligonucleotide arrays, in silico synthesis method that does not employ photolithographic masks, oligo-separation distances <20 m, synthetic efficiencies >95%, and oligo-nucleotide lengths >30 bp; and for mechanical deposition of DNA microarray, diameters <100 m, center-to-center diameters <200 m, and will facilitate deposition of >10,000 DNA spots/oligonucleotides in silico not larger than 25 mm x 76 mm. The arrayer must synthesize or distribute the DNA product evenly across the entire diameter of the spot. In addition, the automated system should be self-contained in a humidity-controlled, HEPA-filtered chamber with the capacity to generate up to 100 slides per iteration. The design should include a high-throughput capacity for processing multiple 96 or 384 well plates. Printed or synthesized arrays should be amenable for reading on standard confocal laser scanners. Furthermore, we seek improvements in the derivitized surface substrates (not limited to silicon) that enhance DNA attachment, access for probe hybridization, and enhance signal-to-noise ratios during laser epi-fluorescence scanning. The

most common methods for microarray generation involve either deposition of DNA products or proprietary photolithographic methods. The former approach involves machined, split-pins which contact a derivitized silicon surface (silanized or poly-L-lysine coated glass slides). Pins typically deposit 1-4 nL volumes of product with spot diameters of 100-150 m and center-to-center diameters of 200-225 m. A drawback to this process is that far more DNA product is aspirated (mL) than deposited (nL), the pins may become deformed after numerous surface strikes, and maximum density cannot exceed 8,000 spots per slide. Furthermore, an artifact of this process is that spotted material tends to collect at the periphery creating a "doughnut" effect upon probe hybridization and confocal laser scanning. The latter approach may yield high-density arrays but the approach is considered proprietary, the manufacturing of photolithographic masks are cost prohibitive, and the oligonucleotide lengths limited to < 25 bp due to reduced coupling efficiencies. Improved methods for high-density DNA microarray generation will facilitate more efficient use of limited research resources. Furthermore, the capacity to include a higher density of DNA products on a solid support will increase our capacity and reduce costs for our drug discovery efforts to identify and validate candidate drug targets. Finally, the refinement of the printing process has broad appeal in other areas of military and civilian importance. This is a technology that may be considered for the dual use science and technology (DUST) and the dual use applications (DUAP) programs.

PHASE I: Evaluate and demonstrate utility of selected approach for meeting deposition criteria. Exit criteria includes data on increased microarray density and enhanced signal-to-noise ratios upon scanning compared to existing printing or synthetic in silico methods.

PHASE II: Refine prototype microarrayer and improve surface attachment chemistries for attachment of DNA products. Exit criteria include delivery of a refined version of the microarrayer and validated approach to enhance surface attachment chemistries.

PHASE III DUAL USE APPLICATIONS: The exploitation of this technology for antimalarial drug discovery may also yield significant advances in other areas of military and civilian importance. Clearly, a potential outcome of this technology is a state of the art approach which may be considered as a DUST/DUAP technology. Furthermore, the utility of this improved microarray technology is that it may serve as a common platform for drug and vaccine discovery, diagnosis, toxicology studies, and resistance monitoring for other infectious diseases of import to include leishmaniasis, HIV, and pathogenic bacterial and viral organisms. It is further anticipated that microarray technology enhancements may prove noteworthy as a platform for biological warfare agent detection.

REFERENCES:

Barry CE 3rd, et al. Use of genomics and combinatorial chemistry in the development of new antimycobacterial drugs. Biochem Pharmacol. 2000 Feb 1;59(3):221-31.

Freeman TC, et al. Analysis of gene expression in single cells. Curr Opin Biotechnol. 1999 Dec;10(6):579-82.

Friend SH. How DNA microarrays and expression profiling will affect clinical practice. BMJ. 1999 Nov 13;319(7220):1306. No abstract available.

Singh-Gasson S, et al. Maskless fabrication of light-directed oligonucleotide microarrays using a digital micromirror array. Nat Biotechnol. 1999 Oct;17(10):974-8.

Richmond CS, et al. Genome-wide expression profiling in Escherichia coli K-12. Nucleic Acids Res. 1999 Oct 1;27(19):3821-35.

Schraml P, et al. Tissue microarrays for gene amplification surveys in many different tumor types. Clin Cancer Res. 1999 Aug;5(8):1966-75.

Morozov VN, et al. Electrospray deposition as a method for mass fabrication of mono- and multicomponent microarrays of biological and biologically active substances. Anal Chem. 1999 Aug 1;71(15):3110-7.

Winzeler EA, et al. Fluorescence-based expression monitoring using microarrays. Methods Enzymol. 1999;306:3-18. Review. No abstract available.

Mir KU, et al. Determining the influence of structure on hybridization using oligonucleotide arrays. Nat Biotechnol. 1999 Aug;17(8):788-92.

Rockett JC, et al. Application of DNA arrays to toxicology. Environ Health Perspect. 1999 Aug;107(8):681-5.

Rodi CP, et al. Revolution through genomics in investigative and discovery toxicology. Toxicol Pathol. 1999 Jan-Feb;27(1):107-10. Review.

Ekins R, et al. Microarrays: their origins and applications. Trends Biotechnol. 1999 Jun;17(6):217-8. No abstract available.

Jones DA, et al. Genomics and the discovery of new drug targets. Curr Opin Chem Biol. 1999 Feb;3(1):71-6. Review.

Vo-Dinh T, et al. DNA biochip using a phototransistor integrated circuit. Anal Chem. 1999 Jan 15;71(2):358-63.

Debouck C, et al. DNA microarrays in drug discovery and development. Nat Genet. 1999. Jan;21(1 Suppl):48-50. Review.

Braxton S, et al. The integration of microarray information in the drug development process. Curr Opin Biotechnol. 1998 Dec;9(6):643-9. Review.

Watson A, et al. Technology for microarray analysis of gene expression. Curr Opin Biotechnol. 1998 Dec;9(6):609-14. Review.

Graves DJ, et al. System for preparing microhybridization arrays on glass slides. Anal Chem. 1998 Dec 1;70(23):5085-92.

Spellman PT, et al. Comprehensive identification of cell cycle-regulated genes of the yeast Saccharomyces cerevisiae by microarray hybridization. Mol Biol Cell. 1998 Dec;9(12):3273-97.

Marton MJ, et al. Drug target validation and identification of secondary drug target effects using DNA microarrays. Nat Med. 1998 Nov;4(11):1293-301.

Schena M, et al. Parallel human genome analysis: microarray-based expression monitoring of 1000 genes. Proc Natl Acad Sci U S A. 1996 Oct 1;93(20):10614-9.

Shalon D, et al. A DNA microarray system for analyzing complex DNA samples using two-color fluorescent probe hybridization. Genome Res. 1996 Jul;6(7):639-45.

Schena M. Genome analysis with gene expression microarrays. Bioessays. 1996 May;18(5):427-31. Review.

Schena M, et al. Quantitative monitoring of gene expression patterns with a complementary DNA microarray. Science. 1995 Oct 20;270(5235):467-70.

Healey BG, et al. Photodeposition of micrometer-scale polymer patterns on optical imaging fibers. Science. 1995 Aug 25;269(5227):1078-80.

KEYWORDS: Microarrays, Biotechnology, Drug Discovery and Development, Toxicology, and Diagnostics

A00-063 TITLE: Systems for Improved Freeze-Drying of Blood Products

TECHNOLOGY AREAS: Biomedical

OBJECTIVE: Improve the Availability of Blood Products for Emergency Use by Freeze-Drying

DESCRIPTION: Recent experience with the use of frozen blood products in the field has demonstrated significant loss of blood product units from storage bag breakage. Alternate storage methods of blood products (e.g. freeze-drying) would eliminate this loss and allow increased availability in remote locations but must not compromise quality, safety, or ease of use. Purified or partially purified plasma proteins have been successfully dried and freeze-dried. The objective is to freeze-dry blood products (red blood cells, plasma, platelets) within the collection bags. The limiting factor is the rate of water vapor removal. Technology to enhance water vapor removal applicable to red blood cells and whole plasma is available. The understanding of polymer chemistry, gas exchange across semi-permeable membranes and blood storage bag design is a minimal requirement for developing a successful storage product.

PHASE I: Identify those polymers that will a) not rupture at freeze-drying temperatures and b) enhance water vapor removal. Design and construct storage bag manufactured with the selected polymer(s) - the design will require additional structural features to facilitate the freeze-drying process and reduce the time required to successfully freeze-dry. Storage bags must conform to AABB and FDA standards and regulations.

PHASE II: Demonstrate efficacy of storage bags in reducing the time for primary and secondary drying of red blood cell, plasma and platelet preparations. Demonstrate efficacy of storage bags in reducing the moisture content of red blood cell, plasma and platelet preparations. Perform or participate in clinical testing of the defined storage solution to include conventional in vitro testing of the stored blood products followed by in vivo testing with autologous human blood product recovery and survival studies.

PHASE III DUAL USE APPLICATIONS: Produce and support use of such a storage bag during its introduction into clinical use. Addresses a market for provision of blood products in rural and disaster care situations where freezer facilities are not available.

REFERENCES:

Weinstein R, Sowemimo-Coler SO, Goodrich RP. Survival of lyophilized and reconstituted human red blood cells in vivo. Transfusion Clinique et Biologique 1995;6:427-32.

Read MS, Reddick RL, Bode AP et al. Preservation of hemostatic and structural properties of rehydrated lyophilized platelets: potential for long-term storage of dried platelets for transfusion. PNAS 1995;92:397-401.

KEYWORDS: blood, plasma, red blood cells, gas exchange, storage bag, freeze-drying, polymer

A00-064 TITLE: General Purpose Miniature Thermometer for Remote Monitoring of Soldiers

TECHNOLOGY AREAS: Biomedical, Human Systems

OBJECTIVE: Develop a state-of-the art medical thermometer that measures body-core temperature and skin temperatures in an ambulatory environment. These thermometers will function as stand alone devices or serve as ambulatory sensors in the Warfighter Physiologic Status Monitoring (WPSM) program. This system will meet two key research sensor requirements of the Warfighter Physiologic Status Monitoring program: skin temperature sensing at multiple sites, and cost effective body core temperature sensing.

DESCRIPTION: The envisioned system would consist of a self-contained temperature sensor with two packaging designs: a thin and somewhat flexible electronics substrate, which could be attached to the body with a small adhesive patch, and an ingestible pill design allowing the sensor to be swallowed. System requirements include: (1) accuracy of 0.10°C over a temperature range of 25 to 50°C, with an accuracy of 0.25°C in the adjacent temperature ranges of -30 to 25°C and 50 to 75°C, (2) no user calibration needed, (3) thermometers to transmit temperature, calibration data, sensor serial number, and other pertinent information by radio frequency (RF), (4) RF transmissions should conform to the WPSM RF network protocol standard, (5) thermometers should not be subject to cross talk even when multiple sensors are worn by one person, (6) acceptable sensor dimensions to allow both patch and pill designs to be implemented, (5) cost effectiveness, with a price per sensor in the $10 to $20 range. The system must ultimately meet FDA certification requirements as a medical thermometer, and support a telemetric link to allow for real time remote monitoring of individuals exposed to heat and cold stress. Expertise in RF transmission and receiver engineering, digital encoding, analog circuitry and firmware design and implementation, as well as specific expertise in electronic manufacturing, encapsulation, coating safety and biocompatibility, is recommended.

PHASE I: Review existing technologies and develop a high level system specification. This specification should provide enough detail on hardware, firmware, software, and system operation to show a viable engineering path forward.

PHASE II: Develop several prototypes in both the surface and ingestible package forms. Innovative approaches will be taken to provide a thin and flexible electronics substrate for the patch design. Provide test data demonstrating durability and functionality of the surface patch and ingestible sensors. Collect experimental data to confirm that the ingestible sensor transmits data reliably through tissue to a body worn receiver. This phase should culminate in a detailed specification (software, firmware, circuit board design, component descriptions, packaging designs, pill coatings, data on accuracy of temperature measurements and pill calibration, etc.) and the demonstration of a prototype system.

PHASE III: This phase focuses on (a) producing thermometer systems to the specification established in Phase II effort, and (b)performing the tests needed for FDA approval. The thermometer systems will include surface and ingestible temperature sensors and stand-alone temperature receiver units capable storing and displaying data from multiple sensors. The stand-alone receiver units will have enough computational power to apply modeling algorithms and provide alerts of both heat and cold stress. The ultimate goal is an accurate, easy-to-use thermometer system to meet the need for real time core temperature/skin temperature monitoring and management of heat stress in firefighters and personnel encapsulated in biological/ chemical protective ensembles, and for continuous temperature monitoring in hospital and home environments.

REFERENCES:

Fox, R.H., R. Goldsmith, and H.S. Wolff. The use of a radio pill to measure deep body temperature. J. Physiol. (Lond.) 160:22-23, 1961.

Kolka, M.A., M.D. Quigley, L.A. Blanchard, D.A. Toyota, and L.A. Stephenson. Validation of a temperature telemetry system during moderate and strenuous exercise. J. Therm. Biol. 18:203-310, 1993.

O'Brien, C., R.W. Hoyt, M.J. Buller, J.W. Castellani, and A.J. Young. Telemetry pill measurement of core temperature during active heating and cooling. Natick, MA: US Army Res. Inst. of Environ. Med., 1987 (Technical Report T97-8)(AD A328003).

Sparling, P.B., T.K. Snow, M.L. Millard-Stafford. Monitoring core temperature during exercise: ingestible sensor vs. rectal thermistor. Aviat. Space Environ. Med. 64:760-763, 1993.

KEYWORDS: core temperature, cold stress, thermal stress, hyperthermia, hypothermia, wearable sensor, infantry

A00-065 TITLE: Development of an Imaging Technique to Identify Angiogenesis

TECHNOLOGY AREAS: Biomedical

OBJECTIVE: Develop, design, and construct innovative screening modalities appropriate to the identification of new blood vessel formation.

DESCRIPTION: The development of improved screening modalities is needed to identify neoangiogenesis. The formation of new blood vessels is a critical component in the healing of many injuries, including surgical wounds, ulcers, non-union fractures (1, 2, 3), as well as the progression of diseases such as cancer (4). In addition, neoangeogenesis can be affected by common therapies, such as nonsteroidal anti-inflammatory drugs (5), and common personal behaviors, such as smoking (6). The ability to determine early in the course of an injury that there is an abnormally low rate of neovascularization could result in early intervention with standard treatments such as surgical intervention or antibiotic treatment. This technology could also identify patients who could be the best candidates for treatment with emerging angiogenic drugs, such as fibroblast growth factor (7) and platelet-derived growth factor (8). Additionally, evidence of on-going or apparently adequate angiogenesis may help soldiers avoid unnecessary additional tests or surgical interventions. More effective determination of neovascularization could reduce the morbidity of injuries, and potentially reduce mortality resulting from complications. In this fashion, soldiers may be returned to full duty more quickly, and with a shorter course of rehabilitation.
The goal of this solicitation is to develop the methodology to identify new vessel formation and confirm the validity of the technique(s). This could be accomplished by a number of complementary approaches involving imaging technology, improved contrast media or data reduction. Imaging technologies could include: (a) magnetic resonance angiography and/or perfusion (8); (b) doppler ultrasound angiography (9); or (c) CT angiography. Improved contrast media could be developed, increasing the sensitivity and resolution of current methods. Enhanced data reduction and analysis algorithms could be added to these other technologies to further accomplish this goal of improved detection of neoangiogenisis. Validity could be confirmed using phantoms that mimic human physiology and/or animal models of wound healing.

PHASE I: The objective of Phase I is to develop the screening modality to identify neoangiogenesis.

PHASE II: The objective of Phase II is to evaluate the technology in patients, as a potential marker for the progression and severity of injury or disease.

PHASE III DUAL USE APPLICATIONS: The development of a screening technique to identify neoangiogenesis would provide commercial potential in several clinical settings. This phase would involve clinical trials of the screening modality for Food and Drug Administration review of safety and efficacy. The complementary military application of this technology would include the ability to more efficiently detect and treat devitalized tissue associated with projectile injuries, crush injuries, blast injuries, and envenomization events from snakes and spiders. The utilization of this technology in military operational settings could contribute to more effective surgical intervention, reduce the numbers of surgeries required for wound debridement, and reduce morbidity and mortality

REFERENCES

1).Wynendaele, W., van Oosterom, A.T., Pawinski, A., de Bruijn, E.A., Maes, R.A. 1998. Angiogenesis: Possibilities for therapeutic interventions. Pharm World Sci. 20(6): 225-35.
2.)Swift, M.E, Kleinman, H.K., DiPietro, L.A. 1999. Impaired wound repair and delayed angiogenesis in aged mice. Lab. Invest. 79(12): 1479-87.
3.)Glowacki, J. 1998. Angiogenesis in fracture repair. Clin Orthop. 355 (Suppl): S82-9.
4.)Folkman, J. 1996. Fighting cancer by attacking its blood supply. Sci Am. 275
(3):150-4.
5.)Jones, M.K., Wang, H., Peskar, B.M., Levin, E., Itani, R.M., Sarfeh, I.J., Tarnawski, A.S. 1999. Inhibition of angiogenesis by nonsteroidal anti-inflammatory drugs: Insight into mechanisms and implications for cancer growth and ulcer healing. Nat Med. 5(12): 1418-23.
6.)Ma, L., Chow, J.Y., Liu, E.S., Cho, C.H. 1999. Cigarette smoke and its extract delays ulcer healing and reduces nitric oxide synthase activity and angiogenesis in rat stomach. Clin Exp. Pharmacol. Physiol. 26(10): 828-9.
7.)Radomsky, M.L., Thompson, A.Y., Spiro, R.C., Poser, J.W. 1998. Potential role of fibroblast growth factor in enhancement of fracture healing. Clin Orthop 335 (Suppl): S283-93.
8.)Bettegay, E.J. 1995. Angiogenesis: Mechanistic insights, neovascular diseases, and therapeutic prospects. J. Mol Med. 73(7): 333-46.

9.)Friedrich, M. 1998. MRI of the breast: State of the art. Eur Radiol. 8(5): 707-25.
10.)Ragde, H., Kenny, G.M., Murphy, G.P., Landin, K. 1997. Transrectal ultrasound microbubble contrast angiography of the prostate. Prostate 32(4): 279-83.

KEYWORDS: Angiogenesis, wound healing neovascularization,,

A00-066 TITLE: Development of a Multivalent Vaccine for Travelers' Diarrhea

TECHNOLOGY AREAS: Biomedical

OBJECTIVE: To develop and evaluate a combination vaccine that provides active protection against the three main causes of travelers' diarrhea (TD): enterotoxigenic Escherichia coli (ETEC), Campylobacter jejuni, and Shigella species.

DESCRIPTION: TD is by far the most common illness in persons traveling from developed countries to lesser developed countries; nearly half of the 100 million such persons experience an episode of TD. During the Persian Gulf War, more than half of Coalition troops reported at least one episode of diarrhea within 3-4 months of deployment. More recently, rates of diarrhea ranging from 25% to 50% have been observed in ground forces participating in exercises in Thailand, Egypt, and South America. TD is also a frequent problem aboard U.S. Naval vessels following foreign port calls; more than a thousand man-hours were lost to TD among sailors and flight crews subsequent to a 3-day visit to Alexandria, Egypt, by the USS Dwight D. Eisenhower. Bacterial pathogens are the etiologic agents in at least 50% of all laboratory-confirmed cases of TD. The most common of these agents is enterotoxin-producing E. coli, or ETEC; Shigella and Campylobacter are also important contributors to the overall burden of TD, and in some cases may be more significant than ETEC. The mix of diarrheal agents is dependent upon the geographic location, season, and length-of-stay of the traveler. An effective vaccine against TD should be aimed at all three of the agents. In addition to the benefit to civilian travelers, such a vaccine would substantially reduce the risk of TD for deployed military personnel and thus contribute to force readiness. There are currently no vaccines available for TD; however, clinical challenge studies and examination of the natural history of diarrheal disease indicate that at least short-term protection is attainable. The Department of Defense has long maintained basic and applied research programs on each of the etiologic pathogens of TD; it is now feasible to consider combining the vaccine candidate products developed in these programs to produce a multivalent vaccine. A number of antigens, including lipopolysaccharide of Shigella, colonization factor antigens and the enterotoxin of ETEC, and flagellin of Campylobacter contribute to protective immunity. In addition, several new mucosal adjuvants may improve overall immunogenicity and protective efficacy when co-administered with monovalent or multivalent vaccines.

PHASE I: Evaluate the potential of several targeted approaches as a basis for combined multi-agent TD vaccines. These approaches include vaccines comprised of: inactivated whole-cells, live-attenuated, live-recombinant carrier organisms, and subunit product candidates. Safety, immunogenicity, and the protective efficacy of selected vaccine prototypes will be assessed in experimental animals and/or in demonstration studies in volunteer human subjects.

PHASE II: Prepare clinical lots of the most promising combined vaccine candidates under Good Manufacturing Practices (GMP) procedures, conduct pre-clinical lot-release studies, and prepare documentation required by the U.S. Food and Drug Administration (FDA) in order to undertake human clinical trials under an Investigational New Drug (IND) application. Assess vaccine potency, safety, and immunogenicity in human volunteers. Evaluate mucosal adjuvants and various formulations with the experimental vaccines to optimize oral vaccine delivery schedule, dosage, and immunogenicity. Assess the protective efficacy of the most promising combined vaccine formulation in volunteer challenge studies.

PHASE III DUAL-USE COMMERCIALIZATION: Infectious diarrhea is a significant problem for persons traveling and working in developing countries. A safe and broadly effective vaccine could be commercially successful. Commercial markets for the potential of domestic, international, and DoD sales need to be evaluated.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: N/A

REFERENCES:

1. Hyams KC, Bourgeois AL, Merrell BR, Rozmajzi P, Escamilla J, Thornton SA, Wasserman GM, Burke A., Echeverria P, Green KY, Kapikian AZ, Woody JN. Diarrheal disease during Operation Desert Shield. N Engl J Med 1991;325:1423-8

2. Wolf MK. Occurrence, distribution, and associations of O and H serogroups, colonization factor antigens (CFAs), and toxins of enterotoxigenic E. coli. Clinical Microbiology Reviews 1997; 10:569-584.

3. Tacket CO, Reid RH, Boedeker EC, Losonsky G, Nataro JP, Bhagat H, Edelman R Enteral immunization and challenge of volunteers given enterotoxigenic E. coli CFA/II encapsulated in biodegradable microspheres. Vaccine 1994;12:1270-4

4. Coster TS, Hoge CW, VanDeVerg LL, Hartman AB, Oaks EV, Venkatesan MM, Cohen D, Robin G, Fontaine-Thompson A, Sansonetti PJ, Hale TL. Vaccination against shigellosis with attenuated Shigella flexneri 2a strain SC602. Infect Immun 1999;67:3437-43

5. Lee LH, Burg E 3rd, Baqar S, Bourgeois AL, Burr DH, Ewing CP, Trust TJ, Guerry P Evaluation of a truncated recombinant flagellin subunit vaccine against Campylobacter jejuni. Infect Immun 1999;67:5799-805

KEYWORDS: Vaccine, multivalent, travelers' diarrhea, Escherichia coli, ETEC, Shigella, Campylobacter, adjuvants, clinical trials, Department of Defense

A00-067 TITLE: Cold Sterilizer Solution for Sterilization of Medical Instruments in Austere Environments.

TECHNOLOGY AREAS: Biomedical

OBJECTIVE: A dry powder or highly concentrated liquid formulation that can be added to potable water or saline to produce a solution that will act as a general purpose disinfectant, a high level disinfectant or act as a sterilant for medical and dental instruments within 30 minutes at ambient temperatures (20 deg C +/- 10).

DESCRIPTION: A need exists to disinfect and sterilize medical or dental instruments in environments where standard heat and pressure sterilization methods are not available. The military is under continuous pressure to reduce the volume, weight, and size of items deployed to support troops in the field. An effective sterilizing solution will allow surgical/dental procedures to be performed in the absence of autoclave-based sterilization and therefore yield savings in logistic demands. Such a solution also has significant implications for care in rural, disaster, or other scenarios where sterilizing facilities are not available. This project would involve the formulation of a dry powder or highly concentrated liquid that, when added to potable water or saline solutions, will produce a solution that will effectively sterilize medical/dental equipment within 30 minutes to the same or better extent as autoclave-based sterilization methods. This sterilization will occur without damage to the medical equipment. This product in its final packaging should have a shelf life of at least two years with four desirable. The product should be environmentally friendly as to be safe for the user and can be easily disposed of as a nontoxic or readily degrades to nontoxic compounds. Ideally this cold disinfectant/sterilant solution could be reused over several hours before disposing.

PHASE I: Produce a trial powdered or highly concentrated liquid formulation that is capable of disinfecting and sterilizing appropriate categories of medical equipment purposely contaminated with known bacterial and viral agents. Outline required real-time testing protocol to achieve up to four years shelf life.

PHASE II: Expand tests of effectiveness of disinfectant and sterilizer formulations to simulated use and clinical trials to demonstrate effective sterilization of medical and dental equipment used on patients. The sterilization should occur within 30 minutes, at room temperature, be at least as effective as autoclave-based methods, and should show no damage to the medical equipment. Execute real-time shelf life testing. Submit a 510(k) Premarket Notification to the Food and Drug Administration for claim as sterilant/high level disinfectant. Submit for EPA registration for claim as General Purpose Disinfectant.

PHASE III DUAL USE APPLICATIONS: A powdered or highly concentrated liquid sterilization formulation has significant dual use application in medical situations in austere environments. This formulation could be useful in civilian medical/dental situations where autoclave-based sterilization is either not available, or where the sterilizer solution is more cost effective.

REFERENCES: Guidance for Industry and FDA Reviewers: Content and Format of Premarket Notification [510(k)] Submissions for Liquid Chemical Sterilants/High Level Disinfectants (Document issued on: January 3, 2000)

1 TITLE: [Peracetic acid: alternative to the sterilization of bronchofibroscopes]. AUTHORS: Villate JI, et al. SOURCE: Arch Bronconeumol. 1997 Mar;33(3):133-5. Spanish. CIT. IDS:PMID: 9181986 UI: 97261452

2 TITLE: Peracetic acid and its application to medical instrument sterilization. AUTHORS: Malchesky PS SOURCE: Artif Organs. 1993 Mar;17(3):147-52. CIT. IDS:PMID: 8215939 UI: 94029608

3 TITLE: Sterilization of reusable medical devices: evaluation of a liquid chemical sterilization process using peracetic acid. AUTHORS: Whitbourne J, et al. SOURCE: Minim Invasive Surg Nurs. 1995 Fall;9(3):111-7. No abstract available. CIT. IDS:PMID: 8680448 UI: 96317354

4 TITLE: Peracetic acid sterilization: a timely development for a busy healthcare industry. AUTHORS: Crow S SOURCE: Infect Control Hosp Epidemiol. 1992 Feb;13(2):111-3. No abstract available. CIT. IDS:PMID: 1541803 UI: 92176594

5 TITLE: Liquid chemical sterilization using peracetic acid. An alternative approach to endoscope processing. AUTHORS: Wallace CG, et al. SOURCE: ASAIO J. 1995 Apr-Jun;41(2):151-4. CIT. IDS:PMID: 7640418 UI: 95367708

6 TITLE: [Fiberoptic bronchoscope disinfection with glutaraldehyde phenolate in 1:8 solution]. AUTHORS: Rodriguez-Frojan G, et al. SOURCE: Arch Bronconeumol. 1994 Dec;30(10):485-8. Spanish. CIT. IDS:PMID: 7827761 UI: 95128528

7 TITLE: [Serum sterilization in the cold with peracetic acid]. AUTHORS: Sprossig M, et al. SOURCE: J Hyg Epidemiol Microbiol Immunol. 1976;21(2):157-63. German. CIT. IDS:PMID: 987107 UI: 77007580

8 TITLE: Use of biological indicators designed for steam or ethylene oxide to monitor a liquid chemical sterilization process. AUTHORS: Kralovic RC SOURCE: Infect Control Hosp Epidemiol. 1993 Jun;14(6):313-9. CIT. IDS:PMID: 8093121 UI: 93367186

9 TITLE: Comparative evaluation of the sporicidal activity of new low-temperature sterilization technologies: ethylene oxide, 2 plasma sterilization systems, and liquid peracetic acid. AUTHORS: Rutala WA, et al. SOURCE: Am J Infect Control. 1998 Aug;26(4):393-8. CIT. IDS:PMID: 9721391 UI: 98388277

10 TITLE: Evaluation of the Steris System 1 Peracetic Acid Endoscope Processor. AUTHORS: Bradley CR, et al. SOURCE: J Hosp Infect. 1995 Feb;29(2):143-51. CIT. IDS:PMID: 7759831 UI: 95279745

11 TITLE: Comparison of liquid chemical sterilization with peracetic acid and ethylene oxide sterilization for long narrow lumens. AUTHORS: Alfa MJ, et al. SOURCE: Am J Infect Control. 1998 Oct;26(5):469-77. CIT. IDS:PMID: 9795674 UI: 99011766

12 TITLE: Disinfection of bronchoscopes, contaminated in vitro with Mycobacterium tuberculosis, Mycobacterium avium-intracellulare and Mycobacterium chelonae in sputum, using stabilized, buffered peracetic acid solution ('Nu-Cidex'). AUTHORS: Middleton AM, et al. SOURCE: J Hosp Infect. 1997 Oct;37(2):137-43. CIT. IDS:PMID: 9364262 UI: 98030837

13 TITLE: New technology for sterilization and disinfection. AUTHORS: Nystrom B SOURCE: Am J Med. 1991 Sep 16;91(3B):264S-266S. CIT. IDS:PMID: 1928174 UI: 92026189

KEYWORDS: Sterilization, disinfectant, autoclave, bactericidal, solution, medical, dental

A00-068 TITLE: A System for Acquisition, Transmission, and Analysis of High Frequency EEG Signals for Real Time Determination of Alertness State

TECHNOLOGY AREAS: Biomedical

OBJECTIVE: Develop, construct, and demonstrate a system for acquisition of high frequency EEG signals using novel optrodes (optic sensors) for real time alertness monitoring and transmission of information to commanders at remote centers.

DESCRIPTION: The development of a system for continuous monitoring of alertness levels and sleep/wake status in real time is needed to assess cognitive performance in sustained (24 hours or longer) operational settings. Laboratory studies have shown that the potential for lapses in performance due to insufficient sleep may adversely impact on the inability to maintain high levels of performance around-the-clock. These studies show decrements in performance of 25% for each 24 hours of continued wakefulness. Cognitive function impairment with increasing sleep deprivation is a prelude to catastrophic events. In critical operations which must be sustained over extended periods of time and which require maximal effective performance levels, cognitive states of individual soldiers in units must be known with certainty by Commanders. This will allow timely, judicious decisions by field commanders, in enforcing sleep discipline for soldiers in need and thus assure effective group performance. No current ambulatory method for providing real time assessment of alertness and sleep/wake states with subsequent feedback to Commanders exists. Brain signals from electroencephalography (EEG) recording are the most direct and precise means to assess alertness levels and differentiation of sleep and wake status. The proposed system will acquire high frequency (1000Hz bandwidth) EEG signals using maintenance-free state-of-the-art optical sensors which, unlike conventional electrodes, require no special preparation nor conductive gel. Since signal acquisition and transmission are via optical pathways, electromagnetic interference is minimized or non-existent. Radio-frequency transmission of the acquired high frequency signals, directly to the soldier personal LAN (pLAN) for processing/analysis (using in-house developed and proprietary software) and results categorizing the soldier as awake, drowsy, not alert, or asleep. The system may also provide redundancy in determining life signs.

PHASE I: Assess and solve the technical problems associated with acquisition of high frequency EEG signals using optrodes as sensors and direct radio transmission to personal computer and remote sites.

PHASE II: Develop prototype hardware from Phase I and integrate with the processing and analysis software. The proposed system must acquire high frequency (1000Hz bandwidth) EEG signals using maintenance-free state-of-the-art optical sensors which, unlike conventional electrodes, require no special preparation nor conductive gel. The electromagnetic interference must

be minimal or non-existent. A series of evaluations must be conducted to assess the efficacy of the prototype system in controlled a laboratory environment.

PHASE III: Build and deliver to the government a complete system for ambulatory on-line, real-time acquisition and analysis of high frequency EEG signals and transmission of results to remote areas. This phase would include field testing of the system in operational environments. Besides the need for assessing cognitive performance in military settings, a simple, non-invasive, unobtrusive method of EEG signal acquisition with minimal electromagnetic field interference and high speed analysis, has many commercial applications such as in surgical suites to monitor anesthesia effects; for evaluating alertness levels of operators of heavy machinery, aviators, truck drivers, and other individuals in occupations demanding continuous high levels of performance

REFERENCES:

H.Sing, J. Williams, M. Thomas, R. Aladdin, A. Welsh, D. Thorne, T. Balkin, D. Redmond, N. Wesensten, M, Russo, L. Rowland, D. Johnson & G. Belenky (1998) Frequency Changes in a Wake EEG Related to Sleep Deprivaion. Journal of Sleep Research 7, Supplement 2:252

KEYWORDS: Alertness, Cognitive Performance, EEG

A00-069 TITLE: Synthesis of Combinatorial Chemical Libraries Containing Potential Inhibitors of Botulinum Neurotoxin Protease Activity

TECHNOLOGY AREAS: Biomedical

OBJECTIVE: To obtain and test combinatorial libraries of compounds, designed to be potential inhibitors of metalloproteases. These will be tested against the protease activities of botulinum neurotoxins, which have long been recognized as potential biological warfare agents. The structures of compounds that inhibit in the first round of screening will be modified and tested again. Multiple cycles of screening and structural modification will be performed, to obtain inhibitors that can serve as model compounds for anti-botulinum toxin drug development.

DESCRIPTION: Botulinum toxins are among the most lethal protein toxins, and are considered to be potential biowarfare and bioterrorist threat agents. Although botulinum vaccines are effective, safe and effective therapeutic drugs that could be used to treat personnel exposed to botulinum toxins are also needed. Unfortunately, at present, no such drugs exist. To this end, a promising avenue of research has been indicated by the discovery that that botulinum toxins are zinc metalloproteases, highly specific for certain proteins involved in neurotransmission (Schiavo, et al., 1995). Hydrolysis of these proteins, catalyzed by botulinum toxins, blocks neurotransmitter release. Therefore, compounds that inhibit the proteolytic activity of botulinum toxins could prove useful for anti-toxin drug development. Obtaining such compounds requires the ability to generate and test very large numbers of samples in a short time.

Current methods in combinatorial chemistry are capable of generating many thousands of compounds in a few days or less. For our purposes, libraries may consist of organic compounds, peptides, pseudopeptides, or peptidomimetics. Based on work with types A and B botulinum neurotoxins (Schmidt, et al., 1998; Martin, et al., 1999) and with similar enzymes (Powers and Harper, 1986: Turbanti, et al., 1993), the presence of a potential zinc-binding moiety such as sulfhydryl, hydroxylamino, or N-carboxyalkyl is necessary for inhibitory activity. For inhibition of type A toxin (but not type B), the presence of a guanidino group in each compound is also required (Schmidt, et al., 1998).

PHASE I: Synthesize four sets of first-generation combinatorial libraries. Within each set, each compound will contain one or more of the following functionalities: set 1, sulfhydryl; set 2, hydroxylamino; set 3, sulfhydryl and guanidino; set 4, hydroxylamino and guanidino. Test libraries for inhibition of types A and B botulinum proteolytic activity using high-throughput assays developed by Dr. Schmidt of USAMRIID.

PHASE II: Refine and resynthesize libraries, based on knowledge gained in phase I, to improve inhibition and obtain second-generation compounds. Test as described above.

PHASE III; DUAL USE APPLICATIONS: Knowledge and experience gained from the studies described above can be applied to develop therapeutic and prophylactic measures against other militarily relevant toxins that contain a protease, such as the lethal factor of anthrax toxin. In addition, because botulinum neurotoxins are currently used to treat a wide variety of muscle dysfunctions in humans, pharmaceutical firms would have an interest in drugs that modulate or inhibit botulinum toxin activity. Finally, drugs that could be used to treat outbreaks of botulism would be of importance to federal and state health agencies, and to the wildlife management and agriculture industry.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: At this time, to the best of my knowledge, no DoD laboratory performs combinatorial chemistry.

REFERENCES:

Martin, et al. (1999) J. Med. Chem. 42, 515.
Powers, J. C., and Harper, J. W. (1986) in Proteinase Inhibitors (A. Barret and G. Salvesen, Eds.), p. 219, Elsevier, New York.
Schmidt, et al. (1998) FEBS Lett. 435, 61.
Turbanti, et al. (1993) J. Med. Chem. 36, 699.

KEY WORDS: Combinatorial chemistry, botulinum, toxins, metalloproteases.

A00-070 TITLE: Telemedicine and Advanced Medical Technology - Medical Modeling and Simulation

TECHNOLOGY AREAS: Information Systems, Biomedical

NOTE: I replaced "Topic Text" above with the following re-write:

OBJECTIVE: To develop and to demonstrate a PC-based, general purpose surgical simulation workstation that combines a 3-D volumetric floating image and co-aligned force feedback to enable a highly realistic surgical simulation.

DESCRIPTION: In April 1998, the General Accounting Office (GAO/NSIAD-98-75, Medical Readiness, p. 2) reported, "military medical personnel have almost no chance during peacetime to practice battlefield trauma care skills. As a result, physicians both within and outside the Department of Defense (DOD) believe that military medical personnel are not prepared to provide trauma care to the severely injured soldiers in wartime…" Objective force concepts of operation require medical readiness capability for combat casualty care. This capability is achieved by providing initial and sustainment training to medical personnel. Development of modeling and simulation capability holds the most promise to meet the gaps that exist in medical training capability.

Based on our extensive meta-analysis of simulation in aerospace, other industries, and health care, no comprehensive capability exists to provide combat casualty care training through simulation.

Thus, there is a need to develop a PC-based, general purpose surgical simulation workstation that combines volumetric floating 3-D images with dual force haptics feedback interfaces to provide the visual and tactile fidelity necessary for surgical and combat casualty care training. The workstation must provide realistic, simulated representations of medical procedures. The system should provide glasses-free, full color, full parallax 3-D images that are projected into free space to provide access for force feedback interfaces. The 3-D images should have all of the characteristics of real 3D objects. The tactile object of the force feedback interface should be accurately co-aligned with the 3D visual image to provide a very realistic surgical training environment. The system should provide enough field of view for both the user and an intructor to see the image and the display mechanism must provide an image such that the spatial location of image features in independent of viewing direction.

PHASE I: Develop the concept and then design a realistic prototype of a medical / surgical modeling and simulation device to provide initial and sustainment training for military medical personnel in combat casualty care skills. Specifically, address a volumetric 3-D floating image display with a single co-aligned force feedback interface with minimal specifications as follows.

Technical performance parameters and/or objectives are:

Display resolution -Minimum total resolution of 5,000,000 voxels and minimum transverse resolution equivalent to VGA mode, i.e., 640 x 480.

Display color depth - Minimum 16 bits of color is requirement; 24 bits is preferred.

Display update rate - Should be in real-time rate in excess of 20-25 frames / second

Display frame rate - Should be "flicker-free", in excess of 40 hz. Minimum update rate of 20 hz or better.

Force-feedback interface update rate - Force feedback update rate should exceed 1,000/hz to provide "real-time" force feedback, that is to read encoders to determine position, perform contact detection, and output forces to the interface.

PHASE II:

Demonstrate a functional prototype of a full performance surgical simulation workstation. Provide a software Application Programming Interface (API) that will enable the development of arbitrary simulation applications. This prototype should include at least the capability to simulate one organ, limb, or whole trauma body as a surgical simulation.

PHASE III DUAL USE COMMERCIALIZATION: This general purpose platform is applicable to arbitrary military and civilian tactile task training. Additionally the workstation will be a powerful control station for telepresence battlefield surgical applications and telepresence robotic applications in remote exploration of underwater, outerspace, and dangerous radioactive, biological or chemical environments.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: N/A

KEY WORDS: Modeling and simulation, medical skills training, individual and unit training, medical force readiness, mission rehearsal, 3D display, force feedback, tactile training.

REFERENCES: NOTE: First reference is the hallmark textbook about Virtual [Simulated] Surgery, edited by Dr. Richard M. Satava, M.D.

Satava, Richard M., M.D., Editor (1998), Cybersurgery: Advanced Technologies for Surgical Practice", Published by John Wiley & Sons, New York, NY, 1998. ISBN # 0-471-15874-7

"Operational Capability Elements: Joint Medical Readiness," Page 6 (section 3.2.1), Joint Science and Technology Plan for Telemedicine (submitted to and approved by the DDR&E, 1 October 1997)

Chapter IV (section F), Joint Warfighting Science and Technology Plan (1997)

A00-071 TITLE: Development of a Vaccine for the Treatment and/or Prevention of Cancer

TECHNOLOGY AREAS: Biomedical

OBJECTIVE: Design, develop and manufacture safe and effective vaccine(s) for the prevention and treatment of cancer.

DESCRIPTION: The development of vaccine based therapy for the prevention and treatment of cancer would complement existing forms of therapy for this disease. This approach could also benefit patients whose disease cannot be treated by conventional therapies, such as those that cannot be resected surgically, or have spread to multiple sites. A potential vaccine could employ a number of different approaches, including basis on tumor cells, carbohydrates, peptides and heat-shock proteins, DNA-based vaccination and the use of recombinant bacteria and viruses to deliver antigens or the DNA coding for antigens to target cells (1, 2). The incorporation of dendritic cell technology in vaccine development also is an important advance (3). These leukocytes can be engineered to overexpress the antigen of interest, stimulating the immune system to induce protective and therapeutic immunity (4). These novel vaccine technologies could be used to develop preventative and treatment modalities against a number of diseases, including HIV, malaria, hepatitis, H. Pylori, as well as cancer (5, 6). The potential vaccine could have the ability to (1) safely induce the immune response in cancer patients against antigens associated with tumors and (2) have the potential to result in regression of an established tumor. A potent therapeutic vaccine could have the additional benefit of preventing the development of cancer in patients with high risk, or preventing recurrence in patients after initial treatment and remission.

PHASE I: The objective of Phase I is to develop the initial formulation of the vaccine that would be considered to have the potential for specific immunogenicity in patients with cancer.

PHASE II: The objective of Phase II is to (1) develop the clinical formulation of the vaccine and (2) conduct phase I and phase II clinical trials in patients with cancer to determine the safety and immunogenicity of the vaccine.

PHASE III DUAL USE APPLICATIONS: Currently available treatments have limited efficacy for a substantial proportion of patients and there are few preventative procedures that have been demonstrated to be effective to reduce the occurrence of cancer in patients at high risk. This technology may permit the development of better vaccines for military personnel and their dependents as well as civilian populations who are at high risk for cancer or recurrence of cancer. In addition, this technology may permit development of better vaccines, and their delivery, for military personnel who are deployed to geographical regions with exotic endemic disease as well as both military personnel and civilian populations exposed to biological agents.

References:

1) Chamberlain, R.S., 1999. Prospects for the therapeutic use of anticancer vaccines. Drugs, 57:309-325.
2) Restifo, N.P., Ying, H., Hwang, L., Leitner, W.W. 2000. The promise of nucleic acid vaccines. Gene Ther. 7: 89-92.
3) Matsue, H., Morita, A., Matsue, K., Takashima, A. 1999. New technologies toward dendritic cell-based cancer immunotherapies. J. Dermatol, 26:757-763.
4) Timmerman, J.M. 1999. Dendritic cell vaccines for cancer immunotherapy. Annu. Rev. Med. 50: 507-529.

5) Romano, G., Michell, P., Pacilio, C., Giordano, A. 2000. Latest developments in gene transfer technology: Achievements, perspectives and controversies over therapeutic applications. Stem Cells. 18: 19-39
6) Liang, T.J., Rehermann, B., Seeff, L.B., Hoofnagle, J.H. 2000. Pathogenesis, natural history, treatment and prevention of hepatitis C. Ann Intern Med. 132: 296-305.

KEYWORDS: Vaccine delivery, Therapeutics, Cancer

Natick Soldier Center (NSC)

A00-072 TITLE: Soldier Conformal Antenna Suite

TECHNOLOGY AREAS: Electronics, Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Project Manager Soldier

OBJECTIVE: Develop a suite of conformal, visually covert antennas and integrate the suite into the soldier clothing or equipment to provide reliable communications from standing to prone positions.

DESCRIPTION: Currently, soldiers use a 30 inch whip antenna for their squad radio that extends from their back pack. They also have two epaulet antennas for the GPS and the wireless LAN. These antennas are easily broken by trees and bushes, limit the soldier's mobility and performance, and are relatively inefficient radiators. A body conformal and visually covert antenna is desired that will not compromise the soldier's signature, provide an omni-directional polarized radiation pattern while standing or laying down, is operationally efficient in all warfighter positions, and does not inhibit the soldier's ability to perform his mission. The suite shall provide multi-frequency signal transmission and reception for the following frequencies:

30 to 88 MHz (Squad radio @ 5 - 10W output)
1750 to 1850 MHz (Soldier Radio @ 750 mW output)
2400 MHz (Soldier Radio @ 500 mW output)
1.375 GHz, 1.55 GHz (GPS, receive only)

A modular antenna suite is desired that may be configured to support various user and operation specific needs.

PHASE I: The technical feasibility to develop a body conformal antenna suite capable of being integrated into the soldier system will be established. The most effective materials and manufacturing processes will be determined and proposed for Phase II efforts. The target suite shall be safe to wear, body conformal, visually covert, flexible, lightweight, launderable, resistant to corrosion and water contamination, and durable to wear and tear. The study will result in a trade-off analysis comparing performance, manufacturability, and soldier safety. Note: Antenna system development and safety issues will be closely monitored with CECOM.

PHASE II: The contractor will develop, prototype and demonstrate the antenna suite proposed in Phase I. The contractor will provide one working prototype configuration of the antenna suite integrated into the soldier's clothing and/or equipment, and shall test the antenna suite with the communications systems.

PHASE III DUAL-USE APPLICATIONS: Electronic communication systems are becoming smaller and lighter and have the potential to be integrated into clothing systems. Durable, rugged, and visually covert antennas can be integrated into protective clothing and may be of interest to personnel working in the Fire Service, Law Enforcement, Urban Search and Rescue, and Medicine.

REFERENCES:
1. Pekka Salonen, et al., "A Small Planar Inverted-F Antenna for Wearable Applications," in Digest of Papers, The Third International Symposium on Wearable Computers 18 - 19 October 1999, Institute of Electrical and Electronics Engineers, Inc.

2. David Kopf, "Advanced Telecommunication and Information distribution Research program, Factor 1.4, Wireless Distribution Systems for the Soldier," U.S. Army Research Laboratory, Aberdeen, Maryland. Contract No. DAAL01-96-2-0002, 10 October, 1996. (available from Ms. Veronica Panciocco (508) 233-4389)

KEY WORDS: Antennas, Wearable Computers, Communication, Radio Frequency, Global Positioning, Microelectronics.

A00-073 TITLE: Cogeneration of Heat and Electricity for Military Equipment

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Manager Soldier Support

OBJECTIVE: Develop a system for new thermal fluid based military equipment which will simultaneously produce heat and electricity subsequently resulting in a significant increase in overall process efficiency, reduce weight and cube, and eliminate dependence on external power sources.

DESCRIPTION: Recent advances in organizational and field feeding equipment have resulted in significant energy savings for the military while simultaneously improving the life of soldiers, most notably with regard to field kitchens and laundries. Regardless of how beneficial these systems are, they do require electricity for their operation and reliance on external generators for this power is impractical and wasteful, particularly because of the small amount of electricity they require. However, the nature of these new kitchens and laundries is such that they are excellent candidates for the application of cogeneration strategies. Configured with efficient and powerful centralized thermal fluid heaters, these new systems need a relatively small amount of electric power. For the thermal fluid based kitchen, the heat load varies from 0 to 100 kW, while the electrical needs range from 3 to 5 kW. An acceptable cogenerator must maintain high efficiency (75% or higher) throughout the load range. Cogeneration is the integrated production of heat and electricity to maximize the efficiency of a system. For instance, waste heat from a burner may be used to generate electricity (bottoming cycle), or, waste heat from a generator may be used for heating purposes (topping cycle). One simple example of the topping cycle is scavenging heat from the exhaust of standard onboard logistical-fuel fired generators. Because internal combustion engines are inherently loud, complex and heavy, alternative approaches are sought. Possible technologies include, but are not limited to, stirling engine or other external combustion cycles, thermophotovoltaics, thermoacoustics, fuel cells or turbine engines. The fuel used by this equipment will invariably be JP8 or diesel. Added value to any developed cogeneration approach would be realized by the system's ability to be combined with heat producing devices such as incinerators such that they could recover what is otherwise a large amount of wasted energy.

PHASE I: Develop a cogeneration concept capable of producing 3-5 kW of electrical power and up 100 kW of heat. Demonstrate an entire system or critical subsystem that proves the feasibility of the approach. Demonstration of the system's ability to provide high efficiency (>75%) at a reasonably constant electrical output alongside variable heat output will be a critical factor in determining the success of Phase I. Ideal characteristics would be quiet operation (<65 dB at 1 meter), instantaneous power, and minimal weight (<500 lbs.) and cost (<$10k).

PHASE II: This phase will involve prototype design and fabrication for installation in an experimental mobile kitchen.

PHASE III DUAL-USE APPLICATIONS: The recent deregulation of the electric power industry has provided an opportunity for consumers to reduce their energy costs through cogeneration. Small scale cogenerators could be coupled with residential heating systems to generate free electric power resulting in consumer cost savings and decreased dependence on municipal power grids. A successful cogeneration system could be used in millions of homes and businesses to decrease nationwide power consumption, environmental pollution and reduce problems associated with power grid failures.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: This topic supports Operating and Support Cost Reduction (OSCR). Lowering operating costs is the primary purpose of cogeneration (smaller foot print and quiet operation are secondary). In field kitchens the generator consumes as much fuel as the burner used to heat appliances. By generating electric power from the heat source, the cost of operating and maintaining a separate engine driven generator can be avoided, and overall fuel consumption can be cut by 30-50%.

REFERENCES:
1. Hurley, J.R., Feasibility Study and Development of Modular Appliance Technologies, Centralized Heating (MATCH) Field Kitchen, US Army Natick RD&E Center, Technical Report Natick/TR-94/023, July 94.

2. Pickard, D.W., Thermal Fluid Heat Transfer: Revolutionary Change in Field Kitchen Design, US Army Soldier and Biological Chemical Command, Soldier Systems Center, NATICK/TP-99/053, June 99.

KEY WORDS: cogeneration, thermophotovoltaics, stirling cycle, thermoacoustics, waste heat, kitchens, laundries

A00-074 TITLE: Flame/Thermal Protective Fabric Test Apparatus

TECHNOLOGY AREAS: Materials/Processes, Human Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Project Manager Soldier

OBJECTIVE: To develop and construct, leading to eventual demonstration and commercialization, a compact and simple apparatus for flammability testing and procurement approval of flame/thermal protective fabrics.

DESCRIPTION: Flame/thermal hazards in the battlefield represent one of the threats the US soldiers are exposed to in combat or non-combat situations.1, 2 Military medical costs for soldier burn treatment were 8 million dollars in 1994 and the number of burn injuries and casualties are increasing.3 There is a need to provide flame/thermal protective clothing for the soldier. Current test apparatuses and procedures for testing the flame/thermal protective performance of military clothing fabrics and their procurement approval are not satisfactory. The Bunsen burner setup in the "Vertical Flame Resistance of Clothing" test method4 is a highly simplified method without any information on skin burn injuries. The "Thermal Protective Performance" test method 5 is an elaborate setup and too complicated to use by the textile industry. A simple yet realistic test apparatus is needed. While the incident heat flux levels and their exposure times on the soldiers depend on the particular fire scenario and vary, heat flux levels up to 2.4 cal/cm2/sec and exposure times up to 6 sec have been identified as the threshold values.6 The fire protective performance of a fabric is expressed in terms of the temperature rise and the heat energy absorbed by a heat sensor or a skin simulant adjacent to the fabric.7, 8,9 Innovative, practical, and user friendly design concepts and test procedures are essential for the test apparatus.

PHASE I: This phase will concentrate on the overall design of the apparatus and the individual components. Apply the latest material science technology, sensor/information processing technology, system design and integration, and heat transfer principles in the design. Considerations should be given to the simulation of the radiant spectral distribution of battlefield fires for the heat source of the apparatus, skin simulant/sensor design, skin temperature measurement and burn injury simulation techniques, data acquisition and processing, and system compactness and simplicity. Each of the system components will be designed, constructed and integrated together for a compact and simple prototype. Preliminary testing will be conducted to demonstrate its practical application for testing flame/thermal protective performance of commercial fabrics and their procurement approval for military use.

PHASE II: In this phase, the prototype will be further tested and improved. A compact and user-friendly apparatus will be constructed. Thorough evaluation of the improved prototype will be conducted in terms of its industrial use for flame/thermal protective performance testing. An apparatus ready for commercialization will then be constructed. Extensive fabric flame/thermal testing will be performed to demonstrate commercialization of the apparatus for fabric industry use.

PHASE III DUAL-USE APPLICATIONS: The apparatus is primarily built for
flame/thermal testing of commercial fabrics for military procurement purpose. The apparatus can also be used for testing of commercial fabrics for industrial use, such as fire protective fabrics for factory workers, power plant personnel, car racers, airline personnel, or any workers in a fire hazardous environment.

KEY WORDS: Fabric flammability testing, fire test apparatus, fabric heat transfer and skin burn simulation.

REFERENCES:
1. "Analysis of Combat Hazards for Balanced Protection", J. B. Sampson, D. W. Tucker, and D. C. Ridgeway, Technical Report Natick/TR-90/0121, US Army Natick R, D & E Center, Natick, MA 01760, Dec 1989.

2. "Front End Analysis of Flame Hazards", D. W. Tucker, J. B. Sampson, and S. A Rei, Technical Report Natick/TR-90/046L, US Army Natick R, D & E Center, Natick, MA 01760, July 1990.

3. "Soldier Flame/Thermal Hard Assessment", D. W. Tucker and S.A Rei, Natick Technical Report in press, US Army Natick Soldier Systems Center, Natick, MA 01760, 1999.

4. "Vertical Flame Resistance of Clothing", Federal Test Method FED TM
5903.1.

5. "Thermal Protective Performance", American Society of Testing and Materials, ASTM D4108.

6. "Battlefield Flame/Thermal Threats, Hazards and Protective Performance Criteria", I. Y. Kim, Natick Technical Report in preparation, US Army Natick Soldier Systems Center, Natick, MA 01760, 1999.

7. "A Critical Appraisal of Test Methods for Thermal Protective Clothing Fabrics", B. H. Hoschke, B. V. Holcombe, and A. M. Plante, Performance of Protective Clothing, 6th Volume, American Society of Testing and Materials, Philadelphia, 1997.

8. "A Study of New and Existing Bench Top Tests for Evaluating Fabrics for Flash Fire Protective Clothing", D. A. Torvi, J. D. Dale, M. Y. Ackerman and E. M. Crown, Performance of Protective Clothing, 6th Volume, American Society of Testing and Materials, Philadelphia, 1997.

9. "Thermal Protective Performance Test for Clothing" W. P. Behnke, Fire Technology, Vol. 13, No. 1, pp. 6-12, February, 1977.

KEY WORDS: Fabric flammability testing, fire test apparatus, fabric heat transfer and skin burn simulation

A00-075 TITLE: Thermoacoustic Refrigeration of Large Food Storage Containers

TECHNOLOGY AREAS: Materials/Processes, Human Systems

OBJECTIVE: Develop a thermoacoustic device to provide refrigeration for large food storage containers. Added value could be realized by utilizing waste heat as the driving power input.

DESCRIPTION: Thermoacoustics is the management of heat energy using sound waves. The application of computers to finite-element flow analysis techniques has recently resulted in a greater understanding of how sound waves are effected by vessel shapes. This has allowed improvement of thermoacoustic systems, namely toward decreased size and increased efficiency thus rendering them strong challengers to the vapor compression systems typically used for refrigeration applications. Thermoacoustic refrigeration however does not rely on complex hydrofluorocarbon (HFC) refrigerants or oils as working fluids and so avoids problems with EPA handling regulations and the increased training and maintenance technicalities of servicing high pressure sealed systems filled with controlled chemical substances Furthermore, with EPA regulations that have prohibited use of all chlorofluorocarbon (CFC) based refrigerants, we have seen a reduction in the efficiency and reliability of vapor compression systems using the alternative HFC compounds. This makes innovative refrigeration approaches all the more attractive. Because these devices contain only one moving part, their reliability is vastly superior to vapor compression, particularly in mobile applications that undergo severe vibration and shock. Another advantage of construction simplicity is curtailing of the parts procurement process and a decrease in tool inventory. Thermoacoustic refrigeration systems may be driven either electrically, or with heat. In the case of an electrically driven device, the power source may be 120-220 VAC and limited to output from common military generators. In the case of a heat driven version, the energy source could be an integral heat producing device such as a diesel burner, although some thought may be given to solar heating or utilizing waste heat from trash incineration or generator exhaust.

PHASE I: Develop a thermoacoustic device capable of providing enough cooling for a 40 cubic foot insulated container. The device's ability to utilize a minimum of electricity or waste heat energy will be a critical factor in determining success of Phase I.

PHASE II: This phase will involve packaging the device into a 40 cubic foot insulated food storage container and ensuring that it may be powered from field available sources. Performance evaluation of the prototype unit will be necessary to demonstrate concept viability.

PHASE III DUAL-USE APPLICATIONS: Thermoacoustic devices could be used anywhere refrigeration is required. Since they do not utilize hydrofluorocarbons and have only one moving part, they are strong competitors with the vapor compression systems commonly installed in billions of large and small refrigeration units worldwide. Their superior reliability and simplicity will save man-hours and logistical costs.

OPERATING AND SUPPORT COST REDUCTION (OSCR): This topic supports Operating and Support Cost Reduction (OSCR). Lowering maintenance and fuel costs is the primary purpose of thermoacoustic refrigeration. The use of thermoacoustic refrigeration systems will eliminate need for the increased training requirements and maintenance technicalities of servicing high pressure vapor compression systems filled with controlled substances. Also avoided are the handling difficulties and procurement and disposal costs inherent to chemicals used in current refrigeration systems. Reliability of thermoacoustic systems is vastly superior to vapor compression, particularly in mobile applications that undergo severe vibration and shock. This increased reliability will reduce food loss costs and delayed meals. Their construction simplicity avoids parts procurement hurdles and decreases tool inventory. The efficiency of electrically powered thermoacoustic cycles will rival their vapor compression counterparts. In field situations where electricity is produced with inefficient diesel generators, heat driven thermoacoustic systems would excel. And, if the heat is provided with waste heat from other processes, the energy is free. At any rate, this potential will greatly decrease fuel consumption and therefore associated logistics.

REFERENCES:
1. William G. Phillips, Home Technology - Furnaces, Popular Science, Page 39, Aug 1999.

2. S.L. Garrett, J.A Adeff, T.J. Hofler, Thermoacoustic Refrigerator for Space Applications, Journal of Thermophysics and Heat Transfer, Volume 7, Number 4, Pages 595-599, Oct-Dec 1993.

3. Lyndon B. Johnson Space Center, Thermoacoustic Refrigerator, NASA Tech Briefs, Volume 21 Number 11, Nov 1997.

4. Steven L. Garrett, Reinventing the Engine, Nature, Volume 399, Pages 303-305, May 27, 1999.

5. S. Backhaus, G.W. Swift, A Thermoacoustic Sterling Heat Engine, Nature, Volume 399, Pages 335-338, May 27, 1999.

6. Pennsilvania State University: http://www.acs.psu.edu/thermoacoustics.html

7. Thermoacoustic links from Yahoo for additional information http://av.yahoo.com/bin/search?p=Thermoacoustics&a=n

KEY WORDS: thermoacoustics, refrigeration, heat-driven, food storage

U.S Army Space and Missile Defense Command (SMDC)

A00-076 TITLE: Development of Radio Frequency Mitigation Technologies for Missile Defense Electronics

TECHNOLOGY AREAS: Electronics

OBJECTIVE: Identify, develop, and demonstrate techniques to protect missile defense radars, communication devices, and other electronic systems from hostile or co-site radio frequency (RF) and electromagnetic (EM) energy.

DESCRIPTION: The incorporation of modern microelectronics into military radar, communication, and sensor systems lowers their threshold for damage from RF and EM sources. Effects of RF and EM radiation can be mitigated through limiters and shielding. While there has been some research on new shielding technologies, significant improvements in limiter capabilities are required to reduce insertion losses, decrease turn-on time, reduce cost, and increase power handling capability. State-of-the-art front-end limiters fall into two categories: 1) very fast, high voltage limiters that are heavy and incompatible with solid state electronics and 2) very small, compact limiters that have limited power handling capabilities. Recent investigations into plasma limiters (Reference 1), fractal limiters, and other innovative front-end isolation techniques indicate the expectation that a new class of limiter can be developed having sub-nanosecond response times and that can reflect up to 10 kilowatts of RF power with very low insertion losses. These limiters are needed in the 10 MHz to 100 GHz frequency band, with primary emphasis in the 1 to 10 GHz region. It is unlikely that a single technology can effectively mitigate across this span of application, but solutions are desired that can mitigate RF effects over the broadest possible bands. While the primary focus of this effort is to protect radar front-end electronics, these limiter technologies will also be applicable to communications equipment and COTS electronics, such as computers. In addition to the limiter technology being sought, innovative RF shielding technologies that can protect from 100kHz to 100 GHz are also needed. Another area of research that has not been extensively investigated is the use of algorithms for mitigation of RF effects on system performance. Even with shielding and limiters, it is possible for some RF radiation to enter electronics. One method of ensuring that electronic systems function as required is to use a sense and respond algorithm that will monitor the performance of the operating electronics and then respond to anomalies generated by the RF interference.
All mitigation techniques proposed must be applicable to Commercial Off The Shelf (COTS) electronics. Because of the potential need to retrofit existing systems, the techniques must be low-cost and applicable to a wide variety of electronic systems.

PHASE I: Analyze, design, and conduct proof-of-principle demonstrations of practical techniques to protect military electronics from high-power external RF emissions.

PHASE II: Develop prototype protection devices and conduct tests to evaluate the performance of protection devices and protected equipment in challenging RF environments. Prepare detailed plans to implement demonstrated capabilities on critical military and commercial applications.

PHASE III DUAL USE APPLICATIONS: Dual applications exist for RF mitigation technologies with the commercial electronics industry. The RF environment that commercial radars, communications equipment, and other electronics are exposed to is becoming increasingly severe. The technologies developed through this research program will provide protection of both military and commercial electronics from both accidental and deliberate threats.

REFERENCES: [1] Kikel, A., et. al.; Plasma Limiters. AIAA paper AIAA-98-2564. 1998

KEYWORDS: Radio Frequency Mitigation, Electromagnetic Interference, Shielding, Limiters

A00-077 TITLE: Enhanced Munitions

TECHNOLOGY AREAS: Materials/Processes, Weapons

OBJECTIVE: The objectives of this effort are to develop enhanced explosive and nonexplosive medium caliber munitions (40-mm to 155-mm) or critical technologies that support these developments. These capabilities would be achieved by adding a directed energy capability or by using new advanced explosive/reactive materials to existing delivery systems.

DESCRIPTION: The radius of damage and the destructive power of conventional munitions is limited to that of the blast and fragments. The objectives of this effort are to extend the lethal range of munitions, increase the scope of the target set, and enhance destruction capability. A directed energy component, such as high power microwave or ultra wideband signals can

attack sensitive electronics and may have longer lethal ranges than blast waves and fragments [1-12]. Reactive materials can be achieved with new types of highly energetic explosives/reactive materials that can provide new sensor blinding and power system disruption mechanisms to enhance lethal damage to targets.

PHASE I: Identify potential technologies and analyze, design, and conduct proof-of-principle demonstrations to 1) verify that the output is predictable and is consistent with predictions and 2) to assess effects on various targets.

PHASE II: Design, build, and test enhanced prototype munitions and verify their capabilities under field conditions. Design production process for mass producing them.

PHASE III DUAL USE APPLICATIONS: The nonexplosive RF technologies developed under this effort could be applicable to multiple military and commercial applications requiring pulsed power. These include water purification units, nondestructive testing systems, magnetic resonant imaging systems, and lightning simulators. The explosive systems could be used for oil and mineral exploration.

REFERENCES:
[1] J. Benford and J. Swegle, High Power Microwaves, Artech House, Boston (1992).
[2] L. Altgilbers, M. Brown, I. Grishnaev, B. Novac, S. Tkach, Y. Tkach, Magnetocumulative Generators, Springer-Verlag, New York (1999).
[3] L. Altgilbers, et al, "Compact Explosive Driven Sources of Microwaves: Test Results", Megagauss 98 Proceedings, to be published.
[4] A.B. Prishchepenko, V.V. Kiseljov, and I.S. Kudimov, "Radio Frequency Weapon at the Future Battlefield", EUROEM, in Proceedings of EUROEM 94, Bordeaux (1994).
[5] A.B. Prishchepenko and V.P. Zhitnikov. "EM Weapon (EMW) in Air Defense or Some Aspects of Application of EM Radiation in the High-Frequency Band as a Striking Force", Air Defense Hearld, No. 7, pp. 51 - 55 (1993).
[6] A.B. Prishchepenko and V.P. Zhitnikov. "Microwave Ammunitions: SUMM CRIQUE", in Proceedings of AMREM 96, Albuquerque (1996).
[7] A.B. Prishchepenko, "Devices Built Around Permanent Magnets for Generating an Initial Current in Helical Explosive Magnetic Generators", Instruments and Experimentation Techniques, 38(4), Part 2, pp. 515 - 520 (1995).
[8] A.B. Prishchepenko and M.V. Shchelkachev, "Operating Regime of an Explosive Magnetic Field Compression Generator with a Capacitive Load with a Consideration of Magnetic Flux Losses", Journal of Applied Mechanics and Technical Physics, 32(6), pp. 848 - 854 (1991).
[9] Prishchepenko, A.B. and V.M. Shchelkachev. "The Work of the Implosive type Generator with Capacitive Load", Electricity, No. 7, pp. 54 - 57 (1997).
[10] A.A. Barmin and A.B. Prishchepenko, "Compression of a Magnetic Field in a Single Cyrstal by a Strong Converging Ionizing Shock Wave", in Megagauss Magnetic Field Generation and Pulsed Power Applications (eds. M. Cowan and R.B. Spielman), Nova Science Publ., New York, pp. 35 - 40 (1994).
[11] A.B. Prishchepenko, D.V. Tretjakov, and M.V. Shchelkachev. "Energy Balance by Explosive Piezoelectric Generator of Frequency Work", Electrical Technology, No. 1, pp. 141 - 145 (1997).
[12] A.B. Prishchepenko, "Electromagnetic Munitions", 96UM0427 Moscow Soldat Udachi, No. 3, pp. 45 - 46 (1996).

KEYWORDS: Munitions, Pulsed Power, Marx Generators, Magnetocumulative Generators, Magnetic Flux Generators, High Power Microwaves, Ultra Wideband, Hot Reactive Metals

A00-078 TITLE: Variable Optical Filter

TECHNOLOGY AREAS: Sensors, Electronics

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Executive Office – Army Missile Defense

OBJECTIVE: Develop and demonstrate an optical filter with transmission (1) variable over at least four orders of magnitude, (2) uniform over the aperture of the filter, and (3) uniform over the visible- and near-infrared- bands.

DESCRIPTION: Conventional cameras use a combination of exposure time and f-stop control (iris) to accommodate brightness ranges of up to six orders of magnitude. Commercial-Off-The-Shelf (COTS) and current state-of-the-art solid-state cameras on telescopes without f-stop control can use electronic shutters to compensate for changes of only three orders of magnitude in brightness. The closest available technology, LCD shutters, provides an insufficient range of transmission and does not adequately block near-infrared (NIR). Missile flight tests include events with large brightness changes. For example, reentry vehicles can brighten more than ten orders of magnitude in 20 seconds; a sensor configured to acquire high-altitude data will be badly saturated and exhibit artifacts at low altitudes. To supplement exposure-time control, a variable filter is needed which, on command, can rapidly change transmission over a range of at least four orders of magnitude. Transmission should change from one known value to another within one millisecond. It is convenient to have the available steps separated by no more than a

factor of two in transmission. Transmission must be uniform over the field of view and should match in the visible and NIR bands. While high transmission of NIR is desired to increase sensitivity, the ability to eliminate NIR is essential to reduce artifacts. (i. e., from 400 thru 1200 nanometers). While high transmission of NIR is desired to increase sensitivity, the ability to eliminate NIR (650 thru 1200 nanometers) is essential to reduce artifacts. Focal planes are typically <13 mm diagonally, but applications up to 60 mm are likely. The most desirable configuration would be a small, non-mechanical, electronically controlled unit, which can be located in or near the C-mount of a lensless solid-state camera. Trade studies can be performed to evaluate alternative solutions such as mechanical obscuration, variable reflectance, and variable passband.

PHASE I: Identify and compare the predicted performance of candidate technologies. Demonstrate proof-of-principle at a bench level of promising approach (es).

PHASE II: Develop, fabricate and evaluate prototype for selected technology. Conduct laboratory and field-testing to demonstrate performance in critical areas (e.g. control of transmission attenuation, focal plane size, frequency response, operational speed, and uniformity).

PHASE III DUAL USE APPLICATIONS: A non-mechanical device should enjoy wide use supporting the transition from traditional to solid-state imaging devices.

REFERENCES:

Brightness Calibration of Charge-Coupled Device Camera Systems, H. Zghal and H. El Maraghy, Opt. Eng. 39 (2), 336-346, Feb. 2000.

A Comparison of the Performance of Spatial-filtering and Time-of-flight Imaging Systems, D. Barnett and P. Smith, Applied Optics and Optoelectronics, Proceedings of the Fourth Applied Optics Division Conference of the Institute of Physics, Sept. 1996.

Optical Filter Design and Analysis, Chapter 7: Optical Measurements and Filter Analysis, C.K. Madsen, Wiley Interscience, New York, 1999.

An Overview of Thermal Imagers and Their Basic Components, D. Dovonan, et al, Applications of Photonic Technology: First International Conference on Applications of Photonic Technology, held Toronto Canada 1994, Plenum Press, New York, 1995.

CCDs for the Lyman Fuse Mission, L.J. Cheng, Applications of Photonic Technology: First International Conference on Applications of Photonic Technology, held Toronto Canada 1994, Plenum Press, New York, 1995.

J. Heflin, et al, SPIE 3147, 10, 1997.

J. Heflin et al, Appl. Physics Letters, Vol. 74 (4), pp. 495-497, 1999.

J. Heflin, et al, SPIE 2854, 162, 1996

G. Decher, et al, Thin Solid Films, 210/211, 831, 1992.

Web Reference: http://www.newport.com/Optics_and_Mechanics/Polarization_Optics/Liquid-Crystal_Light_Control_System/

KEYWORDS: Variable Filter, Optical Filter, Visible-band, Near-infrared

A00-079 TITLE: Mitigation of Magnetohydrodynamic (MHD) Electromagnetic Pulse (EMP) Effects on Long Lines for Missile Defense System and Infrastructure Protection

TECHNOLOGY AREAS: Electronics

OBJECTIVE: Identify, develop, and demonstrate low-cost techniques to protect military and critical infrastructure systems with long power and communication lines from the effects of MHD-EMP.

DESCRIPTION: Ground based missile defense systems and their supporting infrastructure rely on long line cables for power and communications. Solar geomagnetic storms in northern areas have disrupted equipment on the long lines of protected electrical distribution systems [Reference 1]. The response of nuclear MHD-EMP (E3) is similar to that produced by solar geomagnetic storms, but has a somewhat greater electric field intensity [Reference 2] and both can induce very high ground currents that can burnout AC transformers and cause other problems that may be expensive to fix and require replacement of items with long lead times. Because defense systems rely heavily on commercial infrastructure, we seek low-cost, widely-applicable mitigation technologies to alleviate the effects of MHD-EMP on military systems and their supporting infrastructure.

Mitigation will require safe and effective dissipation of very large currents and energy. Reference 2 provides an unclassified overview of the MHD-EMP environment in comparison with solar geomagnetic storms. The same mitigation technologies should be applicable to the reduction of currents induced by solar geomagnetic storms. The next solar maximum is predicted to occur during 2000. This should provide an outstanding opportunity to measure MHD effects on long lines and the mitigation technique effectiveness on systems of interest.

PHASE I: Analyze, design, and conduct proof-of-principle demonstrations of practical techniques to ensure operability of long-line electrical and communication systems when exposed to MHD-EMP and solar geomagnetic storm environments.

PHASE II: Develop prototype protection devices and conduct tests to evaluate the performance of protection devices and protected equipment in MHD-EMP environments. Prepare detailed plans to implement demonstrated capabilities on critical military and commercial applications.

PHASE III DUAL USE APPLICATIONS: Dual applications exist for MHD-EMP and solar geomagnetic storm mitigation technologies within the commercial electrical power distribution industry. Commercial power distributors must ensure that critical electrical systems remain operable in the presence of solar geomagnetic storms and post-EMP operability is critical to national military and economic recovery efforts. While northern power grids have some protection, severe solar storms in the past have caused widespread disruption. The protection technologies developed by this effort can be applied worldwide to ensure that long-line power and communication systems will not be disrupted by severe geomagnetic disturbances and nuclear MHD-EMP.

REFERENCES:
[1] What Utilities Learn From Disasters. Electrical World, November 1993, pp. 50-51
[2] Barnes, P.R., et al.; MHD-EMP Analysis and Protection. Defense Nuclear Agency Document DNA-TR-92-101; September 1993.

KEYWORDS: MHD-EMP, EMP Hardening, Geomagnetic Storms, Survivability

U.S. Army Tank, Automotive, and Armament Research Development and Engineering Center (TARDEC)

A00-080 TITLE: High-Temperature High-Power Silicon Carbide Power Device for Hybrid Vehicles

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

OBJECTIVE: Develop efficient, high-temperature, silicon carbide power semiconductor device for hybrid vehicles.

DESCRIPTION: Future Army hybrid vehicles will require efficient, reliable power devices for electric power conversion and traction motor control. Power devices must meet high current, voltage and power requirements and also improve performance. Improved performance must lead to sub-system benefits such as reductions in size, weight, and cost of converters and cooling systems, and increased efficiency. These lead to improved fuel economy and transportability, and lower overall cost. The extended temperature and operating frequency of power devices made from the novel semiconductor silicon carbide can be expected to provide this improved performance, but achieving this will require advances in device design, materials and processing. This projection is based on silicon carbide's material properties and the measured performance of prototype devices (ref 1). This SBIR addresses device design. It is the concensus among device experts that simply duplicating silicon device structures is not the best approach to silicon carbide device development. This SBIR calls for development of a novel silicon carbide device with the clear potential of meeting future Army needs for an efficient, reliable, rugged, non-latching device capable of operating at 250C and 50kHz, and scaling to 1500V and 2000A levels. High power/current density, and surge-withstand capability are desirable. The proposed device structure must not rely on a future solution to the problem of gate dielectric reliability at high temperature and electric field. Devices must be capable of parallel operation with good current sharing. Devices must be normally off.

PHASE I: Contractor shall design a silicon carbide device capable of meeting the above criteria. Contractor shall establish the feasibility of meeting these criteria through an analysis of device operation based on material parameters and device physics, and shall confirm using computational models. Contractor shall use computational models to predict electrical and thermal performance. All calculations and assumptions shall be reported. Contractor shall contrast proposed design with that of similar device structures reported in the open literature. Contractor shall fabricate a prototype silicon carbide power device according to the above design, and characterize it. Device ratings are at the discretion of the Contractor; the objective is to demonstrate feasibility. Deliverables will include bimonthly reports, a final report, codes or scripts used in the computational analysis, comparison study, fabrication procedures and test results. Contractor shall hold a final review meeting at TACOM near the end of Phase I.

PHASE II: Contractor shall use the results from the Phase I study to fabricate and characterize improved prototype silicon carbide power devices. Device ratings for this second batch shall be chosen to prove concept and provide needed design data, not necessarily to demonstrate maximum performance. Contractor shall analyze test results and refine and device design. Based on improved design, a third batch of prototype devices shall be fabricated, tested and evaluated. The target performance parameters for this final batch of devices shall be chosen to demonstrate all significant advantages, and should meet or exceed the following operating parameters: 300V, 250A/cm2, 250C, 50kHz. Contractor shall characterize parallel operation of devices, switching losses, and conduction losses. Reliability, and the feasibility of scaling devices to higher voltage and current levels shall be investigated. Contractor shall conduct a final review meeting at TACOM near end of Phase II. Deliverables will include bimonthly reports and a final report, including theoretical calculations, fabrication procedures, device test results, performance evaluations, and codes or scripts used in the analysis. Device deliverables shall be four (4) characterized prototype silicon carbide power devices from the final batch.

PHASE III DUAL USE APPLICATIONS: Devices can be expected to find application in military (4) Ground and Sea Vehicles in a wide range of electric power converters, including propulsion motor controllers, dc-dc converters, and power supplies. Robust, efficient, high-temperature, and high-power density operation is also be attractive for actuator controllers and power supplies in (1) Air Platforms and (8) Space Platforms, and power supplies for (10) Weapons systems. Extensive commercial applications can be expected in traction drives in electric vehicles, industrial motor drives, power converters, power supplies, robotics, and appliances.

REFERENCES:
1) M. Bhatnagar and B.J. Baliga, "Comparison of 6H-SiC, 3C-SiC, and Si for power devices," IEEE Trans. Electron Devices, vol. 40, pp. 645-655, March 1993.

KEYWORDS: power semiconductor, high-temperature, silicon carbide, hybrid vehicle

A00-081 TITLE: Bridging Anchorage Systems

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Heavy Tactical Vehicles

OBJECTIVE: To provide the US Army Engineer units an innovative approach for expedient semi-permanent anchorage systems. The primary performance parameter is that the anchorage system shall be readily transportable by the Multi-Role Bridge Company (MRBC) Units, specifically the M1977 Common Bridge Transporters (CBT), (20,000 lbs. capacity). A means of storage and emplacement using current MRBC equipment is desired, for example using the Bridge Adapter Pallet (BAP) with a tare weight of 6,000 lbs. or the M1077 PLS Flatrack with a tare weight of 3,200 lbs. The anchorage system shall be quickly and easily assembled by MOS 12 C bridge crewmembers in no more than 6 hours, and shall adaptable for various site conditions such as gap span, up to 2500 feet (desired); current speed, up to 8 feet per second (required), (up 10 feet per second (desired)); bank, shore and streambed conditions. The anchorage system shall allow for periodic opening of the waterway for river traffic and release of debris collected on the upstream side of the float bridge. The anchorage system shall permit the opening of the waterway without complete disassembly of the system.

DESCRIPTION: Anchorage systems are used to keep Military support bridging in place. They are more commonly used with float bridging instead of dry bridging systems. Both bridge types experience "walking" on the banks caused by the access and egress of vehicles. Float bridges also require anchorage to withstand the water currents flowing in the wet gap they span. Current anchorage systems are kedge anchors, which are dropped from individual pontons of the float bridge to the streambed, and a combination of overhead lines connected to towers at each shore and guy lines. These systems are time consuming to emplace, cumbersome to transport, and prohibit periodic opening of the waterway for river traffic.

PHASE I: Provide a definition of the problem, capturing the multiple variables which need to be accommodated. Examples include, but are not limited to, gap spans likely to be encountered, soil conditions at the shoreline and streambed, bank bearing conditions, and current velocities. Surveys of US Army Engineer Companies shall be conducted to collaborate with the defined scenarios. Provide an analysis of alternatives that identify advanced concept designs with improved performance over current systems. Technologies to be examined are lightweight yet strong materials, ergonomic features, and improved construction techniques. The advanced concept designs shall include details necessary to select systems to develop into prototypes in Phase II.

PHASE II: Develop the selected alternatives into prototype anchorage systems. Demonstrate their effectiveness and highlight their strengths and weaknesses in a variety of scenarios. Scale models and component simulations shall be used where practical during the early development. Phase II shall culminate with a full scale anchorage system demonstration with Multi Role Bridge Company assets.

PHASE III DUAL USE APPLICATIONS: An expedient anchorage system colud be adapted for use in commercial applications. An obvious example is with the Emergency Response industries. They could apply this expedient and easily assembled system during rescue missions in flood disasters. Beyond this, the basic technolgies being investigated in strong yet lightweight materials can be applied in commercial applications such as lifting and tie down slings and equipment.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Current bridge anchorage systems are over twenty years old, employ cumbersome materials and support equipment which is being phased out of the Multi Role Bridge Company. Materials are not readily on hand for units to use, and inventory is not upkept. This limits selection of crossing sites because the anchorage system components must be procured and shipped to prior to being used. The government does not own the data rights for many of the components and must rely on sole source purchases from orignial equipment manufacturers. By developing a system which Units can keep readily available, built of commercially available equipment, will reduce the overall costs of the Bridge Companies.

KEYWORDS: Anchorage, Bridge, Ribbon Bridge

A00-082 TITLE: Position Sensing and Situational Awareness for Robotic Vehicles

TECHNOLOGY AREAS: Sensors, Weapons

OBJECTIVE: To design and implement a system to provide accurate position and situational awareness for an unmanned ground vehicle.

DESCRIPTION: Autonomous and semi-autonomous unmanned ground vehicles (UGVs) will play a significant role in future AAN and 2010 follow on force projection concepts. The digital battlefield capability will allow them to operate synergistically with manned vehicle systems and multi-agent UGV units. The determination of both absolute and relative location is essential for a number of critical UGV mission functions including driving, path planning and navigation, obstacle detection and avoidance, tactical situational awareness, target acquisition and threat reconnaissance.

TARDEC is currently interested in technologies that relate to situational awareness and path planning and in integrating these technologies into a modular UGV platform. Of particular interest for this application are modules for determining vehicle position and the content and geometry of the local area, as well as an internal map to keep track of their relationship. The vehicle position information would rely on sensors such as a Global Position System (GPS) or a pseudo-GPS, inertial guidance systems and other sensors to determine the vehicle's location and heading. The local scene content would be determined by a passive multiple video or thermal camera system combined with state-of-the-art image understanding software. The third piece of the system would be an internal map for path planning and navigation purposes. The map information would include the local terrain geometry, objects in the local area, along with the location and orientation of the vehicle.

Additional features of interest would be the ability to employ the imaging system as a remote viewing and/or cueing device for manually estimating object locations and for target discrimination. A useful accessory would be a software module that would process visual or thermal sensor data and simulate different signature conditions for targets and backgrounds. This would aid in the testing and evaluation of the system under different conditions.

It is envisioned that these systems would communicate with each other. The GPS should provide information for updating the vehicle's position in the internal map. In addition to furnishing data about the vehicle's movement and position, the other navigation sensors could be used to update the geometry of the terrain that the vehicle is traversing. Any obstacles, hazards or changes in scene geometry determined by the passive image understanding system should be automatically incorporated into the map. The scene understanding algorithms may also require data from the navigation and map systems to aid in obstacle detection.

PHASE I: The first phase consists of designing each module, together with the architecture for the entire integrated system. The system consists of the navigation sensor module, the scene understanding module, the situational awareness map, and the communication protocol between them.

PHASE II: The second phase consists of building each of the three modules, which will then be assembled into an integrated prototype system based on the architecture developed in Phase I. At the end of the contract, the system will be evaluated by attaching it to a robotic vehicle and driving it through an obstacle course.

PHASE III DUAL USE APPLICATIONS: Phase III military applications include combat vehicles, reconnaissance vehicles, and supply vehicles. Phase III commercial applications include planetary rovers, police operations, fire-fighting and hazardous waste monitoring.

REFERENCES:
1. Borenstein, J., Everett, B., and Feng, L., "Navigating Mobile Robots: Systems and Techniques." A. K. Peters, Ltd., Wellesley, MA, 1996.

2. Arkin, R.C., "Behavior-Based Robotics," MIT Press, Cambridge, MA, 1998.

3. Neri, F., "Introductinon to Electronic Defense Systems," Artech House, Boston, MA. 1991.

4. "Unmanned Ground Vehicle Technology", SPIE Proc. 3693, Orlando, FL (1999).

KEYWORDS: scene understanding, GPS, robotic vehicle, situational awareness, path planning,

A00-083 TITLE: Wide-Angle Broadband Polarizing Beamsplitter

TECHNOLOGY AREAS: Materials/Processes, Electronics

OBJECTIVE: To develop a wide-angle, broadband (visible), polarizing beamsplitter. Such a beamsplitter is a leap-ahead optical technology component for advanced vision systems to be used on all military platforms.

DESCRIPTION: Beamsplitters are widely used in countless optical and electro-optical devices. Currently available polarizing beamsplitters can perform their function with very little loss in overall transmission, but they only operate well over narrow fields of view and spectral regions. Presently, they are not suitable for broadband, wide-angle devices and require more than 50%

improvement. Innovative and creative designs are required for a wide-angle, broadband (over the visible spectrum), polarizing beamsplitter. This device will double the light transmission of advanced vision system designs currently in development for military systems. It is very common to split light in optical components used in detection, imaging and communications devices. Such beamsplitters would have numerous commercial applications in many light-starved optical and electro-optical systems. The beamsplitter goals are: 1) split the incident unpolarized light into two transmitted portions, one of S-polarization and one of P-polarization. One portion shall be along a direction of travel equal to the incident light path, while the other portion shall be normal to the incident light path (as in a typical cube beamsplitter; other angles will be considered). 2) Perform the polarization split as requested in 1 above for all incident light angles +/- 65 degrees and for all colors throughout the visible spectrum (designs will be considered down to 11 degrees). 3) Polarization efficiency > 96% and extinction ratio > 50:1 for both S and P. 4) All optical surfaces shall be anti-reflection coated to maintain the highest transmission possible. These are only goals; significant flexibility will be extended to the contractor in order to allow for the development of technology to meet this challenging request. Applications of this technology include: projection TVs, liquid crystal displays & projectors, color copiers, and color printers, communications and computing components and vision systems. This beamsplitter device, if successfully developed, would revolutionize the optics industry by significantly improving the performance of numerous optical & electro-optical consumer products.

PHASE I: The contractor shall investigate, design, and provide proof-of-principle demonstration of a wide angle polarizing beamsplitter meeting the goals set forth in the project description. The deliverable under phase one would be a report including the theory for the proposed beamsplitter design and any experimental evidence taken by the contractor and from the literature which supports the theory.

PHASE II: The contractor will further develop the theory to describe the proposed beamsplitter design, supporting each assertion with laboratory data. The contractor will build three working prototypes of their design, with a clear working aperture of at least 5 inches in diameter, and provide the prototypes to the Government for evaluation. In addition, the contractor will provide data supporting their operation in a final report.

PHASE III DUAL USE APPLICATIONS: Phase three will involve teaming with major electro-optics component manufacturers who will provide requirements for inclusion of the beamsplitter into their commercial systems. Producers of medical and satellite imaging systems will be the primary commercial targets. In addition, military optical systems for virtually all air, land and sea platforms will benefit from this technology, a therefore much of phase three will concentrate on the introduction of the new component to military vision system producers.

KEYWORDS: optics, polarization

A00-084 TITLE: High-Speed High-Temperature Silicon Carbide Motor Drive Inverter for Hybrid Vehicles

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

OBJECTIVE: Develop a high-temperature high-speed motor-drive inverter using silicon carbide power devices and evaluate the advantages of this extended performance for hybrid vehicle applications .

DESCRIPTION: Prototype silicon carbide power devices have just become available. These devices are capable of operating at much higher temperatures and speeds than their silicon counterparts. Anticipated advantages of these capabilities are reduced harmonic losses, reduced filter size and weight, and improved cooling - but a systematic investigation is necessary to establish these and and to investigate other possible benefits. This SBIR calls for the development of a high-speed high-temperature silicon carbide motor-drive inverter to determine the benefits of this new operating regime for hybrid vehicle traction and actuation applications.

To provide a meaningful test, this bi-directional inverter must be capable of operating at power levels of at least 5 HP, and of operating at a minimum of 200C junction temperature and 30kHz switching frequency. In addition, the converter must be capable of working from a 300Vdc bus and producing low-harmonic variable-voltage variable-frequency output to drive a high speed AC motor. Main power devices and flyback diodes must be silicon carbide, but control and gate drives can be silicon. Control must be DSP-based and capable of being configured to operate in closed-loop torque control or closed-loop speed control. Contractor shall test and evaluate power converter performance driving a high-speed 3-phase AC induction motor. Measuring will be taken using an appropriate dynamometer and data acquisition system. Dynamometer/data acquisition system shall be capable of measuring motor torque, speed, power and efficiency, and inverter temperature, output power and efficiency.

PHASE I: Contractor shall design and build a bi-directional power converter with Digital signal Processing (DSP) control according to the above specifications using high speed silicon devices. This converter shall be capable of the specified high-speed operation, but high temperature operation is not required in Phase I. Contractor shall select and procure a suitable, matching high-speed ac-induction motor. Contractor shall demonstrate the capability of this silicon-based high-speed motor drive inverter to perform as specified above and at power levels of at least 5 HP. Contractor shall survey silicon carbide power

device sources and identify a source of appropriately rated silicon carbide devices. Based on the reported capability of these particular devices, Contractor shall perform a preliminary design of the high-speed high-temperature power converter. Based on this preliminary design, Contractor shall draft a test plan to explore the enhanced capabilities of converter, and to quantify benefits.

PHASE II: Contractor shall design appropriate high-temperature packaging for silicon carbide power devices. Contractor shall design appropriate thermal management system for high-temperature inverter. Based on Phase I design, and using same motor, Contractor shall design and build high-speed high-temperature silicon carbide based power converter. Contractor shall modify the Phase I control system or alter components as required, to optimize converter for silicon carbide devices. Contractor shall survey available silicon carbide sources and procure silicon carbide devices of appropriate ratings. Upon receipt of components, contractor shall characterize silicon carbide power devices to confirm their ratings and suitability for planned testing. The optimum ranges for temperature and inverter switching frequency shall be determined by the contractor based on device capabilities and projected application requirements. Contractor shall determine the full range of temperature, power, speed, and torque of the power converter/motor , and measure switching losses, conduction losses, inverter efficiency and motor efficiency. Based on an analysis of these results, Contractor shall estimate the projected benefits silicon carbide based power converters for hybrid vehicle applications

PHASE III DUAL USE APPLICATIONS: High-speed, efficient silicon carbide converters with reduced thermal management requirements can be expected to find application as motor controllers for ground vehicle propulsion and suspension actuators. These converters may find a secondary application as actuators for (1) Air Platforms. If performance scales to higher power levels, high-speed low-audible noise low-harmonic distortion silicon carbide converters may find application in Submarines. Commercial applications may include hybrid-electric automobiles and stationary industrial motor drives. Even at power levels demonstrated in this study, commercial applications may include air conditioning, heat pumps, and appliance motor drives.

REFERENCES:
1) "100kHz Operation of SiC Junction Controlled Thyristor (JCT) Switches Used in an All-Silicon Carbide PWM Inverter," S. Seshadri, W.B. Hall, N.B. Nguyen, F.A. Lindberg and P.A. Sanger, Abstracts of International Conference on Silicon Carbide and Related Materials 1999, Oct. 10-15, Research Triangle Park, pg 479.
2) "Silicon Carbide State of Development", T. Paul Chow, T. Burke, Proceedings of the 1999 Vehicle Technologies Alternative Propulsion Symposium, National Defense Industrial Assoc. Event #953, May3, 1999.
3) M. Bhatnagar and B.J. Baliga, "Comparison of 6H-SiC, 3C-SiC, and Si for power devices," IEEE Trans. Electron Devices, vol. 40, pp. 645-655, March 1993.

KEYWORDS: power converter, hybrid-vehicle, silicon carbide, power electronics, high temperature

A00-085 TITLE: Information Intelligence Based Program Management System

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: This research seeks to develop software analysis algorithms and intelligence approaches that integrate data mining and text analysis tools. Existing text analysis tools use term/phrase counts and co-occurrence frequencies to create relational groupings of information. Text analysis generally limits the relational analysis to a single field within the text. Data mining, on the other hand, looks for patterns of quantitative measures across multiple fields. Integrating data mining algorithms with a text analysis system would enable cross-field terms'/phrases' counts and co-occurrence frequencies patterns analyses. Free text analysis would also be supported. For example, terms'/phrases' counts and co-occurrence frequency patterns within and across set windows (e.g., sentences, paragraphs, sections and documents) would be researched for logic grouping potential. We strive to create an information intelligence tool for program managers. Techniques will be developed to analyze and link material needs documentation (e.g., as contained in Army Field Performance databases and Material Needs/S&T Master Plans) to open source R&D documented capabilities (e.g., as contained in such databases as INSPEC, EI Compendex, US Patents, etc). The derived relational analysis results will support systems engineering and R&D program decisions. The software analyses will develop relational groupings of material needs/capability requirements based on an integrated set of data mining and textual analysis algorithms. Quantitative measures of significance of derived requirements' relational groupings will be generated. Similar relational analyses of open source documented R&D will also be automated and links between the two sets of relational groupings provided.

DESCRIPTION: Significant quantitative data is maintained on system designs, operational performance, support requirements and failure mechanisms. Similarly, extensive literature abstract databases document summaries of government sponsored and commercially funded research and development activities. An information intelligence software analyses suite will be designed and developed to first reveal patterns and trends within material needs and field performance quantitative databases and create linkage mechanisms to related bibliometric analysis derived patterns and trends, as educed from research literature abstract files. The ultimate goal would be to have one common tool suite for both quantitative and literature abstract data files, which would support pattern & trend identification, and then linkage to file patterns & trends noted from a second database, either quantitative or text in nature. The developed tool suite could then enable automated full text, table and possibly figure analysis.

PHASE I: Prepare summary report on research on and evaluation of data mining and bibliometric (e.g., both free text and fixed format/field delineated) statistical analysis tools and capabilities. Develop a software design specification for an information intelligence system that would create an integrated data mining/bibliometric statistical analysis tool suite. Integration feasibility demonstration software shall be developed as evidence for justification of the phase II program.

PHASE II: A fully operational information intelligence software system shall be developed in accordance with the government approved, contractor prepared, software design specification. The software with supporting documentation shall be delivered and installed on a current government computer system. In addition to the integrated analysis tool set, the system software shall provide data import/export communication control and analyzed data file management, as well as operator friendly interface (e.g., menu drives, help support, etc.) and analyzed data visualization displays (i.e., graphs, maps, etc.).

POTENTIAL COMMERCIAL MARKET: The developed software system would support integrated product and process design (IPPD) and the evolution towards virtual manufacturing by creating the capability to link quantitative requirements/performance data with analyses of literature detailing capabilities and competencies. Commercial uses would span engineering design, market analysis,.. on to medical diagnosis/prognosis.

KEYWORDS: Data Mining, Latent Semantic Indexing, Natural Language Processing, Inductive Logic Programming, Fuzzy Analysis, Artificial Intelligence, Boolean and Statistical Analysis, Principle Components Analysis, Conceptual Clustering Analysis

A00-086 TITLE: Mission Payload for Small Urban Robots

TECHNOLOGY AREAS: Ground/Sea Vehicles

OBJECTIVE: Development of End Effectors/Mission Modules for small urban robots to perform Reconnaissance & Nuclear, Biological, Chemical (NBC) Detection.

DESCRIPTION: As Military Operations in Urban Terrain (MOUT) becomes more common the need for soldiers to operate in the danger of the Urban environment has increased. The ability for a soldier to gain information on an area of interest without being exposed to danger would reduce the risk of injury and help the soldier successfully perform difficult missions. Desired areas of concept development are in the areas of, but not limited to opening doors, device/camera emplacement, handling/identification of unexploded ordinance, stair climbing, cutting locks/hinges, marking areas of interest, target designation, silent movement, distracters, smoke, and RSTA (Reconnaissance, Surveillance, and Target Acquisition). These technologies will allow soldiers to gain entry to an area by sending back visual images (RSTA), or physically gaining entry to a building or area. Use of automated systems to perform the tasks is encouraged. An example would be to allow the user to send a command to open a door instead of having him control every movement to open the door. Use of lightweight materials, weather resistant packaging, and automated processes that reduce input required by the soldier are encouraged.

PHASE I: Design concepts incorporating chosen technologies in the description should be developed. So as not to develop a new chassis the mission module concepts should be planned to be demonstrated on an existing all terrain weather resistant small robotic vehicle chassis. All concepts will be evaluated for usefulness to the soldier and overall affordability. The top concepts will be chosen for phase II development.

PHASE II: Chosen Phase I concepts will be developed, fabricated, and integrated on the chosen surrogate platform using its respective control station. Capabilities of the prototype Robotic platforms with their developed mission payload technologies will be demonstrated to the government.

PHASE III DUAL USE APPLICATIONS: Developed end effectors could be used on the Tactical Mobile Robotics platforms (DARPA) or the Man Packable Robotics Systems platforms. Both of these programs are developing platforms that are small enough and light enough for a soldier to take into battle to give him new capabilities and reduce his exposure to hostile forces. Commercial use varies depending on which technologies are chosen for development. The stair climbing technology could be used on a wheelchair to give disabled people more mobility. Variations of lock & hinge cutting technology could be used to provide service where a human can not physically fit. Camera/Device emplacement technology can be used to place a camera or monitoring device where a human can not fit or can not go due to environmental contamination. An example use for this technology is emergency search and rescue operations.

REFERENCES: 1) Blitch, John "Additional Deployment Scenarios for UGV Research," Colorado School of Mines, 14 December 1994.

KEYWORDS: Robotic, End effector, mission module, Tactical Mobile Robotics (TMR) Man Packable Robotic Systems (MPRS).

U.S. Army Topographic Engineering Center (TEC)

A00-087 TITLE: Spatial Schema Generation Tools

TECHNOLOGY AREAS: Information Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Project Director, Combat Terrain Information Systems

OBJECTIVE: Peform applied research that will lead to the development and testing of a specification that defines the necessary information to logically model geospatial information (GI). Develop experimental tools and technology to automate the process of creating physical schema for geospatial database using these enhanced GI data content standards. The final results of this effort should provide GI schema building tools which (accompanied by well-defined specification to model GI) will simplify the process of creating physical database schema that supports various GI domains of importance to the Army.

DESCRIPTION: Information communities have (or are in the process of developing) a multitude of domain specific geospatial data content standards (soils, vegetation, transporation, utilities, etc.). These data content standards are often just a domain's dictionary of feature-attribute-domain terms or a classification hierachy. Though these data content standards often have an implied data model associated with each, these are typically high-level conceptual models. These standards, if implemented in geospatial systems by their respective communities, will help support data interoperability between organizations and systems.

However, for most GIS users it is not possible to implement these standards by creating a physical spatial database schema for commercial GIS software.

The primary reason it is difficult to implement these standards is the lack of specificity on how to model this information in a geospatial database and the lack of robust, easy-to-use tools for the various commerical spatial database technologies. It is possible to create a physical geospatial schema for each of these database technologies without a logical model; however, this task requires considerable interaction between a knowledgeable domain expert and a spatial database administrator (and an extensive modeling effort.) (Often the expertise required for this task are not available.) Also, without a well-defined logical model, the physical models created from these data content standards will vary greatly between various implementations and therefore impede interoperability.

What is needed is a well-defined specification for logically modelling GI that supports the most common commercial geospatial database technologies. This specification should serve as a template or framework to alter/enhance domain-specific GI data content standards with the necessary additional information. In additional, software tools will be needed to automate the process of creating physical schema for geospatial database from GI standards (using these enhanced, domain-specific, logical GI models.)

SCOPE: The focus of this project will be to perform research which leads to the development of a viable specification to logically model GI and software tools to generate physical database schema from logical GI models. This research involves: 1) examining various existing and emerging GI spatial database technology; (i.e. geospatial database technology based upon CAD engines, relational database engines, newer object-relational spatial database technology, and the few based upon object databases technology); 2) developing a framework (or template) for logically modeling GI; 3) testing this GI model specification by enhancing domain-specific GI data content standards; 4) developing the necessary interface definition to support the straightforward implementation of these logical data models into common commercial GI database schema; 5) prototyping software tools to create physical database schemas (modelled after enhanced data content standards) for commercial GIS/geospatial database technology commonly used by the Army.

PHASE I: Perform research, experimentation, and documentation of a specification for logically modeling GI (which includes data structure, semantics, and the development of an IDL model interface definition.) Develop prototype (proof-of-concept) tools to create physical spatial database schemas for commercial spatial database technology from these logical modelled data content standards.

PHASE II: Enhance prototype schema tools and GI model specification through user feedback to result in robust specification and easy-to-use tools that can create physical schema for commercial GIS/spatial database technology. These tools should target 3 or more specific commercial GIS/spatial database platforms (e.g., Oracle SC, ESRI ARC/INFO & SDE, Integraph MGE & Geomedia, Autodesk) used by the Army and Army Corps of Engineers for spatial DB systems.

PHASE III: Commercialize the software tools (and potential services) for both military and civil application.

Currently most GIS users hire an engineering/ support contractor to build their physical GIS database schema for a specific commercial product. (Many times these schemas are proprietary.) The availablity of spatial database schema generation tools, together with a specification for conceptually modeling GI, would be very useful for all GI users (both military and civilian). These simple to use 3rd party tools to generate physical schemas for commercial GIS databases will permit these organizations to save money and allows user control of their spatial databases. (GIS vendors are also interested in the availability of such tools because it helps them sell more products.)

REFERENCES: CADD/GIS Center for Facilities, Infrastructure, and Environment (formerly the Tri-Services CADD/GIS Technology Center), "Tri-Services Spatial Data Standards," Release 1.80, February 1999.

KEYWORDS: Spatial Database Schema, GIS, Spatial Data Warehouse

U.S. Army Waterways Experiment Station (WES)

A00-088 TITLE: An Ultrasonic Tomography System for Imaging Reinforcement Steel in Concrete Bridge Girders

TECHNOLOGY AREAS: Materials/Processes, Sensors

OBJECTIVE: To design, develop, test, and demonstrate an ultrasonic tomography system for imaging the cross-sectional area of bridge girders.

DESCRIPTION: From this image the user can determine the number of layers, number of bars, size, and position of reinforcing steel. Rapid movement and sustainment of troops depend upon the safe use of existing bridges to maximum capacity. To that end the bridge's Military Load Capacity (MLC) must be rapidly and accurately obtainable. A research program is currently underway at the U.S. Army Engineer, Engineering Research and Development Center (ERDC) to develop a computer-automated analytical methodology for this purpose, based upon the analytical procedures from FM5-446. These analytical methods are highly effective for most bridge types. However, in the case of reinforced or pre-stressed concrete bridges for which the internal steel reinforcement is unknown, they can only provide overly conservative, low accuracy MLC ratings. This problem became readily apparent during recent operations in the Balkans, where most of the bridges were of reinforced concrete and no steel reinforcing details were available. Conservative estimates of the internal reinforcement were necessary, resulting in possibly overly conservative MLC ratings that needlessly limited troop mobility. For this problem, a nondestructive technology is required to "look inside" the concrete and map the internal steel reinforcement. Some technologies, such as magnetic-based pachometers are currently available for this purpose. However, they are very limited in capability, especially for the typical example of multiple, deeply buried reinforcing. An ultrasonic technique known as computed tomography (CT) appears to offer a better solution to this problem. Tomography is currently being used for such purposes as imaging body parts in the medical field using both CT from X-rays and ultrasonics and from magnetic resonance imaging (MRI) and for seismic imaging of the earth. In the case of bridge girders, ultrasonic shots will be made in a wide variety of angles around the base and both sides of the girder and an overdetermined system of linear equations will be solved in real time to resolve the properties of the cross-sectional area of the girder plotted in the form of pixels. With some work, it is believed that ultrasonic tomography can be adapted for use in a military field environment for the location and definition of internal steel reinforcement. The system will be portable and user-friendly for battlefield diagnostics. The system will provide a tomogram of the cross-sectional profile of the girder. From that tomogram the number of steel bars, the size of the steel bars, and their position can be accurately determined and fed as input data into the computer-automated methodology mentioned above to aid in the determination of the MLC. Tomographic measurements require thousands of readings. In general, the final image resolution is related to the number of measurements and the coverage of those measurements. Because it is impractical to manually position the transducers for these thousands of readings, a scanning system is needed. Examples of potential technologies that might allow for practical data collection include wheel transducers, fixed arrays, and electromechanical drives.

PHASE I: Determine feasibility of system and document plans for further development of hardware and software. The major tasks are to screen a few of the many seismic inversion algorithms that exist and that potentially can be applied to this problem, to image data obtained from existing ultrasonic transducers on concrete models containing reinforcing steel, and to study the potential to package a portable and user-friendly system for the field that can be easily and efficiently used by the soldier. ERDC can assist the proposer in the aspects of the ultrasonic measurements in concrete and with the field system but would expect the proposer to have significant expertise on their knowledge of inversion algorithms and their modification.

PHASE II: Further screen existing inversion algorithms and refine the final inversion software to optimize the image. Provide to the computer code any a priori information about the bridge girder. For example, the concrete properties will normally be uniform and the ultrasonic velocity will lie in a narrow range. The shape of the steel is roughly circular and its velocity also lies in a narrow range. Other a priori information may be possible. Incorporate modifications to transducers such as frequency, damping, focussing, etc. that will improve the data that can be obtained with the transducers. Package scanning system, position encoders, transducers, software, computer, etc. into a field-worthy, portable, and user-friendly device.

PHASE III, DUAL-USE COMMERCIALIZATION: The results of this research will have broad-based commercial potential in the development of sensor and image interpretation algorithms. Additionally, results will benefit both the civilian and military communities through the nondestructive diagnosis of concrete bridges and other reinforced concrete elements.

REFERENCES:

Army Field Manual, FM5-446 "Military Nonstandard Fixed Bridges".

Atkinson, R.H. and Schuller, M. P. "Characterization of Concrete Condition Using Acoustic Tomographic Imaging", Phase I SBIR Technical Report, 1994. Contract Number Nuclear Regulatory Commission-04-93-094.

ASTM Designation E 1441 - 97. "Standard Guide for Computed Tomography (CT) Imaging."

Jackson, Michael J. and Tweeton, Daryl R. "3DTOM: Three-Dimensional Geophysical Tomography", United States Department of the Interior, Bureau of Mines, Report of Investigations No. 9617, 1996.

Olson, Larry D. "Ultrasonic Tomography for Imaging of Consolidation and Other Defects in Structural Concrete", ACI Session, Oct. 1998.

Stewart, Robert R. "Exploration Seismic Tomography: Fundamentals," Society of Exploration Geophysicists, Course Notes Series, Volume 3, S. N. Domenico, Editor, 1992, ISBN 0-931830-48-6 (Series), ISBN 1-56080-052-6.

KEYWORDS: Ultrasonics, Ultrasonic Computed Tomography, Nondestructive testing, Imagery, Inversion

A00-089 TITLE: Rapid Prediction of Pavement Performance Using Time Dependent Surface Deflection Profiles, Obtained Under Rolling Wheel Loads

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Design and build both the hardware and software components of a system for measuring pavement surface deflections that are induced by rolling military vehicles. These measurements would then be used for either: (1) predicting pavement performance under known sustained traffic or (2) classifying the pavement's structural capacity in terms of a numeric parameter, such as a military load classification (MLC) number.

DESCRIPTION: Predicting the performance of a roadway over time, given traffic and environmental conditions, is an extremely complex problem. Military personnel confront this problem on a regular basis, whenever vehicles are used to move personnel or equipment. If military operations are on foreign soil, the complexity of the problem is increased by lack of knowledge concerning foundation soil, pavement material characteristics, and pavement structural thicknesses. When operating near unfriendly territory, the problem can be further complicated by lack of time and the need to keep equipment light and portable. Surface deflections can provide important information concerning the structural capacity of a roadway, and thus improve the accuracy of performance predictions (1-3). Pavement engineers commonly use nondestructive testing (NDT) equipment, such as the falling-weight deflectometer, to measure these surface deflections. These data enable engineers to predict pavement structural characteristics, such as pavement layer stiffnesses (4). These current systems, however, are not easily transported to remote locations and their usefulness is limited by the fact that the loads are imposed by the impact of a falling mass, rather than by rolling vehicle wheels. Advanced NDT equipment, such as the rolling wheel deflectometer, are under development, but these devices have shown limited success and they may never offer the portability needed for military operations. To characterize the structural capacity of a pavement section within a transportation route, surface deflections would only have to be measured under one or two critical vehicles among all the vehicles in transport. The critical vehicles would be those which impose relatively high axle loads. The two critical vehicles may differ in terms of axle configurations and/or tire pressures. Once deflections are measured under these critical vehicles, structural pavement models can predict deflections under other vehicles and thus, predict the cumulative damage imposed on a pavement by a suite of vehicle types. To ensure that the deflection measurements provide sufficient information for accurate predictions of pavement performance, the following requirements must be met. The equipment must enable the user to evaluate deflections in a single wheelpath over a roadway length of at least 4m, with individual deflection measurements spaced no more than 200 mm in the direction of travel. Measured deflections will be accurate to within 20 microns. The equipment will be able to track the position of the vehicle wheel during deflection testing. The software to be developed must provide the ability for the user to control the rate of data sampling. Data will be stored in a format that is both easy to interpret and transportable. The user will be able to view any individual deflection basin (captured at an instant in time) on a portable computer screen, along with the original pavement surface and the position of the loading wheel. The user will also be able to view deflection basins in sequence, at a user-defined rate of change. This capability will facilitate interpretation of the dynamic aspects of the problem. To ensure that the deflection measurement system is practical, it must be portable (without a trailer) and it must require no more than two hours for each test, including set-up time and execution. This time requirement is necessary because the military must be able to perform several tests in a single day. A single transportation route can require many tests because roadways are inherently variable along their lengths in terms of both internal structure and surrounding terrain.

PHASE I: Conduct feasibility investigation, select the most appropriate technology, and prepare a preliminary hardware design. The feasibility investigation must describe at least three alternative technologies and it must explain the advantages of the selected technology, relative to those that were considered and were then dismissed. Preliminary hardware design must include an approximate cost of production, a description of any safety hazards, and an explanation of any availability issues related to equipment components.

PHASE II: Prepare final design and construct working model. Demonstrate the model system and compare selected deflection measurements to a more traditional single-point method of measuring deflection, such as a linear variable differential transformer embedded in a test pavement. Refine the hardware and software components as deemed necessary from the demonstration.

PHASE III DUAL USE APPLICATIONS: This system would be useful for pavement management applications by both military installation personnel and civilian agencies such as state departments of transportation.

REFERENCES:
1. Boyer, R.E., "Predicting Pavement Performance Using Time-Dependent Transfer Functions," Joint Highway Research Project No. 32, Purdue University, West Lafayette, IN, 1972.
2. Highter, W.H., "The Application of Energy Concepts to Pavements," Joint Highway Research Project No. 38, Purdue University, West Lafayette, IN, 1972.
3. Grogan, W.P., "Nondestructive Pavement Testing and Evaluation: Facilities Engineering Applications Program (FEAP) Demonstration," Miscellaneous Paper GL-90-15, U.S. Army Waterways Experiment Station, Vicksburg, MS, 1990.
4. Bush, A.J. and Baladi, G.Y., ed., Nondestructive Testing of Pavements and Backcalculation of Moduli, ASTM STP 1026, American Society for Testing and Materials, Philadelphia, PA, 1989.

KEYWORDS: pavements, deflections, dynamic analysis, performance predictions

A00-90 TITLE: Advanced Multispectral Decoy Technologies

TECHNOLOGY AREAS: Materials/Processes, Sensors

OBJECTIVE: To design, develop, and test innovative ideas that advance the abilities of U.S. Forces and Allies to rapidly and accurately simulate an array of military targets (fixed or relocatable, stationary or mobile) by mimicking their seismic, acoustic, spatial, and spectral signatures. Techniques and concepts that reduce logistical requirements, address spatial and temporal requirements of effective deception, and can be remotely deployed, will be considered. The goal is to create in the enemy's mind a false or misleading view of the overall battlefield or specific targets within the battlefield that causes him to take actions counter to his best interests.

DESCRIPTION: Newly developed lightweight materials, miniaturized electronics, and highly expansive foams are emerging technologies that can be applied to the development of advanced multispectral decoys. With the increasing dependence on remote sensing systems to provide battlespace information, new methods must be developed to rapidly and effectively counter or skew information derived from these sensors. Military decisions are based on the perceived knowledge of the opposing force's abilities, tactics, doctrine and disposition based on both human observation and electronic imagery produced by remote sensor systems. As these sensor systems proliferate, avoiding detection and concealing battlespace intentions become more difficult. This proposed effort will equally emphasize prototype development, theoretical applications, and experimental validation.

PHASE I: Develop and refine decoy concepts and develop projected applications. Assess spatial and fidelity requirements. Identify potential of remotely-controlled seismic and acoustic signature generators as well as the feasibility of remotely-controlled, movable, three-dimensional decoys. Derive validation techniques to support the decoy development process.

PHASE II: Develop a prototype decoy system comprised of a component sub-system allowing for the representation of multiple assets, both mobile and semi-mobile, found in a typical battlespace (i.e., tracked vehicles, fuel bladders, C3I facilities, aircraft, etc.). Develop an experimental design to validate the decoy system's effectiveness against tactical remote sensor systems.

PHASE III, DUAL-USE COMMERCIALIZATION: The results of this research will have broad-based commercial potential in sensor and imagery interpretation algorithms development. Additionally, results will benefit both the civilian and military communities through an improved understanding of the requirements of human perceptions.

REFERENCES:

Army Field Manual, FM-20-3, Camouflage, Concealment, and Decoy

Army Field Manual, FM-90-2, Battlefield Deception

Joint Camouflage, Concealment, and Deception Center, JCCD Test Report

Joint Camouflage, Concealment, and Deception Center, Airbase Camouflage, Concealment and Deception Guide

Air Land Sea Application Center, FM 90-19, Multiservice Tactics, Techniques, and Procedures for CCD Employment in Command and Control Warfare

KEYWORDS: Decoy, Multispectral, Deception, Remote Sensors, CCD

A00-091 TITLE: In situ Biological Treatment for Explosives in Ground Water

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop and test an approach to stimulate the in situ biological degradation of explosives in groundwater. These compounds include trinitrotoluene (TNT), trinitrobenzene (TNB), and hexahydro-1,3,5-triazine (RDX).

DESCRIPTION: Biodegradation of munitions contamination. The currently established method for cleaning up munitions-contaminated soils is incineration, which is both costly and environmentally disfavored. Incineration is also impractical for removing low levels of compounds from groundwater.

Munitions contaminated groundwater and sediments have received substantially less attention than contaminated soils. However, as discussed above, even the relatively low munitions concentrations in groundwater may pose a threat to human health. Some studies have indicated that munitions in groundwater do dissipate over time through natural attenuation, albeit at very slow rates. The established technologies to remediate munitions contaminated groundwater include granulated activated carbon filtration (GAC) and UV-oxidation, both of which can be very costly. Phytoremediation employing constructed wetlands has been demonstrated to be effective under some configurations. Both the established and innovative methods, however, are ex situ in nature, providing treated water as an end product, but do little to actually restore the aquifer by degrading the contaminants sorbed to aquifer sediments. The proposed research will prepare protocols and examine the feasibility of in situ biostimulation and bioaugmentation to treat munitions contaminated groundwater; results will also likely lead to improvements in the ex situ bioremediation technologies as well.

PHASE I: The goal of this phase of work is to develop and demonstrate, at bench-scale, a biological treatment approach using soil and ground water microcosms collected from a contaminated site or prepared with dosed soil. This work would include the comparison of different organic substrates and nutrients to optimize biological degradation. The major objective of this phase will be to identify the bacteria and determine the concentration of the organic substrates and nutrients that will lead to the most efficient and complete transformation of the munitions compounds. This must be achieved without resulting in undesirable changes in groundwater parameters (nitrate, TOC, etc.) or clogging of the sediment due to biomass growth.

PHASE II: In this phase, the goal will be to demonstrate the scale-up and efficacy of the technology at pilot scale at a DoD site with the goal of developing operational data, treatment efficiency, optimization information, and a preliminary cost analysis for full-scale applications. Based on positive results obtained during the proposed research, field demonstrations and evaluation of in situ bioaugmentation, and in situ biostimulation technology may be pursued. Special emphasis will be given to determining to what extent bioaugmentation reduces start-up time, increases contaminant removal efficiencies, and ultimately reduces the overall clean-up costs.

PHASE III: A full-scale site would be selected for demonstration and commercial use of the technology. Such a site could be a DoD site or a privately owned facility, and could include treatment of ground water where no previous remediation had been implemented or used to accelerate the closure of an existing pump & treat system.

REFERENCES:
1. Best, E., J. Miller, M. Zappi, H. Fredrickson, S. Larson, and T. Streckfuss. 1998. Explosives removal from groundwater of the Iowa Army Ammunition Plant in continous-flow laboratory systems planted with aquatic and wetland plants. U.S. Army Corps of Engineers/Waterways Experiment Station. Report# EL-98-13.

2. Bricka, R., and W. Sharp. 1993. Treatment of groundwater contaminated with low levels of military munitions. p. 199-204. In W. E. Station (ed.), Proceedings of the 47th Industrial Waste Conference, Lewis Publishers, Boca Raton, FL, USA.

KEYWORDS: Explosives, TNT, RDX, Bioremediation, Ground water contamination

Topics Addressing U.S. Army Operating and Support Cost Reduction (OSCR) Intiatives

U.S. Army Armaments Research, Development and Engineering Center (ARDEC)

A00-092 TITLE: Lightweight Gun Barrel

TECHNOLOGY AREAS: Materials/Processes, Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Office of Program Manager Small Armaments

OBJECTIVE: To design and build a functional lightweight gun barrel able to perform as well as the standard weight operational gun barrel in the field that is presently made of a chromium-molybdenum-vanadium (CrMoV) steel (Mil S- 46047E). Formulate the necessary gun barrel design criteria to achieve weight reduction without sacrificing gun barrel performance with respect to firing rate schedule and wear/erosion resistance. Define an appropriate affordable manufacturing methodology whereby the candidate lightweight materials are introduced into the gun barrel fabrication process.

DESCRIPTION: Materials research and development in recent years has focused on lightweight materials (aluminum, titanium alloys, intermetallics, organic or metal matrix composites, ceramics and ceramic matrix composite(CMC)) in order to serve the needs of product developments in the industrial marketplace. Various governmental agencies have also spearheaded monolithic and composite materials developments to meet the ever expanding performance requirements of major hardware programs. Gun barrels have not taken potential advantage of the property improvements achieved in many of these programs. The intent of this solicitation is to incorporate these new materials into innovative gun barrel designs in an appropriate manner so as to achieve weight reduction without loss of operational performance. The focus will be on two gun barrel calibers. One is the small caliber (7.62mm) infantry gun barrel where the benefit of a lighter gun barrel would have maximum impact on logistics and soldier endurance. The other caliber is the 20mm (bore) gun barrel in a three barrel gatling system for the Comanche helicopters. A substantial weight reduction here would have significant impact on increasing round or fuel load.

The operational performance of the gun barrel will act as design constraints with respect to the degree to which a weight reduction can be achieved with the proposed innovative concept. One constraint is that the bore surface temperature can reach a value of 1875 degrees Centigrade (the melting point of chromium) with an unrestrained firing schedule. Another constraint is that propellant gas pressures of 50ksi can be reached in the gun barrel during the 3-5 millisecond pressure pulse that occurs with each round fired. With respect to the wear/erosion aspects of the gun barrel, another constraint is that the material exposed to the propellant gases must exhibit sufficient high temperature chemical wear and mechanical creep resistance to survive chemical erosion and rifling wear. Furthermore both the calibers under consideration have traditional land/groove rifling to impart spin to the exiting round. Candidate gun barrel designs must also impart spin to the rounds.

PHASE I: Propose and develop an overall gun barrel design architecture that incorporates lightweight materials. Provide a hollow right circular cylinder (minimum 12" long with a bore diameter ranging from 7.6mm to 20mm) as a prototype to be evaluated at ARDEC. The barrel prototype provided must already achieve a weight reduction compared to a similar section length of a CrMoV steel(density xxx g/cc) gun barrel. The prototype design will be subjected to interior hydraulic pressures of 50ksi at both room and elevated temperatures(500 degrees Centigrade) as well mechanically tested for comparison with gun steel properties. Submit design analyses to indicate that the prototype test cylinder provided will withstand these tests.

PHASE II: Develop the gun barrel design to a maturity sufficient to satisfy weight reduction achievements without sacrificing present barrel performance. Fabricate three test barrels for evaluation at ARDEC. Delineate the gun barrel fabrication process and how the lightweight material is incorporated. Expand the design concept to provide for enhanced wear resistance without the use of chromium plated bore surfaces. Conduct modeling analyses to validate both enhanced wear resistance and weight reduction under typical firing schedules. Fabricate three gun barrels of this advanced design for ballistic evaluation at ARDEC.

PHASE III DUAL USE APPLICATIONS: This program will have potential utility in commercial high performance engines where both lightweight and wear abatement features would contribute to enhanced performance. The design modality developed here for a lightweight gun barrel will also have further usefulness in future military hardware acquisitions.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Increasing the barrel wear life as well as reducing barrel weight contributes to tangible savings by reducing materiel logistic resupply and maintenance manpower requirements. Not only is barrel replacement logistics and aircraft downtime reduced but firepower operational range is also increased.

REFERENCES:
1. Mil-S- 46047E , Steel for Gun Barrels
2. W. Ebihara et al," Mechanisms of Gun-Tube Erosion and Wear", Chapter 11, pp357-376. Gun Propulsion Technology, Vol. 109, Progress in Astronautics and Aeronautics.

KEYWORDS: gun barrel, lightweight, composite

A00-093 TITLE: Innovative Hands-Free Point-and-Click Computer Control Device Within a Moving Vehicle

TECHNOLOGY AREAS: Information Systems, Human Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Deputy Project Management Motars

OBJECTIVE: Design and develop a hardware and software device, using standard Application Program Interfaces (API), that is compatible with common computer architectures and operating systems, and will permit point-and-click operations to be performed by a combat vehicle operator within a moving vehicle. This point-and-click device will replace only the tasks currently assigned to a mouse or trackball. Integrated with a speech recognition system, which will be used to replace the keyboard for data and text input, this new device should permit full and efficient operator control of a computer console without typing or moving a mouse or trackball.

DESCRIPTION: Two types of information input is required for controlling a computer system. Text or data entry is usually accomplished by typing. The second type involves choosing a menu item, or pressing screen buttons displayed by a console's graphical user's interface (GUI); these tasks are usually performed with a low level point-and-click (PAC) device such as a mouse or trackball. Neither device type can be easily operated within a moving combat vehicle. Speech recognition has made great strides in the past few years in terms of noise robustness and language processing, and is slowly gaining acceptance as a keyboard replacement. What is now needed is a mouse and trackball replacement, such as an eye-tracker or some form of neuromuscular sensing device, that can be operated accurately in a moving vehicle so the operator will be able to navigate through menus or select items on a computer screen without needing great dexterity or luck. For full efficiency, speech is needed for command level data input and an improved PAC device is needed for menu and console button pushing. In this way, a natural feel for system control will be achieved, operator training will be minimized, and reaction time will be improved.

PHASE I: Develop overall system design for an improved point-and-click device, or device group, that can replace the common computer mouse or trackball, and can be utilized efficiently in a moving vehicle environment. This device needs to be compatible with all-common computer architectures and operating systems. The software interface should permit easy integration into future as well as legacy computer platforms, and permit smooth command sharing with a speech recognition system.

PHASE II: Results should translate into a practical implementation of a new point-and-click device that will improve the accuracy and speed of an operator maneuvering through menus, selecting a region or area on a computer screen, or "pressing" a software button on the console's graphical user interface. Project success will require a demonstration of a real-time prototype, using a notebook computer that can execute all common mouse and trackball operations as well as accept spoken commands for data entry. Decision aids software shall be used as the demonstration platform, and all operations should be smoothly executed without utilizing a keyboard, mouse, or track ball. Contractor shall provide a fully integrated prototype, all required software to interface to external computers, complete documentation, source code, and a full development environment.

PHASE III AND DUAL USE APPLICATIONS: Most computer programs require both keyboard data entry and point-and-click operations with a mouse or trackball device to operate efficiently. In an office this is fine. In a moving environment such as an airplane, car, bus, or armored vehicle, point and click operations become more difficult. Speech recognition can replace tedious data entry, and with domain specific grammar corrections it can ensure spoken data and dictation are recognized and entered properly. Adding a secondary device to complement speech input, which could perform all the point-and-click operations efficiently and require no steady hand movements, would permit full use of a computer in moving vehicles. Just as this combination would be helpful for the military in controlling combat simulations and interact with command and control consoles, it would also make a useful commercial gaming device for people so inclined. It would also afford many individuals, who are handicapped and cannot effectively use a mouse, trackball, or keyboard, the opportunity to access the next generation internet, and enjoy all the benefits of today's modern computers.

OPERATING AND SUPPORT COST REDUCTION: Data and text entry request for analysis, and acceptance or rejection of results are tasks ideally suited to control by speech. These tasks are usually completed by typing at a keyboard, but they are now also being done by voice interface. Point-and-click operations however, such as maneuvering through menus, designating a point on a displayed map, or pressing a button on a computer's GUI can dominate system operations in a command and control environment. Utilizing speech for these operations is inefficient and has consistently failed in it's acceptance. The mouse or trackball is ideally suited to these PAC operations, but since they require a steady workspace, their operation within a moving combat vehicle is difficult. By developing a usable PAC device for this environment, and coupling it with text and data input by voice, the operator will be able to naturally control all computerized operations, and thereby improve efficiency, reduce support personnel, and minimize training costs.

REFERENCES:
"Training the Disabled to lift an Eyebrow and Open Worlds", New York Times, May 17, 1998

"Thoughts into Actions", Bergen Record Online, April 28, 1998

Spoken Human-Machine Dialog Workshop, Report, Army Research Office, Research Triangle Park, NC, 30 May-1 June 1995.

Nielsen J, "Noncommand User Interfaces", Communications of the ACM 36, 4, April 1993, 83-99

KEYWORDS: Computer interface, eye-tracking, point-and-click, mouse, trackball

A00-094 TITLE: Adaptable and Reusable Hardware/ Software (HW/SW) Architectures And Components for Automated Materiel Handling

TECHNOLOGY AREAS: Information Systems, Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Joint Program Office, Unmanned Ground Vehicle

OBJECTIVE: Develop a generic, multi-mission capable, reusable modular hardware and software suite and development environment to support advanced supervisory and semi-autonomous control of multiple platforms for materiel handling, resupply and logistics automation applications.

DESCRIPTION: Recent advances in sensor based servo control systems for high performance robotic manipulators, visualization technology, intelligent controls, distributed object based computing and high speed PC based processors now make possible a new generation of low cost intelligent control systems capable of supporting supervisory control of multiple platforms . Specifically, high speed PC based multi-processor robotic controllers and supporting software development environments have been developed which permit a broad range of adaptive and compliant motion control strategies, leader-follower strategies, etc. to be implemented for dextrous manipulation and multi-platform control. Standard tele-robotic kits have also been developed and demonstrated for simple mission scenarios that require little dexterity or sensory feedback. Extensions of this technology are required, however, to deal with fundamental problems of mobility and base motion effects, flexible task level control, multi-sensor integration, multi-manipulator coordination associated with automated container handling and movement, autonomous resupply, and distributed, supervisory control of multiple heavy-lift platforms, such as cranes and forklifts, necessary to automate forward resupply point operations. Technical issues of interest include MMI, task visualization, compliant motion control, visual servo control, voice natural language interface for control, multi-manipulator control strategies, modeling, design and real time prototyping tools, knowledge based task level control and control from moving base including path planning, navigation and obstacle detection/avoidance and component based software architectures. Control approaches should also address issues related to multi-platform supervisory control, communication and coordination. The goal is to permit supervisory control of fork lifts and cranes in Corps and forward supply areas, eliminating the need for ground spotters and permit a single operator to build mission configured loads (MCLs) from the four basic configurations of ammunition: strategic configured loads (SCL), break-bulk, single DODIC in a container, and single DODIC on a PLS flatrack (CROP) in container.

PHASE I: Develop methodology and algorithm approaches to intelligent multi-platform tele-operation and task automation for applications to materiel handling and automated logistics. Perform preliminary modeling and simulation studies to determine performance and robustness characteristics of architecture and algorithms, and assess real time processing, MMI and sensor requirements. Provide analysis for evaluating system performance potential for achieving single operator supervisory control of materiel handling equipment and provide preliminary design concept.

PHASE II: Develop prototype controller hardware and software and supporting development environment and interface with laboratory test bed facilities and materiel handling technology demonstrators. Develop test scenarios and mock-ups to demonstrate single operator supervisory control capability. Provide fully integrated prototype module with documentation, source code, models and development environment and evaluate in laboratory and non-laboratory tests.

PHASE III DUAL-USE APPLICATIONS: The technology developed under this program is applicable to a broad range of commercial logistics and material handling applications such as hazardous waste removal, commercial logistics, cargo loading/unloading, factory and warehouse automation, exploration, fire fighting, crime fighting, commercial bridge and high tension power line repair, etc. Topic supports key Army initiatives to increase efficiency and reduce the cost associated with sustaining the future digitized force through the development and application of advanced automation technology.

OPERATING AND SUPPORT COST (OSCR) REDUCTION:
This technology will enable significant cost reductions to digitized Army logistics operations by reducing personnel requirements, training requirements and eliminating waste associated the current labor intensive logistics and rearm process. The use of standard reusable hardware and software components will result in significant cost saving in the area of maintenance and life cycle software support and facilitate evolvability to fully autonomous operation.

A00-095 TITLE: Innovative Coating Technology to Mitigate Erosion of Large Caliber Gun Tubes

TECHNOLOGY AREAS: Materials/Processes, Weapons

OBJECTIVE: To examine and develop an enhanced plasma spray coating process or other competitive coating process that reduces the erosion of large caliber extended range artillery gun tubes. This program will examine enhanced plasma spray, laser coating, or other competitive coating processes with increased coating density, developing hardware, and applying this process to candidate materials selected based on properties of high melting point, elevated temperature performance, and resistance to erosion. The results of this effort will yield materials, process parameters, and hardware that will achieve a reduction in the amount of erosion found in large caliber extended range artillery gun tubes.

DESCRIPTION: Large caliber extended range artillery gun tubes have demonstrated significant wear and erosion problems, resulting in shortened life expectancies. Gun tubes are typically expected to achieve up to 2000 full effective charge firings for a full life expectancy. The erosion of the gun tubes, which is caused by extreme flame temperatures, has caused the actual number of firings to be reduced to 100-200 firings. Because of this short life expectancy, which is between one tenth and one twentieth of the ideal life expectancy, there are significant costs associated with frequently replacing the gun tubes. In order to increase the life span of the gun tubes, and to reduce replacement costs, a method for protecting the tube has to be developed. This program will examine and develop a coating process that yields denser, more wear resistant coatings than current coating processes. This program will examine enhanced plasma spray, laser coating or other competitive processes with the goal of defining a new method of coating application specific to large caliber extended range systems. By closely examining a group of selected candidate materials with high melting points, and then developing testing methods to include the eventual firing of a gun tube coated with one or more of these materials, it will be possible to develop specific hardware and material which will reduce the levels of erosion within the gun tubes.

PHASE I: Assess the merits of innovative coating processes to mitigate gun tube wear and erosion, and determine optimum candidate materials for the process. Select a coating process and develop a set of parameters for same. Develop and perform laboratory test to simulate large caliber firing. Narrow the list of candidate materials through the evaluation of the laboratory tests. Examine the feasibility of multi-layered or bimetallic coatings.

PHASE II: Downselect coating process and coating materials. Determine hardware requirements specific to the restrictive I.D. tube geometry of a gun tube. Prepare coating process hardware design. Develop and refine coating hardware configuration for I.D. tube geometry. Develop prototype coating hardware. Acquire a large caliber gun tube for testing. Coat the tube with the chosen candidate material(s). Further optimize the parameters established for the coating process.

PHASE III DUAL USE APPLICATIONS: Potential commercial applications include the production of economical erosion resistant reactors and tubing used in chemical processes.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: This is an enabling technology which reduces replacement costs.

REFERENCES:
1. Cote, P.J., Rickard, C., "Gray Layers and the Erosion of Chromium Plated Gun Bore Surfaces". September 1999.
2. SBIR A97-141 "Advanced Method for Manufacturing Erosion Resistant Gun Barrels"

KEYWORDS: Plasma Spray Coating, erosion, large caliber extended range artillery gun tubes

A00-096 TITLE: Electronic Sight Unit (ESU)

TECHNOLOGY AREAS: Sensors

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Management Motars

Objective: Develop and demonstrate light weight, low cost, high performance, digital Electronic Sight Unit (ESU) and it's fire control sensors, enabling optimal sensor utility with ports interfacing with modern command and control systems and innovative fire control implementation paradigms. The ESU will provide for firing, displays of weapon level and cross-level status, azimuth and elevation. Navigation in support of ground mobility will also be provided. This will enable the system to function autonomously.

Description: Recent developments in Microelectromechanical Systems (MEMS), optical fibers, sensors, piezoceramics and communications have created innovative and unique opportunities to significantly improve existing optical and mechanical mortar and artillery weapon fire control systems while simultaneously pushing the envelope with new devices. Concurrent with the development of new fire control and advanced interfaces with modern command and control systems is the need to optimize weapon fire control sensor outputs to meet the needs of legacy and future weapon systems.

PHASE I: Design an Electronic Sight Unit which improves on the performance of current weapon fire control systems and links with modern command and control systems. Formulate optimized advanced fire control and sensor algorithms for indirect and direct fire missions. Determine the performance, robustness and durability of the new system utilizing advanced simulations, computer-aided development tools and real time hardware and software.

PHASE II: Develop a fully functional Electonic Sight Unit prototype in an integrated design and test environment. Employ hardware–in-the-loop implementations using dynamic models and real-time, multiprocessors-based rapid prototyping systems for laboratory and test bed evaluations. Weapons will be utilized as required to demonstrate navigation for ground mobility . Optimize developmental hardware and software based on laboratory test data and provide technical documentation on these efforts.

PHASE III DUAL USE APPLICATIONS: The results of this R&D program have a very high probability of being commercialized within the DoD and industry. With appropriate modifications the electronic sight unit could accurately sense level and cross level conditions of a surface i.e. laboratory optical table, trailer, building and boat etc. This level sensor could be a very small electronic unit with a digital "level" output display. Avoided would be the use of "spirit/bubble" type level vials which are had to see, hard to use, can easily be damaged, tends to lose it's sensing spirit fluid and performance over time. A modified electronic unit could also provide direction in mils to a visible reference point Since it is compact the unit's electronic navigation location sensor and digital readout could be adapted for users of boat, bikes, hunters, surveyors etc., where elevation and azimuth bearings to a known point is required. With this information the distance to a point could be approximated.

OPERATING AND SUPPORT COST REDUCTION (OSCR): Savings could be realized because the ESU does not require the expensive precision optics and machined parts used it the status quo sight units. Significant life cycle savings could also be realized because the ESU would not experience the wear and tear of the mechanical sight. The electronic sight would not require specialized surveillance, maintenance facilities and stocks of expensive spare parts.

REFERENCE: Current Fire Control Devices, Military Specification, Sight Unit M67 MIL-S-71027
Military Specification, Telescope Mount and Quadrant M187 Mil-M-70742
Military specification, Telescope and Quadrant Mount M171 Mil-M-48557
Military Specification, Telescope and Quadrant Mount M172 Mil-M-48559
(http://www.astimage.daps.dla.mil/docimages/0000/36/43/72706.PDO)

KEY WORDS: Electronic Sight Unit, Sensors, Navigation, Microelectromechanical Systems, Fire Control, Mortars, Artillery, Command and Control Systems, Links, Advanced Simulations, Computer-Aided Development. Real Time Hardware/Software, Ground Mobility.

U.S. Army Research Institute (ARI)

A00-097 TITLE: Assessing Decision-Making Skills in Virtual Environments

TECHNOLOGY AREAS: Human Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Training and Doctrine Command – Dismounted Battlespace Battle Lab

OBJECTIVE: Develop training assessment procedures and instruments for measuring soldier and small unit leader decision-making skills in virtual urban environments

DESCRIPTION: Limited resources needed to prepare for and conduct large-scale field training events and exercises will force trainers to rely more on alternative methods of training soldiers. Cost effective methods are needed for developing/enhancing decision making and leadership skills of small unit (platoon, squad, and team) leaders in urban operations. One solution is to conduct a portion of this training, such as mission rehearsals, in virtual environments through the use of individual combatant simulators. Preliminary work in this area has shown that virtual environments offer soldiers the opportunity to thoroughly rehearse missions and familiarize themselves with the procedural aspects of specific tasks as well as offering a chance to examine new tactics and techniques. To date, prototype virtual training scenarios developed for urban operations have not systematically emphasized the cognitive aspects of decision making used by junior leaders or the adequacy of these decisions. These leaders require exposure to the cognitive challenges in these environments and practice handling these challenges including recognizing environmental cues and relevant situational factors affecting the decision. A scenario-based instructional program is needed which allows trainers to focus on critical decisions and judgments made by the soldier or small unit leader in conducting urban missions. The program will allow trainers to focus on specific decision points in the scenarios and address specific cues, factors, and strategies and highlight what the soldiers did right and where they went wrong. Performance measures are also needed that will document improvements in decision making over time.

PHASE I: Scenarios will be developed by the trainer and key decision points identified. Each decision will have multiple responses (typically four), also identified in advance by the trainer. Decision points can include environmental cues the soldier needs to notice and interpret and/or tactical factors that must be taken into account when making decisions (also established by the trainer). The objective of this phase is to develop a methodology for an automated data collection and feedback system. The system will allow the trainer to input response alternatives into a data base during the course of the scenario and is capable of tracking the soldier's behaviors, decisions and judgments at these critical (pre-determined) points in the scenarios. The system will permit rapid replay of events at these critical points. In addition, the system will track mission related factors such as rounds fired, casualties, time to complete the mission, soldier movement patterns, etc. and provide relevant summary statistics in a tabular or graphical format following the completion of each scenario. This procedure will also be able to link these factors with the soldier's decisions or behaviors at pre-determined points. To supplement the feedback process, a top-down, snap shot capability depicting the positioning of soldiers in relation to the terrain at specified points in time (determined by the trainer) will be provided. The system should be capable of supporting a PC-based Lennux Red Hot operating system and should be applicable to HLA simulation networks.

PHASE II: This phase will include the development and application of a prototype automated data collection and feedback system with the tracking and feedback capabilities described above. It will also include the development of prototype instruments for observers to assess both operational performance and qualitative changes in soldier decision making over time. The procedure will be validated using soldiers who will execute scenarios stressing different decision skill areas. The contractor will produce reports documenting the methodology and validation research.

PHASE III DUAL USE APPLICATIONS: This phase includes tailoring the decision-making training approach, assessment procedures, and instruments to other military and commercial markets. There is a potential commercial market for virtual environment training for enhancing rapid decision-making in high risk urban situations such as police actions, emergency medical treatments, and fire fighting. There also may be some applicability for sports where skilled team positions, e.g., quarterback, require rapid decisions, judgments and assessments of various situational cues under high stress conditions.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Conducting the appropriate decision skills training at existing real world urban training sites requires extensive exposure to the many cognitive demands facing soldiers in urban operations. This type of training will severely stress available unit resources. A virtual environment, scenario-based instructional program with enhanced data collection/feedback features will provide the requisite knowledge-based training in a cost effective manner.

REFERENCES:

Phillips, J., McDermott, P. L., Thordsen, M., McCloskey, M. & Klein, G. (1998). Cognitive requirements for small unit leaders in military operations in urban terrain (Research Report). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Pleban, R. J., Eakin, D. E., & Salter, M. S. (2000). Analysis of mission-based scenarios for training soldiers and small unit leaders in virtual environments (Research Report 1754). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

KEYWORDS: Decision-making, Virtual environments, Automated data collection

A00-098 TITLE: Training Media to Support Night Operations in Urban Settings

TECHNOLOGY AREAS: Human Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Training and Doctrine Command – Dismounted Battlespace Battle Lab

OBJECTIVE: Develop intelligent trainer software and related lessonware that provides individuals with increased knowledge of and skill in the employment of night equipment within urban settings. The resulting intelligent trainer will stress image intensification and thermal technologies, its advantages and limitations, as these relate to the diversity of urban settings and the dynamic activities that occur within them. It will adapt to individual trainees' performance, create appropriate responses to unprompted trainee questions, and create and ask appropriate questions.

DESCRIPTION: The Army has shifted much of its focus to operations in urban settings and to night operations. The conjunction of these two types of operations places unique training demands on soldiers and leaders. Yet there has been a failure to develop needed state-of-the-art-training for preparing the soldiers and leaders to perform within this operational environment. Individuals must be trained on the technological capabilities and limitations of night equipment, and how these capabilities impact decision-making and use of the equipment in the varied missions that are an inherent part of varied urban settings. These missions range from reconnaissance and observation both short- and long-range movement both external to and within buildings, raids, operating with "lights on" and "lights off," precision shooting, coordination of forces, discriminating different segments of the population within urban settings, operating in obscurants and fires, and other complex tasks. Effective employment of night technologies depends on the nature of the urban setting (building composition and size, layout of the city or town, mixture of industrial/residential/business areas), and thus requires that leaders and soldiers fully understand the limitations and advantages of the equipment available to them. The trainer will adapt to individual trainee's strengths and weaknesses during instruction. It will be able to display all major classes of multi-media lessonware. It will be able to create and adapt lesson sequences in response to trainee performance as well as create appropriate, new information in response to trainee questions and ask the trainee appropriate questions with which will be displayed appropriate graphics. To reduce technical risks, intelligent tutor software should be based on an existing intelligent tutor system. It is expected that significant improvements may be required of this system. Lessonware is to be kept in a different and separable module from tutor software.

PHASE I: Phase I shall consist of a front-end analysis of the unique training requirements associated with conducting night operations in urban settings, a detailed design of the intelligent tutor system, and a final technical report. The front-end analysis will include identification of the deficiencies in the current training and doctrine literature and training support materials, and the technical information required by soldiers and leaders. The tutor system design will include a description of the existing intelligent tutor software upon which is to be improved in this project plus a detailed description of the improvements required, the means by which the tutor will adapt to trainee performance, a conceptual design of the training approach and media, and the overall instructional design. The technical report will consist of the front-end analysis, the system design, the mechanism proposed for making the tutor widely available, a design for evaluating the tutor, and projected costs for all project aspects.

PHASE II: Phase II consists of implementation of decisions and designs made in Phase I. A milestone schedule for collecting and/or developing the necessary graphics and other lessonware shall be established, as well as milestones for the production of the training system. Assessments of the effectiveness of the trainer and reactions by trainees shall be conducted during product development. Reports describing these findings as well as copies of the trainer software and lessonware shall be produced. The tutor should be based upon hardware and an operating system that will be easily available to the Army at the time of Phase II completion. No third party software or lessonware requiring the Army to pay third party licensing fees should be used.

PHASE III DUAL USE APPLICATIONS: The Army's night equipment technologies are spreading rapidly to civilian applications in police departments, fire fighting departments, border patrols, Customs, and even to night vision within cars, to name a few. The training requirements described in this proposal has immediate applicability to training users of night equipment in all these civilian sectors. The effort also has obvious applications for the Marines and special operations forces. The development of intelligent tutor software that can deal with graphic media and ask and answer trainee questions will have wide educational and training uses independent of the night equipment lessonware specific to this project.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: The training products reduce the requirement for individual to experience first-hand the many effects, both positive and negative, of night equipment in urban and similar settings. They also substantially reduce the need for civilian and/or other Department of Defense agencies to develop these training materials, which can be costly given the photographic requirements.

REFERENCES:
Dyer, J.L., & Ford, P. (1998), September). See you on the objective: ARI program NIGHTFIGHTER (ARI Special Report 37). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (DTIC No AD-B241 696)

Dyer, J.L. Brooks, B. (1996, November). Adjusting NVGs in the field. Countermeasure, 17 (11), 10-11
Dyer, J.L., Shorter, G.W., & Westergren, A.J. (1988). Designing multi-media to train the thermal signatures of vehicles (ARI Research Report 1720). Alexandria, VA: US

U.S. Army Research Laboratory (ARL)

A00-099 TITLE: True Time Delay and Constant Phase Shift Circuit Elements

TECHNOLOGY AREAS: Electronics

OBJECTIVE: The Army has a documented need to develop enabling RF technologies that are both affordable and flexible with growth potential to address many radar and communication requirements. For FCS, multi-function, broad band, electronically scanned antennas and receivers are required to fulfill this need. This project specifically addresses the ability to generate the constant phase shift required for wide band antenna performance.

DESCRIPTION: The Army seeks low loss (less than 1dB), wide band (full octave), true-time-delay and constant phase shifting circuits (<5°) at Ka band (35GHz) and higher frequencies operating at full commercial component temperature ranges. Although there are a number of technologies and approaches pursuing these goals, MEMS, ferroelectric, ferrite, MMIC, optical, none have reliably met these metrics at reasonable cost and high levels of producibility.

PHASE I: The goals for a phase one study are to develop novel concepts for wide band true-time delay and or phase shifters as described above. Losses associated with the phase shifter/time delay elements should include matching networks for 50-ohm circuits. These concepts should be modeled to demonstrate potential performance and preliminary designs generated which are analyzed for producibility and cost.

PHASE II. Finalize design, build, test, several prototype phase and/or time delay elements that meet the metrics defined in the phase I. A several elements are required so as to further study phase relation between elements. This will have significant impact in the development of low cost phased arrays. Performance, cost, and reproducibility should be the emphasis of this effort.

PHASE III DUAL-USE APPLICATIONS: This technology has high potential in many commercial RF systems like satellite antennas, air traffic and weather radars and other wireless communication networks. Multiple function Radio Frequency (RF) systems are required for implementation of a broad range of RF systems on Army platforms at low cost, size and power. If implemented properly radar, communications, Combat ID, active protection and electronic surveillance can share the same antennas and receivers drastically reducing cost, weight, size and power. The elimination of multiple antennas alone is appealing. True time delay circuit elements are required to implement low cost electronically scanned antennas for RF receivers with instantaneous broad band performance. Constant phase shift (independent of frequency) circuit elements are required for broad band waveform and signal processing application. This phase includes the manufacture and delivery of 1000 low cost phase shift devices, not necessarily mounted into modules.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Wide band phase shifters and time delay elements will enable a new family of very broad band, electronically scanned antennas and digital receivers. It will reduce the number of antennas and receivers required lowering life cycle costs and will allow enhanced sensor suites on lower cost platforms, improving survivability, communications, and increased op-tempo. This effort specifically addresses the need of the joint Army/DARPA FCS program.

REFERENCES:

1. Distributed MEMS true-time delay phase shifters and wide-band
Switches Barker, S.; Rebeiz, G.M., Microwave Theory and Techniques, IEEE Transactions on Volume: 46 11 2 , Nov. 1998 , Page(s): 1881 -1890

2. Phased array antennas with phasers and true time delay phase shifters
Jespersen, N.V.; Herczfeld, P.R. Antennas and Propagation Society International
Symposium, 1990. AP-S. Merging Technologies for the 90's. Digest. ,
1990 , Page(s):778 -781 vol.2

3. True time delay integrated optical RF phase shifters in lithium niobate
Voges, E.; Kuckelhaus, K.; Hosselbarth, B. Electronics Letters Volume: 33 23 , 6 Nov. 1997 , Page(s): 1950 -1951

A00-100 TITLE: Seeing Through Smoke, Fog, and Obscurants Using Circular Infrared (IR) Polarimetric Imaging

TECHNOLOGY AREAS: Sensors, Electronics, Weapons

OBJECTIVE: Develop an inexpensive IR imaging system that can be worn by the soldier that will enhance the ability to "see" objects that are obscured by a variety of airborne particulates and hydrosols.

DESCRIPTION: An imaging system that would allow an individual to better see objects that are obscured by dense smokes and/or obscurants would be of great value to both military and civilian professionals. Various imaging schemes have been proposed over the years, but none have been developed to the extent necessary to be considered commercially viable. The vast majority of the research in this area has been driven by the medical imaging community in which noninvasive imaging techniques through dense "turbid" media is desired, i.e., human tissue [1, 2]. However, many of these proposed polarization based techniques require complex illumination and image capture/processing schemes, at relatively short wavelengths, and are not appropriate for atmospheric propagation. Recent studies suggest that a relatively simple polarimetric based approach might suffice, and be quite effective in enhancing ones ability to resolve targets that are obscured by dense smokes and/or aerosols [3, 4, 5]. This proposed technique involves active illumination of an obscured target with IR circularly polarized light. Imagery based on the backscattered light is captured with an appropriate IR camera that is polarimetrically filtered to except a particular polarization state based on the nature of the reflected light. It is well known that circularly polarized light reverses the direction in which it rotates when singly scattered from most hard surfaces and/or aerosols. However, recent studies have suggested that for most "real-life" surfaces, i.e., any surface that is slightly diffuse, a surprisingly large amount of the reflected light retains its original circular state [6]. This should allow for effective light discrimination (and subsequent removal) of aerosol scattered "noise" light that typically negates the benefit of active illumination. For example, lets assume right-handed circularly polarized IR light is used to illuminate a smoke cloud that obscures a target of interest. Normally much of this light is scattered back into the imager causing a "white-out" condition thus rendering the illuminating light useless. However, by using the polarized nature of the light one can discriminate and remove the unwanted backscattered light and allow only the "image-forming" light reflected from the target to reach the camera. By placing a right-handed circular polarized filter in front of the camera, all backscattered light from the aerosol is removed since upon reflection it becomes reversed, i.e., left-handed. However, much if not all, prior research has involved spherical nonabsorbing Rayleigh scatters and the aforementioned phenomena might be quite different for highly absorbing nonspherical particles (the type most commonly associated with smokes). Therefore, as part of their proposal, candidates should suggest specific research to be conducted in order to better establish the optimal waveband of operating and polarizing optics that most effectively discriminate/filters the unwanted backscattered light. Candidates should describe a means for actively illuminating an area with polarized light within an optimal waveband region that is sufficiently intense and capable of being hand-held. Candidates should keep in mind safety concerns when considering this illuminator. Similarly, we require a means for IR video capture and display that can easily be worn by the soldier in a non-intrusive manner. Finally, because the imager is intended to operate in "photon-starved" environments, special attention should be paid to detector sensitivity.

PHASE I: Conduct research, i.e., aerosol chamber measurements, that establishes the optimal waveband and polarizing optics combination for a variety of common obscurants and surfaces. Based on these findings begin formal design phase for proposed portable IR polarimetric illuminator/imager system.

PHASE II: Develop a prototype handheld polarized IR illuminator. This should include IR source, collimating/expanding polarizing optics, and power supply. Complete development of a ruggedized, portable, polarimetric IR image and display system. Include all OEM development for the components necessary. Test, optimize, and demonstrate a complete working prototype system under a variety of conditions and obscurants.

PHASE III DUAL USE APPLICATIONS: The type of device proposed here should have numerous applications in both the military and private sector. The most obvious civilian application would be in the area of fire fighting. Currently, various fire departments are already deploying conventional passive IR cameras in the field and a system designed to improve the ability to see through smoke would likely be well received. There appears no fundamental reason why this technique could not be scaled up and range extended for use on military/civilian vehicles and aircraft. It is also conceivable that the proposed technique could easily be incorporated on a robotic platform for remote operation.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: IR imaging technology is rapidly finding its way into more mainstream application as the cost for such sensors continues to drop (e.g., General Motors now offers a grill mounted IR camera for its Cadillac line of automobile). The author believes based on preliminary cost estimates, an effective illuminator/camera system could be mass-produced at a price point that compares well with other technological devises that are designed to be worn in the field.

REFERENCES:
1. J.M. Schmitt, A. H. Gandjbakhche, "Use of polarized light to discriminate short-pass photons in a multiply scattering medium", Appl. Opt., vol. 31, no. 30, 6535-6546, (1992).
2. S.P. Morgan, M. P. Khong, "Effects of polarization state and scatter concentration on optical imaging through scattering media", Appl. Opt. vol. 36, no. 7, 1560-1565, (1997).
3. G.D. Lewis, D.L. Jordan, "Backscatter target detection in a turbid medium by polarization discrimination", Appl. Opt., vol. 38, no. 18, 3937-3944 (1999).
4. P.Chang, J. Walker, "Polarization discrimination for active imaging in active scattering media", Opt. Comm., vol. 159, 1-6 (1999).

5. F.C. MacKintosh, "Polarization memory of multiply scattered light", Phys. Rev. B, vol. 40, no. 13, 9342-9345 (1989).
6. G.D. Lewis, D.L. Jordan, "Backscatter linear and circular polarization analysis of roughened aluminum", Appl. Opt., vol. 37, no. 25, (1998).

KEYWORDS: infrared, polarimetric imaging, image enhancement, obscurants, smokes

A00-101 TITLE: Synthesis Of Affordable Phase Pure Gamma-Aluminum Oxynitride (AlON) Powders

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop methods to produce chemically and phase pure gamma-aluminum oxynitride (AlON).

DESCRIPTION: There is a need to reduce the weight and thickness of transparent armor systems for ground and air vehicles. These systems will need to have increased levels of performance with lower weight, reduced thickness, and increased survivability. Aluminum oxynitride has been shown to be an excellent candidate for use in transparent armor systems. The limiting factor for its insertion has been its high cost. One reason for the high cost is the lack of a commercial, low cost source of gamma-AlON powders. The focus for this topic area is to develop a source for low cost aluminum oxynitride powders that can be densified to transparency. The powders should be at least 99.97 % pure with less than 0.03 weight percent cation and anion impurities including carbon. The powder should have a submicron average particle size as measured by a x-ray sedigraph technique and an average agglomerate size less than 2 microns and a green density greater than 45 % for a dry pressed, cold isostatically pressed (30,000 psi) pellet.

PHASE I: Determine the optimum technique to produce low cost gamma-aluminum oxynitride powder that is phase and chemically pure. The metric of most significance is phase purity. There are many aluminum nitride polytypes that are stable for this system and these should be minimized. The powder should have a submicron particle size that is highly sinterable with no hard agglomerates. The process utilized must be scalable to achieve the large quantities necessary for producing large windows. The powder will be fully characterized for phases present, chemistry, particle size, and particle size distribution and surface area. A design study with cost analysis will be conducted for the production and operation of a large-scale powder production facility.

PHASE II: The focus of this SBIR topic is to manufacture AlON powders that are highly sinterable. The powder process will be optimized to produce a highly dense green compact. The powder will be monitored for phases present, chemistry, particle size, and particle size distribution and surface area. Concurrently, the powder process will be scaled up to produce large quantities (10 kg) of powder in a reproducible manner.
Sintering studies will also be conducted to produce dense, transparent AlON disks with minimum thickness of 0.375 inches. A ballistic evaluation will be conducted using six-inch diameter plates. A ten shot V50 will be determined using the 7.62 APM2 round.

PHASE III DUAL USE APPLICATIONS: The demonstration of low cost AlON would have applications other than transparent armor for military and commercial sectors. Other military applications for AlON are for dome materials and for sensor protection. Commercial applications for AlON include protection for law enforcement personnel, armored cars and security windows.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Any advancement in the development of materials to reduce the overall weight of a system can have operating and support cost reduction through lower fuel consumption and larger payloads.

REFERENCES: Tustison, Randal, Hartnett, T. M, "ALON (Aluminum Oxynitride, A new material for transparent armor, " presented at the DARPA/ARL/ARO Transparent Armor Workshop, November 16-17, 1998.

Rhodes, William, "Processing Transparent Polycrystalline Ceramics," Proceedings DARPA/ARL/ARO Transparent Armor Materials Workshop, November 1999.

KEYWORD: Aluminum oxynitride, AlON, powder, chemical, synthesis

A00-102 TITLE: High Volume, Low-Cost Production of High-Purity Carbon Nanotubes

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop methods of production for high quality carbon nanotubes with control over tube size and structure ("buckytubes") that can deliver high volumes of these materials at reasonable cost.

DESCRIPTION: Carbon nanotubes or "buckytubes" have been the subject of intense research activity for a number of years. There have been numerous applications proposed for nanotubes and numerous predictions that the use of

nanotubes will lead to significant advances in the performance of a range of materials and devices. Experimental evidence confirms that nanotubes have highly desirable properties, such as high strength and high electrical conductivity. It has also been shown that incorporating nanotubes in composite structures can impart these desirable properties to the product at relatively low loading levels. A major impediment to the development of materials and devices based on carbon nanotube technology is the extremely high cost of these materials. At this time, the price for carbon nanotubes, at various levels of purity and uniformity, ranges from $5 to $2000 per gram. These prices make it virtually impossible for carbon nanotubes to be considered for use in any kind of large-scale application or commodity material. The price is dictated primarily by the available supply of these materials. At this time, one of the principal suppliers of high-purity single-wall nanotubes, reports being able to produce about 60 grams per week of material in a 24 hr./day operation. In addition, raw nanotube soot has to be post processed to remove non-nanotube impurities, which adds to the cost. In order for the full potential of carbon nanotubes to be realized, a method of producing nanotubes economically is needed. Furthermore, it will be highly desirable to have a process that can be controlled to allow the production of nanotubes that are uniform in structure and properties, and that will allow the controlled variation of those properties to produce nanotubes with specific properties for specific applications. A few different methods of nanotube production have been reported, including carbon arc deposition and plasma- assisted CVD processes. The available methods need to be studied to determine the requirements to scale-up nanotube production in order to bring the cost down to the range of tens of dollars per pound, where the nanotubes could be considered economically viable for use in high performance engineering materials.

PHASE I: Research and identify the most promising synthetic method for producing large volumes of carbon nanotubes economically. The proposed production method may be related to previously demonstrated lab-scale technologies or may be an entirely new proposed method. Demonstrate experimentally, the ability of the proposed method to produce carbon nanotubes with full control of properties such as size, wall thickness and crystallinity. Conduct a design study for a large scale carbon nanotube production device or devices, based on the most promising technologies identified, including an estimate of the cost of nanotubes produced using the proposed large-scale device.

PHASE II: Continue development of large scale nanotube production device concepts. Determine through experimentation critical process issues affecting production rate, product quality and product cost. Product quality issues include control of specific nanotube parameters of size, conformation and crystallinity. Produce a prototype device that can synthesize large volumes of carbon nanotubes with controlled properties as defined above. The prototype device should produce 1 kg of nanotubes per day at a cost not to exceed $200/kg on a prototype basis. The contractor should also demonstrate how the prototype synthesis device could be scaled-up to produce larger quantities of nanotubes at lower cost.

PHASE III DUAL USE APPLICATIONS: Equipment to produce large volumes of carbon nanotubes economically will be of considerably utility to the R&D community participating in the National Nanotechnology Initiative and will help to accelerate the advance of new materials and device technology based on carbon nanotubes. There are a large number of potential applications of carbon nanotubes, including electronic devices and high performance structural materials that will require large volumes of high quality nanotubes, at low cost.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Cost reduction due to the use of more efficient materials for critical applications in survivability and lethality and reduced logistical burden.

REFERENCES: Synthesis of individual single-walled carbon nanotubes on patterned silicon wafers, JING KONG, HYONGSOK T. SOH, ALAN M. CASSELL, CALVIN F. QUATE & HONGJIE DAI, Nature 395, 878 - 881 (1998) © Macmillan Publishers Ltd.

Large-scale production of single-walled carbon nanotubes by the electric-arc technique, C. JOURNET, W. K. MASER, P. BERNIER, A. LOISEAU, M. LAMY DE LA CHAPELLE, S. LEFRANT, P. DENIARD, R. LEE & J. E. FISCHER, Nature 388, 756 - 758 (1997) © Macmillan Publishers Ltd.

Z.F. Ren et al., Science 282, 1105 (1998)

KEYWORDS: carbon nanotubes, buckyballs, fullerenes, synthesis

A00-103 TITLE: Low Cost, Minimally Invasive Sensor Network for Structural Polymer Composites

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop a low cost, minimally invasive, structurally compatible system for retrieving and processing data from embedded sensor networks capable of detecting sub-surface failure and adverse load conditions in polymer composite structures.

DESCRIPTION: Although a great deal of research has been invested in the development of new sensors for structural health monitoring, very little innovation has been demonstrated in developing a practical means to acquire data from the embedded sensors. Indeed, wires have been recently cited [1,2] as one of the most serious implementation barriers in "smart" materials. The

focus of this research effort is the development of a structurally compatible, low cost means of acquiring data from sensor networks embedded in composite components. The technical challenge is to produce a system that is minimally invasive, inexpensive, reliable, and effective in providing conclusive data about the local state of health of a composite structure. Innovation should be focused on installing, distributing, and interrogating the sensors or sensor networks. Data obtained from local sensor networks should be made available for local preprocessing. The system should be capable, based on initial evaluation of data received from the local sensor network, of transmitting preliminary warning signals indicating the local health status of the composite structure and have minimum power requirements. The solution should use an existing sensor technology and focus on a novel, structurally compatible means of acquiring data from a composite structural member in real time with emphasis given to eliminating or minimizing the number of wires required.

PHASE I: Identifty the most promising means for developing a health monitoring system which acquires and accesses data from an embedded sensor network. Assume sensors will produce low current electrical output. Design and build a prototype of a low cost, structurally compatible method for retrieving embedded sensor data from a minimum of 5 sensors. If wires are to be used in the network they must be compatible with the host polymer composite. Demonstrate that the method is sufficiently robust and effective to interrogate a sensor at a miniumum depth of 5 cm in graphite and glass composites. Demonstrate a fully functionally prototype of the overall system.

PHASE II: Evaluate embedded wireless device performance under electrically "noisy" operating conditions, as well as its effect on the mechanical integrity of the host composite. Demonstrate a means of retrieving data from a local network consisting of a minimum of 10 sensors that can be interrogated from a local network system. The main hub of the network could be located on the surface of the composite and access the embedded sensor with a minimum number of wires. The system should also be able to locally process signals obtained from the local network and relay "warning" information to a centralized data acquisition and analysis site using both a common cable and a wireless transmitter. Develop a user-friendly interface to display the type and location of sub-surface damage in a composite structure. Develop a low cost means for producing and installing clusters of wireless sensor networks; demonstrate centralized data acquisition from a minimum of 5 independent sensor network clusters.

PHASE III DUAL USE APPLICATIONS: A flexible, low cost, sensor network has a wide variety of applications including commercial composite structures and components, remote sensing, and detection of data in hazardous materials and/or environments. Deliver a system for the Army to evaluate installation and assessment in strucutral members representative of those used on rotary wing vehicles and ground vehicles.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: This technology will enable a practical means for fully realizing conditioned based maintenance, which substantially benefits operating and support cost reduction.

REFERENCES:

[1] Proceedings of the 2nd International Workshop on Structural Health Monitoring, edited by Fu-Ko Chang, Technomic Publishing Co., 1999

[2] E. Elghandour, F. A. Kolkailah, Sensors Location Effect on the Dynamic Behaviour of the Composite Structure with Flaw Detection, Proc. of the 44th International SAMPE Symposium, May 1999, pp. 349-358.

KEYWORDS: sensors, health monitoring, smart materials, intelligent composites

A00-104 TITLE: Electromagnetic Modeling of Complex Structures

TECHNOLOGY AREAS: Information Systems, Materials/Processes, and Electronics

OBJECTIVE: To develop a tool to create complex electromagnetic models of military and civilian structures for the purposes of electromagnetic computational analysis of radiation, scattering, interference, and coupling, and visualization of the results in electromagnetic quantities such as surface currents, near-zone and far-zone electric and magnetic fields. This new tool will enable an electromagnetic analyst to characterize electromagnetic effects on military and commericial targets more accurately and more rapidly.

DESCRIPTION: Future Army systems are becoming more electronically complex. Current methods for the creation of complex electromagnetic models is time consuming and is technically far behind the current computational capabilities of available electromagnetic codes. In addition, electromagnetic codes are being employed to study a much broader class of problems under the umbrella of E3 (electromagnetic environmental effects), and the deficiences in the modeling has become even more apparent.

The Army has been interfacing computer aided design (CAD) modeling tools into integrative frameworks with an electromagnetic code with limited success. Translators have been written to bring BRL-CAD (solid modeling CAD tool designed

at the Ballistic Research Laboratory) drawing data into the electromagnetic domain; however, such data usually needs much analyst intervention before it is practical to use it with an electromagnetic code. This "analyst intervention" is usually performed with a graphical visualization and editing tool, but such tools, both Government and commercial, are not well suited to generating modeling elements with the requisite electromagnetic integrity, and the manual editing required to modify the models is too costly. Recently, the Air Force engaged the Army in a joint effort to increase their overall E3 analysis capabilities. One apparent deficiency that quicky emerged was the capability to create complex electromagnetic models of a broad class of targets (aircraft to tank) using various CAD platforms.

A new methodology is needed to devise a way to convert CAD data into electromagnetic modeling elements for electromagnetic codes that meet the electromagnetic modeling guidelines of size, shape, curvature, connectivity, and so forth. The method should be semi-automatic. That is, some minimal intervention by the analyst is acceptable.

PHASE I: 1. The contractor shall design and develop the methodology to convert CAD data into electromagnetic modeling elements for electromagnetic codes that meet the electromagnetic modeling guidelines of size, shape, curvature, connectivity, and so forth. The method should be semi-automatic.
2. The contractor shall demonstrate a preliminary version of this new method through the use of sample cases.

PHASE II: For Phase II, the contractor shall extend the Phase I methodology to the full capability of a productive tool for electromagnetic analysis. The new tool shall be a complete software package that meets the requirements set fourth in Phase I, and shall support the more popular electromagnetic methods used by the EM community, such as method of moments, and the uniform theory of diffraction.

PHASE III DUAL USE APPLICATIONS: The final software shall include a modeling primitive library, an electromagnetic rules library, and examples of Army systems. The creation of this tool will have a broad range of commercial applications. Not only will it directly impact electromagnetic codes capabilities, it will also enhance the commerical application of electromagnetic codes -- more user friendy, etc. Commericial sectors that will benefit from such a tool range from the airline industry to the computer industry -- electromagnetic interference problems are potential problems as computer speeds increase drastically over the coming years.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Development of such a tool will greatly reduce analyst time in creating an electromagnetic model, and reduce the overall cost of electromagnetic analysis of a complex system. The added complexity of modeling will also lead to more accurate analysis. This increased accuracy will have great impacts upon the operation of equipment on the battlefield, and upon the flight safety analysis that the Air Force conducts.

REFERENCES: (1) Processing of Geometry Structures for Electromagnetic Analysis of Military Systems, Final Report prepared for Rome Laboratory and the Army Research Laboratory, Coffey, E. L., July 1997.
(2) F-16 Structure Modeling using GEMACS 5.3, 10th Annual Review of Progress in Applied Computational Electromagnetics, Fisher, R. and Coffey, E. L., March 1994.

A00-105 TITLE: Dynamic Simulation of Human and Vehicle Motion Interaction for System Design

TECHNOLOGY AREAS: Information Systems, Human Systems

OBJECTIVE: Fully interactive, dynamic motion simulation of both vehicle, soldier and the interaction of one on the other so that tradeoffs to soldier task performance and crewstation ride quality given changes in vehicle ride dynamics can be assessed.

DESCRIPTION: This effort involves combining three separate modeling capabilities into one integrated computer-based tool. Standalone commercial engineering analysis tools exist for performing anthropometric analysis (e.g. body size accommodation, reach, vision, etc.), biomechanical analysis (e.g. forces on the body for crash simulation, ejection seat evaluation), and dynamic vehicle analysis (e.g. ride and handling analysis, vibration and stability studies). But none of these tools alone has the capability to model how well people of varying sized and physical characteristics can operate a workstation while traveling over rough terrain. The anthropometric models lack representation of the effect of forces on the body. Biomechanical models lack detailed modeling of the body and the ability to represent the full range of a population. They also lack analysis capabilities such as reach and vision. Both anthropometric models and biomechanical models cannot generate estimates of vehicle ride characteristics. Dynamic vehicle simulations have very low fidelity representations of their human operators. For the Army to be successful in using simulation-based acquisition in development of new systems, the capability to evaluate the usability of system designs in dynamic environments while taking into account vehicle and soldier physical characteristics is essential.

PHASE I: Identify an approach for integrating the analysis capabilities of anthropometric, biomechanical and vehicle dynamics models. Develop a software specification for the combination and build a rapid prototype of the user interface. Identify specific models to be integrated or linked and a test case for validation of the capability (perhaps, a tank commander operating controls while driving off road).

PHASE II: Develop software for the integrated analysis tool according to the specification developed in Phase I. Demonstrate the software accurately modeling the test case identified in Phase I without loss of analysis capability of the contributing analysis tools.

PHASE III DUAL USE APPLICATIONS: The analysis tool developed would be of immediate benefit to designers in any industry in which humans operate controls and work in a dynamic environment on a moving platform. Examples are the automotive, aerospace, petrochemical (off shore platforms), and maritime industries. The entertainment and forensic simulation industries could also make use of the capability to cut down on simulation time and resources.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: The analysis capability described will decrease the likelihood of expensive medical claims due to vibration and ride quality related injuries by increasing the likelihood that vehicle designs will consider the interact of ride quality and human limitations.

REFERENCES:
Ergonomic Models of Anthropometry, Human Biomechanics, and Operator-Equipment Interfaces: Proceedings of a Workshop. Kroemer, K.H.E., Snook, S.H., Meadows, S.K., and Deutsch, S. eds., National Academy Press, Washington, DC 1987.

Modeling and Simulation: Linking Entertainment and Defense. National Academy Press, Washington, DC 1999.

"The Jack interactive human model," P. Lee, C. Phillips, E. Otani and N.I. Badler. Concurrent Engineering of Mechanical Systems, Vol. 1. First Annual Symposium on Mechanical Design in a Concurrent Engineering Environment, Univ. Of Iowa, Iowa City, IA, October 1989, pp. 179-198.

"Jack: A toolkit for manipulating articulated figures," C. Phillips and N.I. Bader. ACM/SIGGRAPH Symposium on User Interface Software, Banff, Canada, October 1988.

Gross, M.E., "The GEOBOD III Program User's Guide and Description," AL-TR-1991-0102, Beacher Research Co., Dayton, OH, 1991.

Day, T.D., "An Overview of the HVE Vehicle Model," SAE Paper No 950308, Society of Automotive Engineers, Warrendale, PA 1995.

KEYWORDS: ride quality, vehicle dynamics, suspension, human systems integration, ergonomics, crew station design

A00-106 TITLE: Platform Noise Reduction

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors

OBJECTIVE: The objective is to develop a technique to continuously and adaptively reduce the noise created by the platform on which acoustic sensors are placed. The technique developed must reduce the presence of noise created by the platform in the signal detected by the acoustic sensors. The platform could be either statically or dynamically deployed. The presence of platform noise within the detected acoustic signal reduces the effectiveness of detection and localization of targets at long ranges. This technique should improve the sensor's capability to detect and localize ground targets of the same type and class as the platform on which the sensors are positioned. The technique should be suitable for future low-cost acoustic systems and will be evaluated in a field test scenario.

DESCRIPTION: Current ground employed acoustic sensors are capable of detecting and localizing multiple targets at long ranges (2 km). Requirements exist for the employment of acoustic sensors on operational vehicles to detect and localize targets in the vicinity. The effectiveness of acoustic sensors on running vehicles is greatly reduced due to the noise created by the vehicle itself. By placing secondary microphones and accelerometers (possibly other sensors) for the measurement of platform noise sources, an algorithm can be developed for the reduction of platform noise in the measured acoustic signal. It is believed that greater than 20 dB in noise reduction is achievable. The more reduction achieved, the greater the detection range demonstrated by the acoustic system.

PHASE I: This phase will define techniques for platform noise signal cancellation. The technique will be demonstrated against real signals to quantify the reduction in platform noise present in the acoustic signal. The algorithm will be capable of performing in real time as part of an array of acoustic sensors and should not distort phase information present in the acoustic signal needed for a typical adaptive beamformer. Techniques for the detection of ground vehicles of the same type and class, as the platform on which the acoustic sensors are positioned, will also be investigated.

PHASE II: A prototype array of acoustic sensors, noise reduction devices and real-time signal processing will be installed on a chosen vehicle for demonstration. The algorithm and sensor suite will be tested for the ability to detect differing types of

vehicles and those from the same type and class. Performance will be measured with and without platform noise sources operational.

PHASE III DUAL-USE APPLICATIONS: Any application of microphones on vehicles (or noisy environments) encounters the interference of local platform noise with a desired signal. Emergency vehicle communications from high noise environments will benefit from improved intelligibility. Vehicle mounted microphone arrays, for "hands free" cellular phone application, will also benefit due to the reduction of undesired signals.

OPERATING AND SUPPORT COST REDUCTION: With the focus on a highly mobile future combat system and the Army's interest in installing acoustic sensors onboard moving platforms, the existence of a developed acoustic sensing system for platform noise reduction is very important. Recent programs have focused on the detection and identification of air and ground targets and the detection and localization of artillery and sniper fire.

REFERENCES:

1. "Transporting Noise Control into the 21st Century; Planning for a Quiet Future", NOISE-CON 98 Proceeings of the Noise Control Foundation Conference, New York, April 5-8, 1998. Internet: http://users.aol.com/noiseconf/program98.html

2. Barth D.R., and Kashani, R., "Engine Noise Reduction Using Narrowband Feedback Control," Proceedings of the SAE Noise and Vibration Conf., Traverse City, MI, May 15-18, 1995.

3. Kiriczi, S. and Kashani, R., "Robust Control of Active Car Suspension with Model Uncertainty Using H-infinity Methods", Advanced Automobile Technology, Velinsky, S.A. et. al. Eds., DE-Vol. 40, The ASME Bk. #H00719,1991, pp. 375-390.

4. Rosenhouse, G., "Active Noise Control Fundamentals for Acoustic Design", Computational Mechanics Inc./WIT Press, 2000.

5. Beranek, Leo L., "Noise Reduction", Peninsula Publisher, June 1991.

KEYWORDS: Acoustic Sensor, Noise Reduction, Target Detection, Target Localization.

A00-107 TITLE: Development of Thallium-containing Semiconductor Materials for High Speed Electronic Devices

TECHNOLOGY AREAS: Materials/Processes, Electronics

OBJECTIVE: Develop new, inexpensive, manufacturable semiconductor materials with inherently better electron-transport properties than is currently available.

DESCRIPTION Today most manufacturers of high-performance monolithic radio-frequency integrated circuits (RFICs) use pseudomorphic high-electron mobility transistors (PHEMTs) made on GaAs substrates. The high performance of the PHEMT comes mainly from the use of InGaAs as the conducting channel. It is anticipated that the Army's interests in RFICs, suitable for operation in the high mm-wave range will increase, stressing the PHEMT technology to its limits. In particular at W-band, and higher, the performance of the GaAs-based PHEMT is marginal, which has spurred development efforts of PHEMTs with higher InGaAs concentration allowed by the use of InP substrates. Although the performance of such devices is promising, the technology is much less mature and manufacturing costs are considerably higher due to the inherent need for more exact crystal growth control, considerably more expensive and smaller substrates, as well as the need for new, InP-specific fabrication steps.

Calculations predict that materials such as TlGaAs and TlGaP, at concentrations that would allow them to be grown pseudomorphically on GaAs, may exhibit better mobility at low electric fields, as well as higher saturation velocity at high fields, compared to pseudomorphic InGaAs on GaAs and even InGaAs on InP (ref 1, 2). If available, these materials would provide the electronics industry with a "drop-in" substitute material for an existing GaAs-based PHEMT process line, at comparable cost. No new fabrication processes or tools would be required, while a significant performance enhancement could be expected. The improvements expected from the proposed material system include one or a combination of: operation at higher speed, higher gain, broader bandwidth, and higher power added efficiency.

PHASE I: Develop the materials synthesis technology. Systematically evaluate and determine optimum crystal growth process parameters. Demonstrate growth of pseudomorphic layers of the new material in combination with a suitable high-bandgap, modulation-doped, charge-supply layer on GaAs. Document the material's chemical, structural, optical and electronic transport properties.

PHASE II: Develop a robust materials growth process, and any needed ancillary hardware enhancements (it is anticipated that any such technology change would be minor in order to meet the goal of low cost and suitability for mass production). Demonstrate pilot runs of RFICs to prove enhanced performance at mm-wave frequency of chips made with the new materials compared to InGaAs on GaAs-based PHEMTs.

PHASE III DUAL-USE APPLICATIONS: The RFIC is an enabling technology in the hand-held personal communications hardware business area. Unfortunately, due to the heavy emphasis on low cost, this business sector seldom strives for the ultimate performance levels that can make a difference on the battlefield. Also, the commercial interests typically do not cover the high frequency bands that are of interest to the Army. Since the RFIC market today is driven mostly by commercial rather than military needs it is of great value to provide chip manufacturers with more potent materials that can also satisfy military needs with existing processes, while providing lower cost in commercial parts.

An improved semiconductor material will benefit the trade-off between system performance and cost for both commercial and military systems: In general, higher chip performance can be obtained, either by using finer lithography (at greater cost), or by substituting a material with inherently better properties (in the proposed case at no additional cost). Alternatively, if an enhanced material becomes available, the same performance level can be maintained while relaxing the lithography requirements, yielding a lower cost system. From these considerations we expect that the technology proposed here will have a pervasive impact on the electronics industry, benefiting both military and commercial users.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: The dual use prospect, described above will reduce the cost to the Army since high-performance RFICs will be available at lower cost. If high enough performance can be achieved it is even conceivable that COTS chips can be used in Army system designs.

REFERENCES:

1. A Proposed TlGaAs/AlGaAs Pseudomorphic Heterostructure Field Effect Transistor, S.P. Svensson and F.J. Crowne, J. Appl. Phys. 83, 2599, (1998)

2. Ab Initio Investigation of the Electronic and Geometric Structure of Zincblende
Ga1-xTlxAs Alloys, S. Mankefors and S.P. Svensson, Accepted

A00-108 TITLE: Crew Station Design Tool

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: Develop a computer-based tool that automatically determines the optimum arrangement of controls and displays based upon sound human engineering and ergonomics principles.

DESCRIPTION: The Army is emphasizing simulation-based acquisition, rapid prototyping and virtual evaluations of new systems. In the dynamic design environment of the future, the design will undergo multiple iterations in a short period of time. Many current tools provide a means of evaluating a design but are usually employed after a crew station concept exists. New methods of embedding human engineering principles into design development are needed to keep pace in the future. A new PC-computer-based tool is required that helps optimize crew station design and provides flexibility for rapid adjustments. The concept here is for an interactive tool that helps the designer optimize selection and placement of controls and displays, provide for full range of motion while performing crewstation tasks (entering, exiting, and operating), and minimizes cognitive workload. The tool will help generate the proper sequence of information input and output as well as consider the cognitive and physical requirements for control operation through techniques such as task and workload analysis. Finally, the tool selects the optimum type and placement of control or display, and automatically provides a 3-Dimensional interactive view of the crewstation layout. The tool should highlight conflicts in design and suggest optimal approaches and alternatives. The tool should be flexible enough to easily update with new human engineering principles and guidelines, handle hundreds of controls and displays (such as in a tank or helicopter cockpit), handle traditional controls and displays, and provide mechanisms for including new technologies (such as 3-D audio or haptic devices). The tool should be able to handle placement of individual controls or groups of controls and allow rapid update for new control considerations. The format should be interchangeable with existing major CAD and human figure model programs. For the purposes of this SBIR, a crew station is defined as a single stationary operator seated or standing or two stationary operators seated either in tandem or in-line. The user interface shall be a simple and intuitive approach employing alternative control technologies where logical and feasible.

PHASE I: Demonstrate the feasibility of concept with a working model using a small representative subset of traditional controls and displays and provide evidence of flexibility to expand to new technologies. Identify critical technical challenges and data voids for Phase II and proposed techniques for resolving challenges. Identify viable and unique approaches for user interface with the tool. Identify the approach for validation of the software tool in Phase II.

PHASE II: Create a fully functional tool and demonstrate the capability to build a complicated crew station (defined here as 350 controls) for both the one operator and two operator stations from scratch within the power constraints of a high-end Windows PC computer. Demonstrate use with a wide variety of controls and displays, placed individually and as part of sub-components.

Validate the tool against a real crew station for one and two person operation, showing capability for effective tool operation and problem resolution for 5th percentile female through 95th percentile male.

PHASE III DUAL USE APPLICATIONS: The tool could be used by any designer, not just human engineering professionals, for any workstation including a production line control point, an Army tank, a jet cockpit, a nuclear power plant operator station, or an office desk arrangement. If integrated into existing commercial Computer Aided Design packages as a module, this set of software could be used by hundreds of thousands of commercial and government designers.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Training operators for military systems is a large part of lifecycle costs. Employing sound Human Engineering principals in system development will reduce those costs associated with training.

REFERENCES: :
MIL-STD 1472D Human Engineering Design Criteria for Military Systems, Equipment, and Facilities

Natick Research, Development and Engineering Center Technical Report Natick/TR-89/027. "1988 Anthropometric Survey of U. S. Army Personnel: Summary Statistics Interim Report." Claire C. Gordon, Thomas Churchill, Charles E. Clauser, Bruce Bradtmiller, John T. McConville, Ilse Tebbetts, Robert A. Walker. March 1989. AD-A209 600.

Woodson, Wesley E., Tillman, Barry, Tillman, Peggy: Human Factors Design Handbook. McGraw Hill Publishing Co., New York 1992. 2nd Edition.

Weimer, Jan, Ph. D.: Handbook of Ergonomic and Human Factors Tables. PTR Prentice Hall, New Jersey 1993.

Evaluation of Human Work, A Practical Ergonomics methodology. Edited by Wilson, John R. and Corlett, E. Nigel. Taylor and Francis Inc, Bristol, PA. 1995. Second Edition.

KEYWORDS: Human Engineering, Ergonomics, Computer-Aided-Design, Crew Station Design

A00-109 TITLE: High Speed Solid State Mid-Infrared Spectral Tuner for Laser Radar Applications

TECHNOLOGY AREAS: Electronics

Objective: Design and build a compact solid state mid-infrared laser source which is capable of tuning at MHz rates in CW model, or >1kHz in a pulsed mode. System will have no moving mechnaical parts, and will have a tuning range in the 3.4 to 3.7 micron regions with a spectral resolution of 1cm-1. The unit will permit applications both as a mid-infrared source and as an optical up-converter. System will output 1mJ/pulse and should be scalable to 10mJ/pulse.

Description: There is a need for hyper-spectral sources and detectors for laser radar and lidar applications. These systems must be robust, yet at the same time be able to scan hundreds of infrared bands in time periods under one second. In the past, tunable etalons, angle tuned OPOs, etc. have been used as sources. Detectors have used tuning monochrometers and etalon systems. Development of a high speed solid state tuner would allow the construction of hyperspectral laser radars and lidars capable of spectral analysis of targets for target ID and clutter analysis and chemical remote sensors. Use of a solid state tuner would also allow the construction of robust nonlinear optical up-converters.

Phase I: Assemble and demonstrate the basic system components of the solid state high-speed mid-infrared spectral tuner.

Phase II: Refine components necessary to begin assembly of a breadboard tuner that addresses the technical issues of beam quality and linewidth in order to meet the design requirements for a fieldable long range (50km) laser radar utilizing the high speed tuner.

Phase III Dual Use Applications: The all solid-state tunable mid-infrared laser source will provide a robust capability of electronically tunable wavelengths that have applications in laser radar and lidar. Applications of such a system include detection of infrared countermeasures and target identification; these areas are important with respect to survivability on the battlefield. Lidar applications of such a system include both direct chemical detection and chemical imaging. Such technology can be utilized in the commercial sectors for environmnetal monitoring and imaging applications including medical diagnostics.

Operation and Support Cost Reduction (OSCR): This proposed topic is requesting a high speed tuner for remote sensing applications. Specific components/capabilities are required and can be leveraged from existing technologies. This initiative will permit the development of a high speed tunable system without start-up development and reserch. This will permit considerable savings in cost and time.

References: Air Force SBIR #F33615-97-C-1161, "Long Range Chemical DEtection by Means of Pulsed Infrared Optical Up-Conversion (Enhanced Compact Lidar System)"

"Compensating Differential Albedo in Topographic Lidar through the use of Three or More Lidar Wavelengths", D. F. Schaack, SPIE AeorSense Conference, Orlando FL, April 2000.

Keywords: Spectral tuner, lidar, laser radar, mid-infrared, reflectivities

A00-110 TITLE: Powder Injection Molding for Large Military Components

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop advanced techniques, materials and/or equipment necessary to produce high quality, large volume powder injection molded components.

DESCRIPTION: Powder injection molding offers the opportunity to form components to net-shape through the use of particulate materials. Usually, a feedstock of metal or ceramic powders blended with polymer binders, are injected into dies in a manner identical to polymer injection molding. The formed parts in the as-injection molded condition are called "green". After molding the polymer binder is no longer needed and is usually removed from the formed part by a combination of solvent and thermal debinding; the remaining metal or ceramic powder, brown part, retains the formed shape. These debound parts are then sintered in the usual way. Powder injection molding is a process that is capable of producing complex metal and ceramic components at a great cost savings. The process is commercially successful for parts of limited volume. The Army is interested in the fabrication of parts where the volume of material injection molded may exceed 100 cubic centimeters. These parts will be used in high precision applications such as warhead liners and fin sets for kinetic energy projectiles. These parts will be fabricated from either refractory metals or high performance stainless steel compositions. The nature of the parts necessitates the use of very tight dimensional tolerances. The fabrication of these parts will require modeling of the injection molding process for mold design and process optimization, precise control over the process variables, the incorporation of novel materials such as nanoparticulates and the use of non-destructive inspection techniques.

PHASE I: Identify and develop advanced methods for the production of high quality powder injection molded components. Demonstrate the appropriateness of the methods for the applications. Deliver demonstration components produced with the techniques, methods or procedures developed. All phase I work should concentrate on one type of material for a single application so as to concentrate on developing the innovation.

PHASE II: Work in phase II should exploit the phase I success, expand the range of materials and begin to apply the methods developed to production-like situations. This work should highlight the generic nature of the developed material, process or method and deliver prototype or demonstration components. The work in powder injection is inherently dual-use and demonstration components should reveal this aspect of the process. If appropriate, a prototype of equipment developed should be delivered.

PHASE III DUAL USE APPLICATIONS: It can be expected that there will be numerous dual use applications for the methods, materials and procedures developed here. Powder injection components can find application in the automotive, appliance, firearm, computer and cutting tool industries.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Cost reduction due to the use of more efficient materials for critical applications in survivability and lethality and reduced logistical burden.

REFERENCES: Powder Injection Molding, Randall M. German,Metal Powder Industries Federation, Princeton NJ, ©1990.

KEYWORDS: Metal Injection Molding, Powder Injection Molding, Non-Destructive Testing, Metal Processing, Quality Control

A00-111 TITLE: Magnetic Microsensor Modules

TECHNOLOGY AREAS: Sensors, Electronics

OBJECTIVE: Develop battlefield magnetic microsensors modules

DESCRIPTION: We are seeking to develop technology for small, low-power, low-cost sensor modules to detect magnetic anomalies (MA) in the battlefield generated by the presence and movement of armed troops, tracked and wheeled vehicles. Magnetic microsensor can be low-cost because they can be fabricated by microelectronics and MEMS techniques. These magnetic sensor modules could be incorporated in a network of battlefield microsensors systems employing a variety of sensor technologies (which may include, but are not limited to: acoustic, seismic, IR,etc.). Such networks, could play several roles. For example, when linked to indirect fire (e.g., from artillery) these sensors may help obviate the need for conventional landmines. Magnetic sensors have advantages compared with other senesors which include insensitivity to weather conditions, sensitivity to

only ferromagnetic objects, and relatively short range sensitivity. The latter charateristic facilates locating the source of detected signals and counting of vehicles passing nearby on a road. For battlefield use the magnetic sensors must be incorporated into magnetic microsensor modules that will integrate the magnetic sensors with other components that include electronics, a power supply, and sensor and communication interfaces. Utilizing the existing industrial base will
minimize capital investement.

PHASE I: Research is needed in designing magnetic microsensors modules which are optimized to fulfill battlefield requirements. The major considerations are the following: (a) The ratio of the area over which a tank can be detected over the total cost of the module should be maximized. (b) The sensor chosen for the design should either be currently available or a sensor based on a near term emerging technology. In the latter case, realistic estimates of performance parameters such as sensitivity and sensor noise should be used. (c) The module should include necessary electronics, a power supply, and sensor and communication interfaces (either a RS-232 or a RS-485 intrface). (d) Consideration should be given to power management and temperature compensation. Other considerations that are secondary but which should not be totally ignored are: (a) Maximizing the length of time the module can remain in service
unattended. (b) Minimizing the size and weight.

PHASE II: Phase II research should culminate in the demonstration of a prototype magnetic microsensor module based on the Phase I design. The research should include (a) detailed modeling and analysis to support trade-off decisions during prototype development, (b) testing this prototype, and (c) development of prototype filtering hardware demonstrating improved performance. An algorithm may be supplied for target detection, classification, and localization.

PHASE III DUAL USE APPLICATIONS: It is anticipated that the research described above could also be applied to commercial networks of magnetic microsensors used to monitor urban or highway traffic, automated warehouses, and secure installations, perimeters, and borders.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: The "network microsensors" concept represents a fundamental shift in the way we view the battlefield, as compared to the high-cost, high-resolution, fixed sensors which are often employed today. By definition, network microsensors must have very low cost so that that they can be remotely deployed in large networks and never recovered. They will require no external power, no spare parts, and no maintenance.

REFERENCES: T.E. Jones and T.N Roy, "Electromagnetic Sensors for Deployable Autonomous Distributed Systems", Technical Report 1776, SPAWAR System Center, San Diego, 1999.

KEYWORDS: Magnetic, Microssensors, Anomaly Detection, Unattended Ground Sensors

A00-112 TITLE: Continuously Variable Transmissions For In-The-Wheel Electric Motors

TECHNOLOGY AREAS: Ground/Sea Vehicles

Objective: Continuously variable transmission for axial gap electric motors to increase energy efficiency and system performance

Description: Energy efficiency and maximizing performance are of paramount importance to electric motor applications for both the military and civilian communities. A rapidly maturing sector of electric motors is the axial gap brushless DC motors. These motors are ideally suited for high-torque moderate-speed applications. They have high power densities and are dimensionally compact, especially in the motor's axial dimension. Their small axial dimension generally improves system packaging.

As energy efficiency and motor performance requirements increase the high power density and compactness will quicken the transition of axial gap motors into automotive, consumer appliances and industrial equipment markets. Further improvement in operational efficiency and performance can be achieved by incorporating a continuously variable transmission (CVT), ref. 1 and 2, that is compatible with the small axial dimension of these motors. A further improvement in system efficiency of exceeding 20 percent is anticipated through the adaptation of CVT technology. These increased efficiencies will be realized by extending the motor's operational range, that is higher torque at low speeds as well as higher maximum speed. Integration of CVTs to the motor will also eliminate the need for planetary gears.

Continuously variable transmission's axial dimension is typically greater than its radial dimension. It is the objective of this project to develop a CVT whose axial dimension is on the order of 20 to 30 percent of its radial dimension so that the total motor-CVT assembly has a minimal package size. Package size greatly influences end product design. For instance, integrating an axial gap electric motor with a CVT into a vehicle's wheels inlieu of "under the hood" reduces the vehicle's volume by more than 15 percent. This translates to weight saved, increase operational range and potentially reduced acquisition cost.

This project will be challenging in that conventional belt or toroidal CVT concepts may not be applicable necessitating the development of new mechanical concepts or atleast radically altering the adaptation of conventional approaches. Achieving mechanical efficiencies of 90 percent or greater will technologically challenge the new CVT concepts.

Continuously variable transmissions have been under development for over a century. CVTs offer many advantages (infinite gear ratios, simple mechanical design reducing overhaul costs and increasing reliability, potentially lower costs, and greater fuel efficiency) over conventional manual or automatic transmissions. With advances in electronic control, sensors, and materials technology CVTs are rapidly maturing and are commercially available in selected internal combustion engines and are being developed for radial gap electric motors. However, none of the current CVT designs are compatible with the minimal packaging requirements as sought in this project. Furthermore, if the proposed CVT can be developed then it will have applicability to non-automotive markets.

For this project the CVT concept should be focused on a 40 to 60 hp axial gap brushless DC motor that has a maximum shaft speed of approximately 6000 rpm. The CVT shall provide at least an equivalent gear ratio between 6:1 and 4:1, however the greater the range the better. The outer diameter of the CVT housing should be approximately 10 inches and a goal of 3 inches or less in the axial dimension should be sought. All mechanical aspects of the CVT must be contained within the 10" X 3" cylindrical geometry. The technology used in the CVT should be scaleable. Any obvious scaling issues should be identified and explained. Power transmission efficiency shall be 90 percent or higher to be consistent with conventional automatic or manual transmissions.

Phase I: Develop CVT concept. Demonstrate feasibility of concept through simulation and / or the testing of key mechanical components.

Phase II: Design, fabricate and demonstrate CVT on test stand.

Phase III: Integrate CVT with axial gap brushless motors selected by the Government and conduct a 200 hour durability test.

Operational Support and Cost Reduction (OSCR): The development of continuosly variable transmissions for axial gap brushless electric motors will result in quicker response at a lower operating cost by the Army to the movement of men and materiel and is consistent with the needs of the Army. Without this capability the soldier's movement could be severly constrained.

References: 1. Chana, H.E. 1986. Performance of CVT Transmissions, SAE Paper No.860637, Society of Automotive Engineers, Warrendale, PA (US).
2. Machida, H., and N. Kurachi. 1990. Prototype Design and Testing of theHalf Toroidal CVT, SAE Paper No. 90055, Society of Automotive Engineers,Warrendale, PA (US).

Key Words: Continuously variable transmission, hybrid electric drive, axial gap brushless motors

A00-113 TITLE: Alternative Energy Storage System

TECHNOLOGY AREAS: Materials/Processes, Electronics

OBJECTIVE: Develop a compact, lightweight energy storage system that has revolutionary performance.

DESCRIPTION: Alternatives to batteries fuel cells, and capacitors are needed to make power-conditioning systems extremely compact and lightweight. The major types of energy storage and their potential energy density are listed below:

(1) electric energy: $1x\ 10^7$ joules/cubic meter
(2) magnetic energy: $1x10^8$ joules/cubic meter
(3) kinetic energy: $1x10^9$ joules/cubic meter
(4) nuclear isomers: $1x10^{16}$ joules/cubic meter

The information presented above shows that nuclear isomers, magnetic energy storage, and kinetic energy storage have higher energy densities than electric energy storage. The project is aimed at developing extremely high energy storage system(s) that are alternatives to batteries, fuel cells, and capacitors.

PHASE I: The contractor shall develop a design for the energy storage system and show its potential revolutionary performance using theoretical/analytical data, or computer quantitative data, or experimental data, or a combination of data. The deliverable will be a technical report that includes a preliminary design, critical subsystems/components, risk assessment, projected performance, technical challenges, and potential show stoppers. A facility is available at ARL for the contractor to conduct his experiments if required.

PHASE II: The contractor shall conduct both analyses and experiments that are aimed at demonstrating a scaled-down version of the energy storage system. A breadboard system of the scaled-down version is a deliverable. Also, a technical report is a deliverable and it shall include the theoretical, analytical, and experimental results of the phase II effort. The report shall address the design of a prototype system, safety issues, stability, power extraction techniques, and other relevant areas required for full-scale systems.

PHASE III DUAL USE APPLICATIONS: The contractor shall explore applications of the technology and features of the design for weapon systems, soldier systems, future combat vehicles (FCV), and commercial systems that require compact, lightweight, and more economical energy storage. The contractor shall generate a production plan for the new energy storage system related to a specific application that is to be determined by the government.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: When one examines ways to reduce the cost, size, and weight of power conditioning systems for weapons, soldier systems and the FCV, it is clear that energy storage is a main contributor. A breakthrough in energy storage is critically needed for more mobile Army systems.

REFERENCES: The Army Science and Technology Master Plan gives guidance for Army
energy storage requirements. The document is available at ARL or at the Office of the Assistant Secretary of the Army.

KEYWORDS: Energy, energy storage, power conditioning, prime power.

A00-114 TITLE: Software Agent Technology for Large Scale, Real-time Logistics Decision Support

TECHNOLOGY AREAS: Information Systems, Human Systems

OBJECTIVE: Development of tools and methodologies to effectively utilize software agent technologies to enhance the real-time collection, synthesis, analysis and management of the large-scale data, information and knowledge associated with logistics decision support systems. While there are numerous potential logistics thrusts, applications of special interest include consumption trend analysis, anticipatory logistics, predictive failure (prognostics), and readiness level analysis. The inclusion of web-enabled technologies is also highly desirable due to the inherent distributed nature of the target data and information.

DESCRIPTION: Decision support systems have grown in popularity as an effective means to analyze and manage complex areas of interest; this is particularly true in the military. A central requirement for any decision support system is the availability of relevant data, information, and knowledge. Tomorrow's digitized battlefield will not only provide unprecedented access to data and information, but also threatens to overload commanders and staffs with this information [1]. The value of available information lies not in its volume but in its relevance and understandability [2]. Systems must be developed to determine what data and information is useful to an individual user under specific circumstances.

While the "information overload" problem has been widely recognized, there are few commercial software tools available to assist domain experts with collecting, synthesizing, and interpreting data and information [3]. The tools that are commercially available suffer from limited flexibility, demand considerable input from the user, and lack support for collaboration.

Software agents are generally defined as processes that are long-lived, semi-autonomous, proactive and adaptive with the goal of assisting users with computer-based tasks[4]. The degree of autonomy and proactive behavior associated with an agent is highly dependent on user preference and the agent's goal and inferential capacity. As the degree of autonomy increases the importance of the system interface and interface agents becomes more significant. Software agents are a promising technology for application to the information management problem; their definition implies the ability to allow flexibility, independence, and collaboration. In fact, a recent report from the NATO Research & Technology Organization [1] lists "agents capable of autonomously navigating complex database structures and extracting information for a user" as a critical technical challenge. There are many conceivable application areas within the military for software agent technology; an area of great potential payoff is logistics. A BBN Technologies study commissioned by the Air Force Research Laboratory determined that "the work performed by the typical duty officer in many logistics operations has been identified as a set of tasks that would be well supported by an agent-based system" [5]. Other specific applications could include consumption trend analysis, anticipatory logistics, predictive failure (prognostics), readiness level analysis, and many more.

The large amounts of data and information, coupled with the inherent distributed nature of such data and information, presents a real problem in developing useful logistics-oriented decision support systems. Required is the ability to couple software agent technology with large-scale (gigabit), real-time, military decision support environments to allow improved information collection, greater data synthesis and better knowledge management. Special attention should be given to allow the assignment and deassignment to the degree of autonomy of agents dependent upon situational information and user preference. Areas of related research interest include web-enabled technologies, data mining, meta analysis and knowledge management technologies.

PHASE I: Analyze and identify logistics applications in which agent technology could have high impact. Identify the appropriate agent-based approaches, to include degree of autonomy, for use in the suggested application area(s). Determine the potential payoff associated with applying the approaches to the application areas.

PHASE II: Develop a prototype system that would demonstrate the utility and effectiveness of a coupled large-scale, real-time, decision support system with software agents oriented toward a logistics application (as identified in Phase I). Refinements to the process and products would be a direct result of its maturation.

PHASE III DUAL USE APPLICATION: The development of a combined large-scale, real-time software agent / decision support environment for the military logistics community would have huge applicability for the commercial market. Obvious beneficiaries would include any organization with significant logistics concerns such as in manufacturing, construction, fleet maintenance, food service, and the like. Many commercial concerns could benefit from the ability to manage and utilize large amounts of data irrespective of a logistics orientation; the health care industry is but one example.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Managing gigabits of battlespace information in real time will be greatly enhanced with advanced software agent technology. The direct benefit will be orders of magnitude decrease in time spent collecting, analyzing and managing dynamic battlespace data. Further, better control of logistic operations has the potential for dramatic reductions in logistic support costs.

REFERENCES:
1. NATO Research & Technology Organization Report 8, "Land Operations in the Year 2020 (LO2020), " March 1999.

2. Rouse, W. and K. Boff, "R&D/Technology Management: A Framework for Putting Technology to Work," IEEE Transactions on Systems, Man and Cybernetics, Vol. 28, No. 4, pp. 501-515, November 1998.

3. Gallimore, R.J., et. al., "Cooperating Agents for 3-D Scientific Data Interpretation," IEEE Transactions on Systems, Man and Cybernetics, Vol. 29, No. 1, pp. 110-126, February 1999.

4. MIT Media Lab, March 2000, Software Agents Group [Online].
Available: http://agents.www.media.mit.edu/groups/agents/

5. BBN Technologies Report AFRL-HE-WP-TP-1998-0007, "Intelligent Agent Feasibility Study Volume 1: Agent-based System Technology," February 1998.

6. CECOM Logistics Command and Control (Log C2) Advanced Technology Demonstration (ATD) Management Plan (Draft), 3 June 1998.

KEYWORDS: Software Agents, Decision Support System, Data Mining, Meta Analysis, Knowledge Management.

A00-115 TITLE: Low Cost, High-Purity Boron-Rich Boron Carbide Powders for Lightweight Armor Applications

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: To develop a low cost process for the synthesis of high-purity boron-rich boron carbide powders. The process must exhibit a high-degree of control and lot-to-lot consistency with respect to variations in chemical composition, chemical purity, particle size, and particle size distribution.

DESCRIPTION: For protection against small-caliber armor-piercing threats, hot-pressed boron carbide is the ceramic of choice in high mass-efficiency passive armor technologies. As a compound, boron carbide exists as a single phase between 9 at.% and 20 at.% carbon (see Figure in reference 1). More importantly, as shown in the Figure in reference 2, the hardness and toughness of boron carbide are strongly dependent upon composition (i.e. B/C ratio). The maximum hardness and toughness corresponds to a B/C ratio of 4. For B/C ratios less than 4 (i.e. > 20 at.% carbon), both properties decrease sharply due to the presence of carbon particles predominately at grain boundaries. The conventional method for producing boron carbide powder is the carbothermal reduction of liquid boron oxide by carbon (graphite) at elevated temperatures in air [ref.3]. Since a significant amount of graphite is lost due to oxidation with air, excess amounts are added to the initial reactant mixes. As a result, conventional boron carbide powders typically contain micron-size graphite particles. Furthermore, because hot-pressing operations are normally conducted in carbon-rich environments, densification via hot-pressing does not allow the easy elimination of these graphite particles. As a consequence, armor-grade boron carbide tiles contain graphite particles which, as shown in Figure in reference 2, degrade both hardness and toughness.

PHASE I: Demonstrate process feasibility by producing boron-rich boron carbide powders in quantities sufficient for chemical and particle size analysis, as well as a limited hot-pressing study with tiles 5 cm x 5 cm x 1 cm in dimension. The process must

demonstrate the ability to produce powders with boron/carbon ratios between 4 and 7 (20 at.% and 12.5 at.% carbon, respectively) with compositional variations less than 1 %, free carbon contents less than 1 wt.%, oxygen contents less than 1 wt.%, metallic impurities less than 100 ppm, and average particle sizes less than 3.0 microns (powders suitable for densification by hot-pressing). At least three compositions within the specified compositional range shall be produced in quantities sufficient for characterization and a limited hot-pressing study. For each of these compositions, powders will be characterized for boron/carbon ratio, oxygen content, free carbon content, free boron content, major metallic impurities, particle size and distribution, and particle morphology. Powders from different lots shall also be characterized in order to evaluate lot-to-lot consistency. An economic analysis (cost/pound) for the scaled-up production of 100 and 1000 kilogram lots will be provided upon the end of the Phase I period.

PHASE II: Scale-up the process to produce powder lots at least 1 kilogram in size. For compositions (at least three) agreed upon at the start of Phase II, produce both powders and dense boron carbide tiles (10 cm x 10 cm x 1.27 cm) for mechanical and ballistic testing. The powders produced shall be fully characterized in accordance with standard practices and provide, as a minimum, the data required in Phase I. Mechanical testing shall include hardness, fracture toughness, and four-point bend strength. Tile densities shall also be measured. V50 ballistic evaluation shall be performed on dense boron carbide tiles (10 cm x 10 cm x 0.762 cm) against the standard NATO 7.62 mm APM2. A standard Kevlar-backing determined at the start of Phase II shall be used during the ballistic tests. All data shall be supplied to the U.S. Army for further analysis. A goal of a sucessful phase two is to produce 10 tiles (10 cm x 10 cm x 1.27 cm) for each composition and provide them to the U.S. Army for independent evaluation of mechanical properties and ballistic performance.

PHASE III DUAL USE APPLICATIONS: Process scale-up to produce powder of the optimal composition in order to manufacture armor tiles for protection of U.S. Army, U.S. Marine Corps, Department of Justice, and other law enforcement agencies personnel and vehicles. COMMERCIAL POTENTIAL: Both law enforcement and the protective services industry would be interested in more efficient personnel armor. The private armored vechile industry will be interested in lower weight plate armor. Other opportunities include lightweight NIJ level four protection for law enforcement, self-healing neutron absorbers for nuclear power generation, and a host of wide band-gap semiconductor applications.

REFERENCES:
1. F. Thevenot, "Boron Carbide - A Comprehensive Review," J. Eur. Ceram. Soc., vol. 6, 205, 1990;
2. K. Niihara, A. Nakahira, and T. Hirai, "The Effect of Stoichiometry on Mechanical Properties of Boron Carbide," J. Am. Ceram. Soc., vol. 67, C13, 1984;
3. Carbide, Nitride, and Boride Materials Synthesis and Processing, edited by A. W. Weimer, Chapman and Hall (New York) 1997 ISBN 0-412-54060-6

KEYWORDS: Armor, Boron-Rich, Boron Carbide, Low Cost Manufacture

A00-116 TITLE: Proton-Conducting Inorganic Membranes for Fuel Cells

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop a high-conductivity, proton-conducting inorganic membrane that does not require water maintenance for protonic transport. With such a membrane available, investigate means to fabricate membrane-electrode assemblies for use in a low-temperature fuel cell (T < 150 C).

DESCRIPTION: The Army has need for high-energy, lightweight power sources. Hydrogen-air and direct-methanol polymer electrolyte membrane fuel cells (PEM FCs) are candidates to fill these needs. The PEMs in these devices, however, are based upon polymeric ionomers (e.g., NafionÓ) that must be hydrated for protonic conductivity, which adds the complexity of a water-management system and limits the operation temperature. Certain classes of inorganic materials are known proton conductors (e.g., ion-doped zeolites, metal oxides, hydrous salts, etc…) that, if successfully incorporated as the electrolyte in a fuel cell, offer the possibility of eliminating the weight, volume, and system complexity associated with a water-management system. In addition, the cell could operate at elevated temperature (in comparison to PEM FCs) which would yield more tolerant electrodes to reaction poisons such as CO from reformate fuel.

PHASE I: Identify and characterize inorganic proton-conducting materials that may be fabricated into membrane form and are competitive with state-of-art PEMs (room temperature conductivity ~ 0.1 S/cm). Determine the conductivity, gas permeability, and chemical and electrochemical stability of candidate membranes. Identify and analyze critical issues/concerns that must be addressed for application of these membranes in a FC.

PHASE II: Develop techniques to fabricate viable membrane-electrode assemblies (MEAs) using the best Phase I material and evaluate these MEAs in a single-cell, hydrogen-air and reformate-air FC.

PHASE III DUAL USE COMMERCIALIZATION: Developments in fuel cell power sources will have immediate impact on a wide range of commercial power sources from computer power to emergency medical power supplies to recreational power uses.

OPERATING and SUPPORT COST (OSCR) REDUCTIONS: Potential fuel savings by higher efficiency power production via subject technology. Successful research would reduce significantly the cost due to battery consumption in the field.

REFERENCES:
T. Norby, "Solid-state protonic conductors: principles, properties, progress and prospects," Solid State Ionics, 125, 1 (1999).

KEY WORDS: Fuel cell, proton conductor, membrane-electrode assembly, soldier

A00-117 TITLE: Ultra-lightweight Field Unit for Production and Repair of Chemical Biological Warfare (CBW) Protective Materials and Instant Bandages

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Manager Soldier

OBJECTIVE: To develop an ultra-light weight, low energy system for generating nonwoven fibers for the repair of CBW protective materiel, for the field generation of CBW protective clothing, and for generating instant bandages. This unit will be used to spray fibrous membranes onto surfaces for chemical and CBW protection in diverse processing environments, including field and battlefield situations, hospital units and medical offices, repair depots, and factory manufacturing.

DESCRIPTION: Nonwoven membranes have recently been prepared and evaluated for use as clothing materials for protection against liquid and vapor chemical agents, biological warfare agents, and bacterial/fungal growth. The microporous membranes produced by electrospinning have shown promise as new lightweight clothing layers for protection from these and other threats to the wearer (Ref 1). Currently, such membranes are limited to manufacturing in industrial environments using line powered high voltage power supplies producing small amounts of material at a time. Although this is an effective process for producing the materials, it is impractical for field applications requiring hundreds or thousands of times as much material generation rapidly to meet immediate needs and threats. A portable field unit could apply protective membranes to numerous surfaces and substrates for specific military applications in nonmanufacturing environments in real time as threats and requirements arise. Currently there is no portable system capable of generating large quantities of nonwoven materials rapidly in the field. This topic seeks to develop a battery-powered system that uses electrostatic charging for rapidly generating large quantities of nonwoven materials in the field. Using a portable, independent, battery-operated power supply, the Army will be able to repair damaged Chemical/Biological Protective suits in the field, apply added aerosol protective layers to garments, gloves, hoods and other components to protective systems, and produce medical dressings targeted for specific treatments. The unit would also have significant private sector uses including generating bandages targeted for a variety of injuries and for generating protective clothing in the home to protect against civilian terrorist threats and chemical spills.

PHASE I: Research efforts should focus on exploring the characteristics of the fluid to be dispensed, such as electrical conductivity and viscosity, and correlating spin characteristics with the charge density of the fluid. One this is established, the project should focus on developing a unit that can electrospin polymer solutions into microfiber/nanofiber webs for two hours of continuous operation. The target maximum weight of the power supply is one kilogram with dimensions on the order of a military side arm for effective handling. To meet current Army needs for electrospinning fibers, it is anticipated the unit will need to generate voltages of approximately 20,000 volts at currents of 10-100 micro Amps. The design shall not exceed the use of D size batteries with smaller size batteries desirable. A successful Phase I will be the delivery of a working prototype of a portable battery operated system. Specific solutions of interest will be identified by the Army for funded Phase I efforts and can be supplied to the contractor.

PHASE II: Within the context of Phase I success, explore alternative, innovative approaches for delivering the electrostatic charge to the spinning solution for purposes such as improving control of the electrostatic field, directing the fiber spray, and improving coverage onto complex shaped substrates, such as 3-D mandrel targets. The generation of specific materials of interest to the Army will be carried out and studied. The coprocessing of electrospun fibers with new materials, such as suspended particles, metals, adhesives, and other useful additives, should be explored to generate new kinds of membranes

PHASE III DUAL USE APPLICATIONS: There are tremendous commercial applications for this system. Until now, only a handful of companies' worldwide are known to manufacture microfibers by electrostatic spraying. Capital cost of high voltage generators and associated costs of occupational safety is a key reason. This new system will make it possible for any small manufacturer to access and further develop electrostatic spinning for a variety of applications such as protective clothing, materials tailored for specific properties, such as protection against disease, and other medical uses such as bandages.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Operating and Support Costs (O&S) will be very favorably impacted by this technology. A portable, lightweight, battery operated unit can be used for field repair of damaged CB clothing, for field deposition of additional (aerosol) protection into permeable CB suits, and for increased efficiency in manufacturing of the original articles. O&S for non-CB protective materials will be favorably impacted as well. This new portable technology will be easily adapted for new biodegradable, environmentally sustainable smoke and obscurant materials generation by electrospraying of fine particles and fibers into target areas.

REFERENCES:

1. Gibson, et al., J. Coated Fabrics, vol. 28, pp. 63, July, 1999.

KEYWORDS: Electrospinning, electrospraying, atomization, electrostatics, clothing membranes, nanofibers.

U.S. Army Test and Evaluation Command (ATEC)

A00-118 TITLE: High Speed Direct X-ray Imaging System

TECHNOLOGY AREAS: Sensors

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Project Manager Soldier Support

OBJECTIVE: Design a high-resolution, high-speed digital x-ray imaging system capable of recording a minimum of eight images at an equivalent 100,000 frames per second under harsh conditions presented by an explosive test environment. The system shall provide sequential, near real-time digital x-rays in non-destructive medical and destructive live fire test applications. High-speed, high-resolution (medical diagnostic quality) digital x-rays are required to analyze the effectiveness of personal protective equipment exposed to a variety of threats. Types of tests and research conducted against personal protective equipment try to eliminate overpressure and blunt trauma injuries associated with anti-personnel mines, small caliber weapons, explosive blasts and resulting fragmentation.

DESCRIPTION: There is a need for a multi-image, high-speed, high-resolution (medical diagnostic quality) digital x-ray system, capable of recording high velocity events. Current digital x-ray systems used in the medical community (Ref 1-3) provide a single high-resolution image integrated over a relatively long time period dependent upon what part of the body is being imaged. This time can be as long as ½ a second in the case of a chest x-ray to provide just one image. Although, technologically sound, this approach is not fast enough to stop the motion of small arm rounds, explosive land mine fragments or the crack propagation in bones subjected to an external force received in blunt trauma injuries. The developed system will need to be able to use very short x-ray pulses between 25 and 70 nanoseconds duration to stop motion in these high velocity events. The developed technology will need to capture and record a minimum of 8 independently computer programmed and triggered high-resolution diagnostic images with a minimum of 10us between each image (equivalent 100,000 frames per second recording speed). This will allow sufficient data points and a visual timeline to be constructed of these fast events for data reduction purposes. The entire area the system should be able to image is 2 feet square since this is the area of interest on a typical explosive or personnel mine interaction test. The system should be portable and ruggedized for use in harsh destructive field environments with extreme shock and over pressures, allowing digital x-ray data acquisition of these explosive events. Full programming, control and viewing must be provided from a remote location up to 2 kilometers due to safety requirements of the various explosive tests.

PHASE I: Produce a detailed plan for developing the total system and a design for each component. Define in detail how the requirements can be met and estimate the cost of developing the total system. Identify the system components or sub-systems and how they integrate to provide multiple images in a hostile environment transmitted in near real time up to two kilometers from the event.

PHASE II: Implement the technology developed in Phase I, proceed with prototype development of a demonstration system and demonstrate performance of the system and quality of the digital x-ray images on actual test projects at Aberdeen Test Center.

PHASE III DUAL USE APPLICATIONS: There are numerous applications for use throughout Department of Defense, medical research, automotive testing, ergonomic and bioengineering studies. For example head, neck and pelvic injuries in automobile crash testing and airbag deployment tests, de-mining operations protection devices tests, law enforcement protective clothing tests and blunt-trauma studies in non-lethal weapons testing.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Currently there is no direct digital x-ray system that is high-speed and high resolution (medical diagnostic quality) enough to stop motion and provide multiple full resolution images of a high velocity event. The lack of this information often leads to speculation on the exact sequence of events in a dynamic test scenario.

This leads to multiple retest and design changes to verify the assumptions made by lack of sufficient data points. This system shall be designed to minimize design and testing costs by providing clear qualitative images of the test event.

REFERENCES: 1. Direct vs Indirect conversion process. Direct Radiography Corp. www.directray.com

2. Flash X-ray systems. Maxwell Physics International. www.maxwell.com

3.Amorphous-silicon image sensors. DpiX Inc. www.dpix.com

4. Honour,J and Hadland, R (1987) Cinemax intensifier for high speed cameras. Proc.SPIE 832, 361-364.

KEYWORDS: x-ray, radiography, high-speed imaging, and digital imaging

A00-119 TITLE: High Resolution/High Speed Infra-Red Imagers

TECHNOLOGY AREAS: Sensors

OBJECTIVE: New or novel techniques and/or technologies are solicited for the development of advanced high speed and high-resolution infrared imagers systems. The goal of such systems are to provide resolutions on the order of 1 mega pixel at frame rates on the order of 250 frames per second. Realization of these goals is anticipated to require the use of materials with high quantum efficiencies in the mid infrared region, such as InSb and implement Focal Plane Arrays architectures that are not charge transfer devices.

Current state of the art IR camera systems can provide either the required resolutions or frame rates, but not both simultaneously. To realize the objective of this effort, it is anticipated that a deviation from traditional IR imager design architectures will be required. As can be learned from advancements in visible cameras where these performance barriers have been overcome, the investigator may consider the use of active pixel architecture applied to an InSb or other suitable high quantum efficiency substrate.

DESCRIPTION: Significant improvements in the collection of infrared imagery are required to address deficiencies encountered in the Test and Evaluation (T&E) of military systems where it is often necessary to collect IR imagery during the conduct of weapons testing. An example of such is a missile launch or engagement

IR imagery is crucial to T&E of the weapons systems performance. The speed at which events of intrest occur and the lack of suitable IR imager technologies have forced T&E ranges to compromise resolution for speed. For example within the Army at White Sands Missile Range, successful development of high performance imagers (Ref 1.0) has been successfully executed to the limits of the then available technology and provided IR camera systems that begin to approach the the needs of T&E ranges. Similarly, a complemenatry effort within the Navy T&E range at China Lake, the MIRIS project IR camera system development is also advancing IR camera systems for T&E applications. Despite the advances made by White Sands and China Lake, the full requirements of the T&E ranges for IR imagers is yet to be realized.

Beyond T&E ranges, a review of the current state of the art IR image collection indicates that despite current and past industry and government efforts, the combination of a high resolution and high frame rates for IR imagers has not yet been achieved. Limitations in the performance of current state of the art IR camera system may be attributed to physical limitations in the architectures employed in Focal Plane Arrays (FPA). Minor to radical changes to IR imager designs and philosophys may be necessary if significant improvements are to be realized in IR imaging.

The investigators shall identify, research and develop such architectures. The technology developed shall be suitable for use in the mid-wavelength IR band (i.e. nominally the 3 - 5 micron wavelength). Design goals are to simultaneously provide pixel densities on the order of 1k x 1k at frame rates on the order of 200 frames per second and with 10 to 12 bit digitization. The developed technology should be scaleable to allow even greater pixel densities at similar frame rates. Monolithic sensors are perferred over tiled. In addition to the resolution and speed, other specifications that the sensors shall provide such as high quantum efficiency, good dynamic range, sensitivity, noise, etc. are to be comparable or better than current state of the art devices while minimizing blooming and smearing effects.

PHASE I: The investigator shall conduct the necessary analysis and research to develop the technology for the design and fabrication of IR sensors and associated cameras that can simultaneously provide high speeds and high resolutions as described above. The analysis and research shall provide the basis for a full-scale camera prototype development in Phase II. Technical risk is to be minimized by leveraging.

PHASE II: The investigator shall proceed with prototype development and demonstration of the technology proposed in Phase I. The full-scale camera development shall ensure that other issues beyond the sensor are addressed. These issues include but are not limited to memory management, high-speed data interface, data timing, real time image viewing, etc.

PHASE III DUAL USE APPLICATIONS: There is a tremendous world wide application for significantly improved IR imagers. Improved imagers will find wide spread use in law enforcement, industrial inspection systems, search and rescue, military, aviation, and pssibly even in emerging consumer automotive applications to aid night driving.

REFERENCES:

1. High Frame Rate IR and Visible Cameras for Test Range Instrumentation, SPIE July 1995, Dr. Joseph Ambrose and Brad King (White Sands Missile Range) and John Tower et. al Sarnoff Laboratories

2. 640 x 480 MWIR and LWIR Camera System Developments, SPIE 1992, John Tower, Sarnoff Laboratories

3. Summer 1999 Update - Law Enforcement Technologies, http://www.acq.osd.mil/bmdo/bmdolink/html/update/sum99/updhor2.htm

4. Rydberg Atoms Enable High Speed IR Imaging: Photonics Technology News, July 1999, www.laurin.com/Content/Jul99/techRydberg.html From:

KEYWORDS: Infra-Red, IR, imagers, cameras, sensors, FPA

A00-120 TITLE: Image Generation for Forward Looking Infrared Sensor Stimulation

TECHNOLOGY AREAS: Information Systems, Sensors

OBJECTIVE: Develop innovative methods for improving fidelity and realism in simulated infrared (IR) imagery. The proposed methods may include some combination of physics-based research, mathematical modeling, novel simulation techniques, and the development of advanced hardware/software IR simulation tools. The effort should leverage available commercial and government computer, simulation, and gaming technologies. However, applying more hardware to existing solutions will not likely yield the desired level of performance. The realism of the developed method should far surpass that of any existing capability.

The developed system will be used to simulate mission scenarios as seen through the aperture of an aviation-based Forward-Looking Infrared (FLIR) system. The realism of the simulation must be sufficient for performing objective FLIR test and evaluation (T&E) tasks, such as demonstrating that targeting algorithms perform identically between real mission imagery and a simulation of the same mission.

DESCRIPTION: There are many image generation resources commercially available for entertainment and training applications. Entertainment applications combine realism with fantasy, while training applications, such as a flight simulator, requires a close resemblance to reality. FLIR sensor simulation and stimulation for T&E applications require even further realism and simulation fidelity than training simulators.

Simulating IR imagery is more complicated than visible imagery since the energy comes from both reflected energy and emitted energy. Commercial-off-the-shelf (COTS) or government-off-the-shelf (GOTS) IR scene generation tools are currently available, as well as commercial entertainment games. The existing IR scene generation tools have focused on ground-based and missile applications, however the tools are not currently adequate to meet the fidelity and realism requirements of rotorcraft aviation T&E applications. Additionally, these tools do not offer true physics-based realism for IR target and background signatures for most scenarios.

Aviation missions are much longer than missile missions. As a result, very large databases and high-resolution real-time rendering are required to adequately simulate a low-altitude aviation mission. This is compounded with wide fields of view for navigation and search. Additionally, the eye-point may be above, at, or below the tree-top height, and targets of interest may be partially occluded by trees, branches, etc. Successful rotorcraft aviation IR simulation would therefore require looking through various vegetation from above or below the tree-top canopy as well as simulating varying tree types and heights. Other features of interest to aviators are also required, such as power and phone lines, radio towers, guide wires, clouds, etc. Other areas to be addressed include surface reflections, glint off water, horizon anomalies, and atmospheric effects.

The simulated aviation IR imagery created in this effort will have broad utility. Some of the specific imagery generated in this effort will be used to drive the Mobile Infrared Scene Projector (MIRSP). The MIRSP emits long-wave IR imagery into the aperture of an installed FLIR sensor. The MIRSP is capable of driving a 544 x 672 resistor array at 30 Hz. It is capable of projecting up to 5 minutes of stored imagery or to continually navigate a simulated database. It is very important to validate the realism of the simulated IR imagery. For example, search and track algorithm performance during a flight test should be repeatable using a simulated version of the same flight test. Some test imagery may be available, but a contractor's ability to gather FLIR data for simulation validation would be preferable.

PHASE I: Design a method to improve fidelity and realism in simulated IR image scene generators. The proposed method may include some combination of physics-based research, mathematical modeling, novel simulation techniques, and the development of hardware/software tools. A method will be designed that will generate realistic infrared simulations of arbitrary aviation mission scenarios. The tool will build on available COTS and GOTS simulation and gaming technology.

The designed method should be physics-based, incorporating parameters such as temperature cycles, environmental and atmospheric effects, date and time effects, surface reflections, glint off water, horizon anomalies, etc. Components in the designed method may also include advancements in target and/or background modeling, terrain and texture paging, compression techniques, or any other techniques for increased polygonal throughput.
Simulation validation against real infrared data should be demonstrated using a prototype version of the designed method.

PHASE II: Develop the method designed in Phase 1. Simulated imagery generated from the new system will be projected through the MIRSP (or other IR scene projector) into a unit under test. Recorded simulated imagery will be compared with recorded flight test imagery for a given scenario to determine the degree of realism. Changes to the new system may be made to increase the degree of validation, and a new scenario simulated. Depending on budgetary and time constraints, this cycle may be repeated to complete a validated infrared scene generation system.

PHASE III DUAL USE APPLICATIONS: In addition to supporting aviation-based applications, the developed method will provide ground vehicle and missile applications revolutionary realism and flexibility in the use of IR simulations.
Realistic infrared (IR) simulation will facilitate new dimensions in search-and-rescue and covert law enforcement operations. Objects of interest could be realistically simulated in the natural environment allowing for quick training and decisive use of available resources. Atmospheric effects such as rain, fog, or smoke, can be accurately simulated in urban environments, which also include towers, poles, wires, etc.

This technology will also bring about better pilot training systems, nighttime security systems, and manufacturing quality inspection by training automated systems with specific imagery based on accurate thermal predictions. When used in conjunction with an IR scene projector (the original intended use), then all installed IR systems on aircraft, satellites, ships, automobiles, security systems, etc. can be thoroughly evaluated and characterized prior to initial delivery or as part of continuing maintenance. (Installed systems testing highlights overall performance of integrated system as opposed to the performance of the stand-alone sensor.)

IR target detection and identification can be integrated into automobiles for nighttime situational awareness and collision avoidance. Additional realism for entertainment applications may also prove feasible.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Use of realistic infrared simulation in scene projection systems will allow for installed system test points not achievable in flight tests. Search and track algorithms can be tested and tuned shortly before a mission. Mission rehearsal with installed FLIR systems will be achievable for the first time. FLIR system failures can be diagnosed and characterized while installed in aircraft.

KEYWORDS: infrared scene projection, MIRSP, infrared stimulation, infrared simulation, infrared modeling

REFERENCES: Zabel, K., Stone, R., Martin, L., Robinson, R., and Manzardo, M., "Utilization of a Mobile Infrared Scene Projector for Hardware-in-the-Loop Test and Evaluation of Installed Imaging Infrared Sensors," Proc. of the SPIE, Vol. 3697, No. 11, (Orlando FL) 1999

A00-121 TITLE: High-Output Near-Monodisperse Aerosol Generator

OBJECTIVE: Design and build a portable, high-output, low shear-force, near-monodisperse (almost uniform in particle size) inkjet-type aerosol generator with aerosol particle size control that is capable of generating variable final dried-down particles of sizes from one to ten microns diameter as desired. The aerosol will be generated from a slurry containing biological particles of approximately 1 micron and aggregates thereof. The aerosol generator will be employed in tests pertaining to national biological defense programs.

DESCRIPTION: Performance evaluation of biological aerosol detection systems against biological warfare agent attacks requires a substantial supply of near-monodisperse biological aerosol particles with dried-down sizes of 1-10 microns, depending on the item being tested. Currently, there is no aerosol generator that can meet the requirement because they are either too low in output or high in output but generate a high percentage of particles that lie outside the desired size range. In addition, some of these aerosol generators exert detrimental shear force on the biological particles as they exit the orifice or nozzle of the generator. The shear force may rupture the biological particles, leading to inaccurate results for evaluation of the detection systems. This solicitation seeks effort to design and develop a portable, high-output, low shear-force aerosol generator that can generate near-monodisperse biological aerosol with adjustable dried-down sizes of 1-10 microns, at the rate of approximately 75,000 to 1.5

million particles/min, as measured with the Aerodynamic Particle Sizer. At this rate, the output will be appropriate for biological defense device testing in environmental chambers, but not high enough to be used for offensive purposes.

PHASE I: Develop an overall system design and conduct a feasibility study to illustrate the proof-of-principle of the aerosol generator.

PHASE II: Develop and demonstrate the full-size prototype and optimization of parameters.

PHASE III DUAL USE APPLICATIONS: This generator can be adapted for use in dissemination of agricultural agents and fire retardants. It can also be used to disseminate chemical and biological decontaminants in equipment or large area decontamination operations.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Monodispersity of biological aerosol produces accurate useful data, and therefore reduces the cost for make-up trials. In addition, the near-monodispersity capability of the aerosol generator reduces the quantity of biological simulants required to achieve the desired concentration, hence more cost-effective.

REFERENCES:

P.C. Reist; Aerosol Science and Technology, 2nd Edition; McGraw-Hill, NY, 1993.

KEYWORDS: aerosol, near-monodispersity, generator, high-output, biological, shear-force

A00-122 TITLE: Low Cost High-Resolution Radar System

TECHNOLOGY AREAS: Sensors, Electronics

OBJECTIVE: Design a low-cost, ultra-reliable, high-resolution radar measuring system and research the high-risk areas of this system.

DESCRIPTION: There is a need for a low-cost, high-resolution, ultra-reliable radar imaging system to augment tracking radars (Ref 1 or 2). This radar system will provide high-resolution imaging data for processing with Complex-Image Analysis (Ref 3) to obtain measurements of miss distance, attitude, object deployment and extent of damage. This system must have a range resolution of one foot; it must be sufficiently sensitive to collect data on small targets at long ranges; it must not interfere with other radars; and it must be capable of unattended remote operation. It will be slaved to the tracking radars (i.e., use data from the tracking radars to position the angles and range gate) and it must record or transmit the data in real time for post-mission processing. This radar system should make extensive use of commercial off-the-shelf hardware, solid-state components, digital waveform generation, and high-speed signal processing. Ultimately, this system will consist of five imaging radar units, all interconnected and coordinated from a central location.

PHASE I: Produce a detailed plan for developing the total system and a design for the individual radar units. Define in detail how the requirements can be met and estimate the cost of developing the total system. Identify the system components or sub-systems which pose the greatest risk and show how those risks will be retired. Potential high-risk areas include digital waveform generation (stability, low noise, versatility of waveform, processing of long pulses), use of solid state and/or CW transmitter components (stability, low noise, reliability, low cost, pulse width vs peak power), interoperability (control of multiple stations, remote operation, avoiding interference and eclipsing), and data recording or transmission (data volume).

PHASE II: Research the high-risk areas identified in Phase I. Implement critical components of one of the radar units and demonstrate performance of the unit and the quality of the radar image using actual WSMR radar targets.

PHASE III DUAL USE APPLICATIONS: There are many test ranges in the U.S. and throughout the world that are candidates for a low-cost, ultra reliable, high-resolution radar imaging capability to augment tracking radars.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: This system will be designed to minimize initial cost, operating costs and support costs. It will be slaved to the tracking radars to avoid all the costs of developing independent tracking functions. It will use solid state components to ensure the reliability needed for unattended operation, as well as for long life. It will use digital waveform generation for stability, versatility and reliability, thus reducing the maintenance costs.

REFERENCES:
1. A Radar Road Map, ITEA Journal, Sep/Oct 1998, p. 31 (Imaging Radars section, pp. 35 & 36)
2. The Radar Roadmap, Range Commanders Council, Electronic Trajectory Measurements Group, RCC Report 260-98 (Imaging Radars section, p. 9)
3. Radar Resolution and Complex-Image Analysis, A.W. Rihaczek and S.J. Hershkowitz, Artech House, 1996

KEYWORDS: High-resolution radar, imaging radar, target imaging, instrumentation radars

A00-123 TITLE: Ruggedized High Volume Tracking System

TECHNOLOGY AREAS: Information Systems, Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Manager - Range Instrumentation Systems

OBJECTIVE: New or novel technology is solicited for the development of a compact ruggedized system for the collection of time space and position information (TSPI) from large numbers of live participants engaged inmilitary test or training exercises. The developed instrumentation is to operate under harsh conditions presented by a military tactical environment. The individual devices are to be compacting fully autonomous and only minimally intrusive to the system or persons being tracked. The developed technology will provide very small instrumentation packages allowing for the simultaneous collection of TSPI from at least 1000 participants. Participants may range from individual foot soldiers, to ground vehicles, aircraft, and ships. The range of the system should be at least 250 miles. The individual participant data packages are to be very compact and very cost effective, relatively.

DESCRIPTION: Large-scale test and training exercises often involve many thousands of participants. It is common for such exercises to require as many of the participants as possible to be tracked in real time. Past approaches have commonly used separate Global Positioning System (GPS) receivers coupled with separate data radios. Although, technologically sound, this approach often led to bulky and inefficient implementations. The technology to be pursed in this application is the miniaturizing

of the differential GPS package and data relay system (e.g. data radios). The entire volume of a participant package should be on the order of 50 cubic inches, including the GPS receiver, data relay, power supplies (e.g. high capacity batteries), antennas, etc. Each individual participant data package must have a very low power consumption rate to allow autonomous operation for at least 7 days without being serviced. Full addressable control and configuration of each individual participant package is to be provided from a remote central host and Geographic Information System (GIS). Collected participant TSPI data is to be routed or relayed to the central GIS for processing with no more than a 100 ms latency.

PHASE I: The investigator shall conduct the necessary research and design analysis to develop a ruggedized and miniaturized GPS based tracking system as described above

PHASE II: The investigator shall proceed with prototype development of a demonstration system of the technology proposed in Phase I. The prototype system shall demonstrate the capability of tracking at least 50 participants and be scaleable to at least 1000.

PHASE III DUAL USE APPLICATIONS: Tremendous application for this technology exist for this in commercial markets. For example, tracking of emergency vehicles and personnel engaged in large scale emergency actions such a forest fires, weather disasters, police forces, etc.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Currently there is no efficient means of acurately providing TSPI data on large numbers of participants, especially foot soldiers and ground vehicles, (>1000) that are engaged in test and training exercises without the use of bulky and intrusive devices. The lack of this information often leads to speculation on the exact location of participants. In some cases such as the All Service Combat ID Evaluation Test (ASCIET), this is unacceptable and can lead to erroneous assessments. The consequences may negate the effectivness of an exercise and its associated cost which often is in the millions of dollars.

REFERENCES:
a. Interstate Electronics Corporation - http://www.iechome.com/gps/gpsfrme.htm

b. Trimble Corporation – http://www.trimble.com

c. Javad Corporation – http://www.javad.com

KEYWORDS: GPS, Time Space and Position Information, TSPI

U.S Army Aviation Research, Development, and Engineering Center (AVRDEC)

A00-124 TITLE: Scaleable Aerodynamics and Coupled Comprehensive Methods for the Prediction of Rotorcraft Maneuver Loads

TECHNOLOGY AREAS: Air Platform

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Manager, Utility Helicopters

OBJECTIVE: The operation of helicopters at high speeds or at high lifts (as in maneuver) is marked by the occurrence of extremely complex rotor flows, especially "dynamic stall" - a sudden flow separation marked by the generation of strong vortices that cause large blade forces. This is complicated by the fact that a rotor blade is an inherently light and flexible structure that is easily deformed by these forces. The interaction of the aerodynamic loads with structural deformations produces extreme loadings that differ markedly from those of a purely aerodynamic system. These extreme loads determine the speed and maneuver limits of a helicopter and it is not yet possible to predict these (and design for high-speed or maneuver) with rigor or with confidence. The pacing difficulty is the inability to predict first-principals blade aerodynamics to sufficient accuracy and within a useful computing time. The aerodynamics prediction is not only a problem in its own right, but it also prevents the development of the needed structural coupling methods. The goal of this topic is the development of innovative CFD (Computational Fluid Dynamics) flow models that employ computational parallelism coupled with a structural analysis and to thereby demonstrate the feasibility of practical computation of extreme rotor loads.

DESCRIPTION: This problem first requires a CFD analysis that is capable of treating all the relevant blade-flow physics in a "first-principles" manner (to the maximum extent possible) while providing high computation speeds. This includes the ability to predict (in order of importance) pitching moment, lift, and drag for the entire range of speed and lift conditions, and in particular the effects of three-dimensional, compressible, dynamic-stall phenomena, typical of retreating rotors during high-speed or extreme maneuver. The required computation speed will entail a flow analysis with the smallest possible grid while maintaining the ability to convect the stall vortex with minimum dissipation. (This implies that some minimum level of modeling is inevitable

- the nature of which is a major driver of computation speed and an area for innovation.) This analysis must be scalable and adaptable to a typical
and readily accessible parallel computer. This parallelized analysis must include a suitable structural/dynamic/wake analysis (often called a "comprehensive" analysis - 2GCHAS, for example, is recommended for its easy availability and existing coupling logic). The analysis shall be tested for a range of flight conditions of increasing complexity, leading to a demonstration of the ability to predict extreme airloads such as those documented in the NASA/Army UH-60 Airloads Database.

PHASE I: Develop and demonstrate an innovative aerodynamics method with the requisite ability to compute all flow regimes - especially the prediction of the leading edge stall vortex and its subsequent convection under compressible flow conditions - and of the speed, accuracy and scalability of that method. A full three-dimensional computation is desirable but not required at this point unless it is deemed necessary to demonstrate scalability. The aerodynamic method will be tested initially with a prescribed blade (airfoil) motion. Following this, it will be required to demonstrate the ability to perform a basic aerodynamic/structural coupling (a simplified structural model is acceptable at this point, since the aerodynamic concept will be the primary difficulty) - all in the context of a parallel computational environment.

PHASE II: A complete coupled analysis - based on the concept demonstrated in Phase I and employing innovative parallel computation methods - will be designed, built and tested. A full comprehensive code will be used (rather than the simplified analysis of Phase I) and the flow analysis will treat the complete local blade aerodynamics, employing an innovative means of coupling this to the wake/inflow model. Large-scale parallelism will used to the maximum extent and encompass both the aerodynamic and structural/dynamic analyses. The validation process will test the critical subcomponents of the analysis, including the basic code accuracy, the effectiveness of the aerodynamic/structural coupling, the accuracy of the inflow coupling and the total system stability and speed. The method will finally be assessed for its ability to emulate stall-related loading behaviors known to occur in extreme flight conditions.

PHASE III DUAL USE APPLICATIONS: This analysis will be an important development both for DoD rotorcraft organizations and for the rotorcraft industry as it will eliminate one of the main technical barriers to current analytical capabilities, the inability to predict detailed blade load histories. This inability is a primary cause of large development cost, time and risk. It impedes the development of system upgrades, future advanced rotorcraft, and increases in mission effectiveness. It is for this reason that the extensive UH-60 Airloads Database was acquired. However, there is currently no analysis method available that will allow a generalization of this data and an improved analysis of blade loads. A primary application will be a detailed modeling and comparison with these UH-60 maneuver loads. The desired capability will enable the Army to better understand maneuver capabilities of its rotorcraft and will enable U.S. industry to improve and design more capable rotorcraft.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Military rotorcraft encounter violent maneuvers whose stall-induced loads quickly consume the allowable fatigue life and require replacement of dynamic components. The requested ability to predict these loads will enable their minimization through design and the development of improved parts-replacement criteria. The resulting predicted loads would reduce operation cost via reduced parts replacement and aircraft loss.

REFERENCES:
1. Bousman, W.G., "A Qualitative Examination of Dynamic Stall from Flight Test Data," 53rd Annual Forum of the American Helicopter Society, Virginia Beach, Virginia, April 29 - May .1, 1997 - (A description of the stall loads on a maneuvering UH-60)

2. G.R. Srinivasan, J.A. Ekaterinaris, and W.J. McCroskey, "Evaluation of Turbulence Models for Unsteady Flows of an Oscillating Airfoil," Computers and Fluids, Vol. 24, No. 7, pp. 833-861, 1995 - (A description of currently available means of modeling stall using CFD. - i.e. the thing we need to improve on.)

3. Lee, C, Saberi, H. and Ormiston, R.,"Aerodynamic and Numerical Issues for Coupling CFD into Comprehensive Rotorcraft Analysis," 53rd Annual Forum of the American Helicopter Society, Virginia Beach, Virginia, April 29 - May .1, 1997 - (The most recent study of the coupling of CFD with comprehensive analyses.)

KEYWORDS: rotors, dynamic stall, load prediction, computational fluid dynamics, aerodynamics, parallel computing, comprehensive analysis
aerodynamic/structural coupling, the accuracy of the inflow coupling and the total system stability and speed. The method will finally be assessed for its ability to emulate stall-related loading behaviors known to occur in extreme flight conditions.

A00-125 TITLE: Knowledge Acquisition Tools for Cognitive Design Aid and Development

TECHNOLOGY AREAS: Information Systems, Human Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Air Maneuver Battle Lab

OBJECTIVE: To develop a suite of software tools to conduct and manage the Knowledge Acquisition (KA) processed involved in developing Cognitive Decision Aiding (CDA) system for Army air and ground combat vehicles and for Command and Control Systems. The software tools should support the development of KA requirement from program objectives, manage the collection of information throughout the program, permit analysis of the information for systems and software engineer, and track information usage through out the entire software development process.

DESCRIPTION: Under the Rotorcraft Pilot's Associate (RPA) Advanced Technology Demonstration Program, the Army developed a fully integrated cockpit incorporating a cognitive decision aiding (CDA) system to maintain a higher level of situational awareness while reducing pilot workload through intelligent automation. The goal of the program was to develop a system that not only provide decision aids and recommendations to the pilot but also maintained sufficient domain and context knowledge to perform tasks autonomously as authorized by pilot. In order to produce the level of aiding in the RPA system, a large amount of knowledge from a wide variety and diversity of domain experts was needed. This large amount of domain knowledge was required so that the system could track where the pilot was in the Mission, react robustly and predictably to changing situations, and provide aiding to the pilot that was appropriate and beneficial. In RPA, KA sessions with pilots and other domain experts were taken before any of the software was written, and KA was taken after each evaluation during the Rapid Prototyping Phase. Although KA was used extensively throughout the program, the process could have been improved substantially. Among the areas that could have been improved were the identifacation of what knowledge was needed, tools to analyze and interpreter the KA sessions, and a better ways to define and track information from requirements through KA sessions to the system/ software development and ultimately into testing. The goal of this topic is to develop tools to aid the system, knowledge and software engineers to navigate through KA process.
The functionality of the software tools should include the following: 1) support the development of KA requirement from program objectives, 2) manage the collection of information throughout the program, 3) permit analysis of the information for systems/software engineer, and 4) track information usage through out the entire software development process. The tool set needs to provide aids to the system/ knowledge engineer to help him define the information requirements for the software development effort and help identify what KA is needed. As KA is collected, the tool set should support the storing, correlating, and organizing of knowledge from a variety of domain experts holding diverse and sometime contradictory views. The tool set must support the analysis of the KA data by the system engineer to aid the CDA design process and aid the extraction of potential processes and functionalities needed to produce the desired high level of aiding. When ever possible these analysis tools should work with commercial analysis tools and incorporate industry standard techniques for analysis of the data which could include Cognitive Task Analysis or the use of knowledge-representation language. The tool set needs to be able to track how information from KA is implemented in the software through out the life of the CDA development process. The tracking needs to include where and how this information was implemented in software, how it is modified or refined through the development process and ultimately what was it's significance. The tracking functions must work with conventional CASE tools.

It is possible that this set of tools could be developed as a CDA applied to KA process but this approach could add additional risk which would have to be weighed versus the level of proposed aiding provided. This approach would be encouraged under this program as long as risk is properly addressed.

PHASE I: Literature Search, identify the appropriate KA processes and techniques to include Knowledge Task Analysis, develop a system /process description of the functionality of each of the tools, and validate some of the processes through manual implementation of the process for a Command & Control System CDA to validate the process.

PHASE II: Develop a system design for KA Software Tools and conduct manual testing as needed to validate the proposed KA Process. Develop KA Tools Suite could do (but is not limited to) the following: to help develop KA requirements based program objectives, aid in the collection and management of the information, provide aids to help system developer analyze and assess the knowledge collected, support rapid prototyping with iterative KA, track the knowledge from the KA sessions the system design and into coding. The software tracking will be compatible with COTS Case tools. During its development and as a final test the Tool Suite will be used to conduct and analyze KA session for a Command & Control System CDA.

PHASE III DUAL USE APPLICATIONS: The Tools developed under this program would apply to a wide variety of software systems that could incorporate CDA. This software would be applicable to almost any software system where humans and machines must work together as a team. Potential current applications would include efforts to develop CDA for FAA, NASA, and DOE applications. Follow-on application for this KA tool set within the Army could include Joint Battle-Command Intelligent Strike System ACTD (Proposed) and development of the Commanche Tactics Expert Function (TEF).

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Successful completion of this program would develop the tools necessary to transition and adapt technology developed under RPA program to other project and domains. This tool set will help to capture the domain knowledge for DOD systems in order to produce intelligent and robust software system. This tool should substantially reduce the amount of "re-inventing the wheel" (or re-capturing knowledge) each time a new program is started which is common among this type of complicated knowledge intense system.

REFERENCES:

1) Mcgraw, K.L, and k Harbison-Briggs, "Knowledge Acquisition: Principles and Guidelines," Printice Hall, Englewood Cliffs, New Jersey, 1989
2) Schmalhofer, Franz, "Constructive Knowledge Acquisition: A Computational Model and Experimental", Lawrence Erlbaum Associates, Inc, July 1999
3) Rippy, L; George Dimitrov; "Rotorcraft Pilot's Associate: Technology for the Battlefield of Tomorrow", presented to the American Helicopter Society 55th Annual Forum and Technology Display, Palais des conges de Montreal, Canada, May 25-27, 1999
4) "Rotorcraft Pilot's Associate (RPA) Program - Final Report," under contract DAAJ02-93-C-008 for the US Army Avaition Applied Technology Directorate, Ft. Eustis, VA:to be released March 2000 thru DTIC.

KEYWORDS: Knowledge Acquisition, Cognitive Decision Aid, Software Design, Associate Systems, RPA, Cognitive Decision Aid

A00-126 TITLE: Optical Assessment of Component Creep/Fatigue

TECHNOLOGY AREAS: Air Platform, Information Systems, Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Executive Officer, Aviation

OBJECTIVE: The objective of this effort is to develop technology(s) that are capable of optically assessing creep and fatigue in aircraft components on-wing to save O & S costs.

DESCRIPTION: Current maintenance techniques for inspecting components for creep or fatigue damage require disassembly of aircraft systems/subsystems and inspection using NDTE techniques such as eddy current technology. This process is time and labor intensive, resulting in excessive O & S costs and maintenance downtime for the aircraft. The development of technologies to assess creep and fatigue damage of components while on-wing will reduce labor time and increase the availability of the aircraft. As an example, a candidate flight critical part could be chosen to have a baseline structural signature imprinted in a known high stress area. Hand-held devices which use infrared techniques could be used to scan the imprinted signature and assess the fatigue condition of the part. These devices would have the ability to detect microstrain in the high stress areas. The information obtained through the scanning device could be downloaded to a personal computer (PC) to analyze for structural integrity (i.e. fatigue and creep) of the scanned component. Novel scanning borescope-type devices which can probe into difficult to reach areas of the aircraft such as inside turbine engines to determine the health of turbine/compressor blades would be a great benefit to all aircraft maintainers both military and civilian.

PHASE I: The Phase I effort will explore technologies to assess component creep and fatigue damage without removal from the aircraft. The effort will explore technologies such as optical inspection techniques with microstrain identification capability. Coupon testing will be performed to demonstrate the concept. The most promising techniques/devices will be considered for Phase II.

PHASE II: The effort shall consist of specifications, development and demonstration of the selected Phase I technologies with a working prototype. The prototype shall permit the operator to assess components for fatigue damage without removing from the aircraft. The system shall automatically perform the assessment and report the results to the operator.

PHASE III DUAL USE APPLICATIONS: Several of the working prototypes shall be tested on aircraft in the field at multiple locations. The robustness and usability of the system shall be assessed.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Costs will be saved through the reduction of man-hours spent not removing and installing components on wing.

REFERENCES: Silicon Sensors and Circuits: On-Chip Compatibility, R.F. Wolffenbuttel, Capman & Hall, December 1995

KEYWORDS: maintenance, inspections, fatigue, creep

A00-127 TITLE: Data Mining for Aircraft Maintenance and Logistics Management

TECHNOLOGY AREAS: Information Systems, Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Executive Officer, Aviation

OBJECTIVE: The objective of this SBIR is to develop data mining techniques to extract valid and useful patterns from the large amounts of maintenance and logistics data generated by newer rotorcraft. This information would be used to modify maintenance practices, reduce logistics support, aid aircraft fleet management and reduce O&S costs.

DESCRIPTION: Data mining is the extraction of implicit, valid, previously unknown, potentially useful and ultimately understandable patterns from huge amounts of data. Aircraft such as the Longbow Apache or the coming Comanche can produce large amounts of data from the onboard systems. The potential retrofit of data recorders or health and usage monitoring systems provides older aircraft similar capability. Development of the Global Combat Support System - Army (GCSS-A) will digitize and network the aircraft maintenance and logistics process. GCSS-A will provide a wealth of data from the aircraft, the supporting unit and higher maintenance echelons. Advanced techniques are needed to combine and condense this mountain of data into useful information to aid maintenance and logistics decisions for both operational commanders and fleet managers. Automated methods are required to minimize the manpower required for this analysis.

PHASE I: Phase I of the effort will design and prototype a data mining tool focused on aircraft maintenance. Data mining techniques such as rules, trees, neural networks, genetic algorithms, visualization, identification of sequential patterns, data clustering, data classification and statistics will be considered. The needs of aircraft maintenance and fleet managers will be identified. Techniques and source data will be matched to these needs. Phase I will develop the tool sufficiently to prove the viability of the required functions.

PHASE II: Phase II will develop the Phase I prototype into a fully functional analysis tool suitable for use by military maintenance managers, operational planners and aircraft fleet managers. Data from existing sources for a specific
Aircraft type will be assembled into a database to emulate full implementation of GCSS-A. The tool will be tested using Army users and refined based on the results of testing. Development will consider integration into the future Army aviation logistics architecture.

PHASE III DUAL USE APPLICATIONS: This technology could be used for management of any aircraft fleet. Commercial operators as well as other military services are collecting data similar to Army Aviation. This technology could be integrated into existing commercial maintenance data systems.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: This SBIR will reduce O&S Costs through better management of the aircraft fleet.

REFERENCES:
Infrastructure Definition for Digitally Enhanced Aviation Logistics Coordinated Final Report, Rotorcraft Industry Technology Association, Inc., September 1998.
P. Adriaans and D. Zantinge, Data Mining, 1996.
S. Anand and A. Buechner, Decision Support Using Data Mining, Financial Times Pitman Publishing, 1998
Alex Berson, Stephen J. Smith, Data Warehousing, Data Mining, and OLAP, McGraw Hill, 1997
M.A. Bramer (Ed.), Knowledge discovery and data mining: theory and practice , IEE Books, 1999
Peter Cabena, Pablo Hadjinian, Rolf Stadler, Jaap Verhees, Alessandro Zanasi, Discovering Data Mining from Concept to Implementation, Prentice Hall, 1997
K. Cios, W. Pedrycz, R. Swiniarski, Data Mining Methods for Knowledge Discovery, Kluwer, 1998, ISBN 0-7923-8252-8.
Nelson Ebecken, ed., Data Mining, Proceedings of Int. Conference on Data Mining, Rio de Janeiro, Sep 1998
U. Fayyad, G. Piatetsky-Shapiro, P. Smyth, R. Uthurusamy, editors, Advances in Knowledge Discovery and Data Mining, AAAI/MIT Press, 1996
Robert M. Mattison, Data Warehousing and Data Mining for Telecommunications, Artech House, 1997
Ryszard S. Michalski, Ivan Bratko, Miroslav Kubat, eds., MACHINE LEARNING & DATA MINING: Methods and Applications, John Wiley, 1998
Tom Mitchell, Machine Learning, McGraw Hill, 1997.
Dorian Pyle, Data Preparation For Data Mining, Morgan Kaufmann, 1999
Bhavani Thuraisingham, Data Mining: Technologies, Techniques, Tools, and Trends, CRC Press, 1999
Sholom M. Weiss and Nitin Indurkhya, Predictive Data Mining: A Practical Guide , Morgan Kaufmann, 1997
Chris Westphal, Teresa Blaxton, Data Mining Solutions, John Wiley, 1998

KEYWORDS: Data Mining, Digitized Aviation Logistics, Aircraft Maintenance

A00-128 TITLE: Variable Geometry High-Lift Airfoil for Rotorcraft

TECHNOLOGY AREAS: Air Platform

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Executive Officer, Aviation

OBJECTIVE: Develop advanced concepts for variable geometry high lift airfoils to substantially increase the mission capability of current system upgrades and future Army rotorcraft by increasing range and payload (up to 20%), speed, and maneuverability.

DESCRIPTION: Army rotorcraft are being called upon to operate in much more demanding environs than in the past, particularly in areas of nap-of-the-earth (NOE), deep-penetration, and air-to-air combat. Highly maneuverable, agile, and survivable rotorcraft demand greater aerodynamic capability from the rotor system. Aerodynamic performance is currently limited, to a great degree, by the low maximum lift coefficient of conventional rotor blade airfoils (Ref. 1). Practical considerations have traditionally ruled out variable geometry airfoils such as deployable flaps and slats commonly found on fixed-wing aircraft. Rotor blade aeroelastic constraints limit the use of airfoil camber and rule out trailing edge flaps to increase airfoil lift. Multi-element airfoils with fixed leading edge slots and approaches based on unsteady boundary layer control offer potential benefits and are currently receiving considerable attention but both approaches have significant technical limitations (Refs. 2-4). This topic specifically addresses an integral, variable geometry airfoil (Refs. 5-7) that will increase the leading edge camber, or droop, through a continuous change in airfoil contour rather than rotating a fixed segment of the leading edge around a hinge pivot. The additional leading edge camber will increase maximum lift coefficient (30%) to substantially increase the available rotor lift capability and reduce or eliminate dynamic stall problems of current rotorcraft. To be effective for a rotor system in edgewise (helicopter) forward flight, the geometry must vary as a function of the rotor blade azimuthal position at a frequency of at least once per revolution. Concepts specifically will address and satisfy the all-important considerations of structure, weight, and chordwise balance constraints of practical rotor blades and will also specifically address actuator systems of reasonable size, weight, power, and reliability. The structural configuration is particularly challenging for the rotor blade since the blade spar and balance weight typically occupy the entire leading edge volume of the rotor blade. Desired concepts specifically do not include discrete variable geometry devices, e.g. conventional multi-element deployable slats, rather, continuous contour deformation concepts are sought in order to satisfy low drag rotor blade applications.

PHASE I: Candidate concept(s) will be refined through preliminary engineering analyses and evaluated with respect to available airfoil geometry variation, weight, mechanical stress, actuator force and displacement requirements, actuator integration method and integration. Specifically, physical compatibility with the required blade spar space and blade chordwise balance constraints will be fully satisfied. Appropriate variable geometry airfoil shapes will be chosen based on general knowledge of desirable high-lift airfoil profiles. Appropriate discrete or integral actuators will be identified and appropriate engineering analysis performed to satisfy practical requirements for stroke, force, power, and excitation frequency. Required frequency ranges from steady deflection to a minimum of once-per-rotor-rev variations of airfoil shape; up to three or four-per-rev frequencies are desirable. The best candidate concept will be selected based on the results of the preliminary analyses. Phase I engineering design analyses will continue in sufficient depth and detail that the physical capabilities and overall practicality of the concept can be determined. This will include assessment of material fatigue life, producability, mechanical reliability, etc. Component laboratory testing will be conducted if and where appropriate.

PHASE II: Two-dimensional airfoil performance estimates will be made for representative airfoil geometries, using appropriate aero codes (e.g. CFD codes) and this data will be used to estimate rotor system performance. Depending on the results of these analyses, modifications or refinements to the concept and/or the variable geometry airfoil profile contours may be considered. Actuation concepts will be refined and a suitable actuator will be selected or developed. This may be an integral or discrete smart structure device, an electromagnetic actuator, or any practical alternative. A detailed engineering design for the variable geometry airfoil will be developed to enable fabrication of a full-scale prototype blade section in order to evaluate mechanical performance and producability characteristics. Mechanical performance will include fidelity of the variable geometry contour to the design shape, actuation force characteristics, actuation frequency, power requirements, etc. The variable geometry airfoil concept may be adapted to an existing rotor blade design and hardware article or designed for an entirely new blade structural configuration. Limited repetitive testing will be performed to demonstrate minimal mechanical reliability of the structural concept as well as the actuator design integration. Finally, a representative spanwise specimen will be used to conduct 2-D wind tunnel testing to evaluate the aerodynamic lift, drag, and pitch moment characteristics.

PHASE III DUAL USE APPLICATIONS: This technology is equally applicable to both military and civil rotorcraft. The topic addresses one of the key technical barriers to rotorcraft technology, the inherent rotor aerodynamic performance limitations. Fundamental improvement in airfoil technology will significantly benefit both the speed and aerodynamic efficiency of the helicopter and tiltrotors. If successful, such technology will find application to nearly all future rotorcraft and likely contribute to considerable expansion of the civil rotorcraft market by virtue of significantly improved helicopter performance, and operational capability. Commercial potential is considered to be very significant.

OPERATING AND SUPPORT COST (OSCR) REDUCTIONS: This topic addresses a fundamental limitation that has existed since the invention of the helicopter. Improving the aerodynamic performance and reducing retreating blade dynamic stall with variable geometry airfoils will directly and significantly reduce the operating and support costs of rotorcraft by improving aerodynamic efficiency, thereby reducing fuel consumption; increasing cruise speed, thereby increasing productivity; and by reducing vibratory loads, thereby decreasing equipment and component failure rates and maintenance requirements.

REFERENCES:

1. Dadone, L.U., Cowan, J. and McHugh, F.J., "Variable Camber Blade Study," NASA CR-166382, Aug 1982.

2. Narramore, J.C., McCroskey, W.J., Noonan, K.W.; "Design and Evaluation of Multi-Element Airfoils for Rotorcraft," American Helicopter Society 55th Annual Forum Proceedings, Montreal, Canada, May 25-27, 1999.

3. Noonan, K.W., Allison, D.O., and Stanaway, S., "Investigation of Slotted Rotorcraft Airfoil at Mach Numbers from 0.20 to 0.88 at Full-Scale Reynolds Numbers," American Helicopter Society Specialist's Conference, San Francisco, CA, Jan 1994.

4. Noonan, K.W., Yeager, W.T., Singleton, J.D., Wilbur, M.L., and Mirick,P.H., "Evaluation of a Model Helicopter Main Rotor Blade with Slotted Airfoils at the Tip," American Helicopter Society 55th Annual Forum Proceedings, Montreal, Canada, May 25-27, 1999.

5. Chandrasekhara, M.S., Wilder, M.C., Carr, L.W., "Control of Flow Separation Using Adaptive Airfoils," AIAA 97-0655, 1997.

6. Chandrasekhara, M.S., Wilder, M.C., Carr, L.W., "Unsteady Stall Control Using Dynamically Deforming Airfoils," AIAA 97-2236, 1997.

7. Smith, J.W., Lock, W.P., and Payne, G.A. "Variable-Camber Systems Integration and Operational Performance of the AFTI/F-111 Mission Adaptive Wing," NASA TM 4370, 1992.

KEY WORDS:
rotorcraft, helicopter, variable geometry airfoils, high lift, rotor performance

A00-129 TITLE: Advanced Corrosion Protection Scheme for Magnesium Helicopter Components

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Manager, Comanche

OBJECTIVE: The objective of this effort is to develop and demonstrate coatings, treatments, sealants, assembly compounds, and other materials that can provide an improvement in the corrosion resistance of assembled magnesium components on rotorcraft and thereby reduce the associated maintenance costs. It is highly desirable that these materials be free of chromates in order to ease the environmental impact of their usage and reduce the associated production and overhaul costs. Cast magnesium gearbox housings are the primary component of interest. The materials developed must be comparable in cost to those currently used.

DESCRIPTION: Lightweight magnesium alloys possess high strength to weight ratios, stiffness to weight ratios and good specific fatigue strength versus aluminum. Newer alloys possess improved high temperature performance as well. The importance of low empty weight for rotorcraft make cast magnesium an attractive material for complex shapes such as gearbox housings. The poor corrosion characteristics of magnesium versus aluminum must be addressed in any magnesium application. Magnesium gearbox housings are currently protected by a hard anodic treatment (DOW 17 or HAE) followed by surface sealing with multiple layers of chromated epoxy or phenolic resin (MIL-R-3043, Araldite PT 961 (non chromated), or Sermatel 1083/1098) followed by multiple coats of chromated epoxy polyamide primer (MIL-P-23377 Type II) followed by multiple coats of epoxy paint (MIL-C-22570). All hardware is wet assembled using a chromate pigmented sealing caulk (MIL-S-81733 or MIL-S-8802 Class B2). Each of these materials has limitations that reduce the effectiveness of the protection scheme and increase the cost of ownership associated with the magnesium component. The presence of chromates in the protective materials is undesirable from an environmental standpoint. Development of a chromate free protection scheme is desired. Current protection schemes have less than desirable damage tolerance due to the brittle nature of the paint, primer, and sealing materials. Dropped tools or assembly/disassembly frequently damage the protective coating allowing moisture exposure and corrosion initiation. Protective materials with greatly improved toughness are desired. Machined surfaces of the housing, such as mating flanges and bearing bores are anodic treated and sealed. The sealant must be applied to close thickness tolerance on machined surfaces due to assembly requirements. Application of the sealant to 0.0005 inch thickness tolerance is difficult to achieve using conventional paint spraying techniques and results in extensive rework. A sealant that results in a uniform, controllable dimensional buildup and has improved protection is desired.

The housings are typically overhauled several times during their service life. During overhaul the protective scheme must be removed to allow inspection of the housing. Steel liners that are pressed in during original assembly are typically left in place. Sealants that are applied over the hard anodized magnesium surface are cured at 400 oF. This temperature is high enough to cause potential tempering of the steel liners. A sealant that cures at less than 275 oF is desired.

PHASE I: The objective of Phase I is to conduct small scale evaluations of potential materials and/or processes that address the limitations of the current magnesium corrosion protection schemes. The results of these evaluations should identify the potential of the materials and allow selection of those that should be further pursued in a Phase II effort.

PHASE II: The Phase II objectives are to further develop the selected materials and application process in an effort to optimize its protective capability. Further small scale performance testing may be necessary followed full-scale demonstration on a helicopter gearbox housing. The objective of this testing would be to demonstrate both the manufacturing processes needed to apply to protection scheme/materials, and the performance of the new protection scheme in a simulated aggressive environment.

DUAL USE APPLICATIONS: The resulting technology will be applicable to both military and commercial aircraft, automotive, trucking, marine, and sporting goods markets.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: The application of this technology will have a direct impact upon the amount of maintenance effort required to repair damaged mag housing in the field. It will result in an increase in the life of magnesium parts. The elimination of chromated materials will have a very large positive environmental impact. This impact will be felt at both the original equipment manufacturer and at the depot level during overhaul.

REFERENCES:
(1) "Surface Treatments for Magnesium Alloys in Aerospace & Defense", Magnesium Elektron Booklet #256, January 1997

KEYWORDS: Magnesium, Corrosion, Chromate, Engines, Transmissions

A00-130 TITLE: Integrated Warning Caution and Advisory System (IWCA)

TECHNOLOGY AREAS: Air Platform, Human Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Executive Officer, Aviation

OBJECTIVE: Develop a warning caution and advisory system which provides integrated audio alerts for aircraft systems malfunctions, flight parameter alerts, and tactical alerts and which is reconfigurable for the several different rotorcraft in the Army Fleet.

DESCRIPTION: As Army rotorcraft have received increasingly capable mission equipment, flight controls, and aircraft systems, there has been an associated increase in the number of different alerting messages, both visual and audible, that need to be presented to the aircrew in case of systems failures, tactical threats, or out of tolerance flight parameters. Methods have been sought for organizing the alerting information and standardizing its presentation to the crew. Considerable progress has been made in the presentation of visual alerts in the form of text on dedicated areas of cockpit displays with consistent presentation formats of alerts by priority and by subsystem. However, the presentation of audible alerts, whether sounds or spoken messages, has continued to be accomplished by a collection of individual aircraft systems and mission equipment systems. Each new system added to Army aircraft generates its own audible alerts. These alerts are fed into the intercom system (ICS), mixed with other audible sounds and voice, and presented to the crew in their helmet earphones. This can result in multiple, concurrent audible alerts presented to the pilot with each alert masking others and greatly increasing pilot workload. Current speech synthesis technology, sound generation and presentation technologies to include 3-D audio are available commercially off the shelf (COTS) and are within weight, size, and cost constraints for implementation in avionics systems. However, research and development is needed for audio alert presentation to the crew in a manner that will ensure that the crew receives the most time-critical information first without overloading the crew in the auditory mode. This research and development should develop an intelligent; decision based human-centered design approach. Integrated Warning Caution and Advisory audio design logic, presentation modality and rationale should be documented. This design approach taken should result in improved cognitive readiness for Army aircrew by optimizing and enhancing crew performance in the area of detecting, diagnosing, and dealing with warning, caution, and advisory information from both within the aircraft and from outside the aircraft. This topic aims to develop the design for an integrated human machine interface for cockpit audio alerting systems which will enhance aircrew situational awareness and cognitive readiness, and which will be applicable to and reconfigurable for each Army rotorcraft.

PHASE I: Determine relevant hardware and software alerting system design interface characteristics of current Army rotorcraft and future Army rotorcraft that are currently under development so as to understand the interfacing requirements and decision logic and presentation modality for an IWCA. Review COTS speech synthesis and sound generation technology for suitability. Review relevant data buss, processing, memory, non-volatile storage, operating systems, and other relevant hardware and software to support an IWCA. Develop a functional description of a human-centered design and rationale for an IWCA which, based on human factors literature and cognitive psychological research, will result in improved cognitive readiness for the aircrew. Provide a Phase I contractor report for Government publication addressing findings, description, research and proposed Phase II approach and deliverables.

PHASE II: Develop a prototype IWCA with a fully functional set of integrated audio alerts, including aircraft systems alerts, flight parameter alerts, and tactical alerts, presented to the aircrew in accordance with rules for priority and without overloading the crew. Provide rationale documentation for the IWCA design and audio alert decision logic. Demonstrate this prototype IWCA in a part-task combat rotorcraft flight simulation. Design the alert presentation logic so as to be reconfigurable in software for at least the following parameters: alert signals (spoken or sound), spoken alert wording, alert repetition logic and timing, assignment of priorities to alerts, and alert triggering conditions. Provide a Phase I contractor report for Government publication to include a proposal for a Phase III approach and deliverables.

PHASE III DUAL USE APPLICATIONS: The IWCA design will be directly useful for rotorcraft and fixed wing aircraft in the other services as well as in the civil sector. While the civil sector is not normally concerned with tactical alerts from enemy weapons systems, it does have a need for tactical alerts in the form of traffic alerts and obstacle alerts. And both the military and civil sectors can benefit from an integrated alerting system design which delivers systems, flight parameter, and tactical alerts in a way the improves cognitive readiness for the crew.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: An IWCA which can be common across the Army Fleet by being software reconfigurable for different rotorcraft will reduce initial acquisition costs as well as maintenance costs. The reconfigurable nature of the IWCA will also reduce the cost of upgrades by allowing the same hardware to be reprogrammed to add or change alerts and their presentation characteristics and priorities rather than requiring the development of a new system for each different rotorcraft or upgrade.

REFERENCES: _____

Bond, Z. S., and Garnes, S. (1980). Misperceptions of fluent speech. In R. A. Cole, (Ed.), Perception and production of fluent speech (pp. 115-13). Hillsdale NJ: Lawrence Erlbaum & Associates.

Chapanis, A. (1975). Interactive human communication. Scientific American, 232 (3), 36-42.

Cole, R.A. (Ed.). (1980). Perception and production of fluent speech. Hillsdale NJ: Lawrence Erlbaum & Associates.

Hakkinien, M. T., and Williges, B. H., (1984).

Synthesized voice warning messages: effects of alerting cue in single- and multiple-function voice synthesis systems. Human Factors, 26 (2), 185-195.

Joint Service Specification Guide (JSGS) 1776: Aircrew Systems (DRAFT), U.S. Department of Defense, 30 January 1998.

Kryter, K. (1972). Speech communication. In H.P. Van Cott and R.G. Kinkade (Eds.). Human Engineering Guide to Equipment Design (pp. 161-226). Washington, D.C.: U. S. Government Printing Office.

Military Standard: Aircrew Station Alerting Systems (MIL-STD-411F) DRAFT, 20 January 1995, [as edited per Tri-Service and industry review] US Department of Defense.

Miller, Heise, and Lichten. (1951). The intelligibility of speech as a function of the context of the test materials. Journal of Experimental Psychology. 41, 329-35.

Simpson, C.A., McCaulley, M., Williges, B., Roland, E., Ruth, J. 1985. Speech Controls and Displays, in Salvendy, G. [Ed] Handbook of Human Factors, John Wiley & Sons, 1987.

Simpson, C. A. and Williams, D. H. (1980). Response time effects of alerting tone and semantic context for synthesized voice cockpit warnings. Human Factors, 22 (3), 319-320.

Sorkin, R.D. Design of Auditory and Tactile Displays, Chapter 5.2 in Salvendy, G. [Ed] Handbook of Human Factors, John Wiley & Sons, 1987.

Voorhees, J. W., Bucher, N. M., Huff, E. M, Simpson, C. A., and Williams, D. H. (1983). Voice interactive electronic warning system (VIEWS). Proceedings of the IEEE/AIAA 5th Digital Avionics Systems Conference Seattle, Washington, October 31-November 3.
(83CH1839-0) (pp. 3.5.1-3.5.8).
New York: IEEE.

KEYWORDS: alerts, warnings, cautions, advisories, audio, speech, rotorcraft, helicopters

A00-131 TITLE: High Temperature Material Application for Turboshaft Engines

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Manager, Utility Helicopters

OBJECTIVE: The objective of this effort is to develop an inter-turbine duct using advanced materials which can operate at high temperatures thereby reducing the cooling flow requirements. This technology which will increase efficiency, decrease cooling flow and reduce specific fuel consumption (SFC) will have a positive impact on reducing Operating and Support (O&S) costs for future helicopters.

DESCRIPTION: In order to meet IHPTET goals and requirements advances in materials technologies for turbine engines must be developed. High performance gas turbine engines require cooling of engine components to meet performance requirements. To reduce the use of cooling air and still achieve the performance requirements, advanced materials are needed to operate at relatively high temperature. One particular component in which cooling air can be minimized is the inter-turbine duct. This component is a critical diffuser section between the high temperature HPT and the LPT. Ceramic matrix composites (CMCs) are materials that offer the capability to economically produce inter-turbine or transition ducts that allow for higher temperature operation than is currently possible with superalloys. This program will use technology from current CMC nozzle programs.

PHASE I: Working with a gas turbine engine manufacturer identify processes to economically produce 360-degree CMC duct type components. Conduct preliminary design studies to determine attachment methods. Evaluate 2-D vs 3-D fiber architecture.

PHASE II: In conjunction with a gas turbine engine manufacturer and utilizing results from Phase I, perform detailed analysis of designs and select the optimum design. Demonstrate the process by fabricating and testing an inter-turbine duct from CMCs.

PHASE III DUAL USE APPLICATIONS: The resulting technology will be beneficial to both the military and commercial sectors, being applicable to a wide variety of applications such as the tank, automotive, aircraft, as well as, any other market using engines.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Technologies which lead to higher efficiencies, decreases in cooling flow and reductions in SFC will have a positive impact on reducing O&S costs for future helicopters.

REFERENCES:
(1) A.G. Evans and D.D. Marshall, "The Mechanical Behavior of Ceramic Matrix Composites," Acta Metall. 37[10] (1989) 2567-2583.
(2) K.M. Prewo, "Fiber Reinforced Ceramics: New Opportunities for Composite Materials," Ceramic Bulletin, 68 (1989) 395-400.
(3) A.W. Pryce and P.A. Smith, "Matrix Cracking in Ceramic Matrix Composites under Quasi-Static Tensile Loading," In Proceedings of the 8th International Conference on Composite Materials. Tsai, S.W. and Springer G.S. Edt., SAMPE, Covina, CA (1991) 24 A-1 to 24 A-10.

KEYWORDS: Gas Turbine Engine, High Temperature Materials, CMC's

U.S. Army Communications and Electronics Command (CECOM)

A00-132 TITLE: Bandwidth Management

TECHNOLOGY AREAS: Information Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Warfighter Information Network - Terrestrial

OBJECTIVE: Army communications networks that support the tactical operational force currently consist of relatively low bandwidth (B/W) wireless links. Various users of the networks, each with varying types and priorities of information, exist and vie for the limited communications resources provided by the networks. This results in an environment where B/W is a critical and scarce resource that must be properly managed to meet the Army's operational needs. Currently, there are no viable approaches or techniques to providing for the network wide management of B/W. This deficiency is critical as the Army continues with digitization and development of new communications capabilities to support its future operational objectives.

The objective of this effort is the research and development of new and innovative B/W management techniques that complement Army digitization and enable network managers to efficiently allocate network resources to support Army Battle Commanders.

DESCRIPTION: Army communication networks such as Wireless Local Area networks (WLANs), and Line of Sight (LOS) and Non LOS (NLOS) networked radios must be wireless and highly mobile with no fixed infrastructure. Different bandwidths and other parameters such as reliability and delay characterize these networks. In addition, these networks must support various types of data such as voice, data, and video information, each of which require different amounts of bandwidth.

Much of the research in the area of providing QoS in IP based networks is concerned with high B/W, low delay, and high reliability wired media. Bandwidth management techniques that operate across the different types of networks and support the different types of data are required for a tactical military environment. QoS mechanisms must be extended for real time multimedia traffic along with voice and data traffic of varying priorities over wireless ad-hoc/multi-hop networks.

This effort may include the development of the ability to manage B/W based on the network available, the user precedence or priority, or the type of information. I may also include support of B/W reservations, development of proxies to drive B/W aware applications, and the addressing of IP QoS over tactical wireless links.

PHASE I: Perform a study to design and develop B/W management techniques. Explore design considerations, develop metrics, provide trade off considerations and document the results.

PHASE II: Build on the results of Phase I and design a solution set which can be demonstrated to address the issue. Build a prototype or model of the solution that demonstrates the capability

PHASE III DUAL USE APPLICATIONS: Product of this SBIR will have application to emerging commercial wireless communications.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: The development of such a capability will allow the military and commercial users (i.e., telemaintenance users, telemedicine users, etc.) of networks to optimize the use of required bandwidth to deliver information in an integrated network. This will result in a reduction in communications infrastructure costs and operating and maintenance costs.

REFERENCES:
(1) CECOM S&TCD Multifunctional On-the-Move Survivable Adaptive Integrated Communications (MOSAIC) Advanced Technology demonstration (ATD) Management Plan, dated, 25 Nov 99

(2) MILCOM 99 Paper, Titled: MOSAIC ATD

KEYWORDS: bandwidth management, wireless communications, protocols, networks, quality of service

A00-133 TITLE: Information Assurance Protection for Command and Control (C2) Intelligent Software Agents

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Research, prototype, demonstrate, and apply innovative Information Assurance protection for mobile intelligent software agents, currently under development for the Battlespace Command and Control (BC2), Logistics (Log) C2 and Command Post (CP) XXI Advanced Technology Demonstrations (ATDs).

DESCRIPTION: Digitalization of the Battlefield enables the Army to control the operational tempo, environment and battlespace, resulting in Information Superiority; this, however, creates dependence upon the integrity of that information. The need for increasing information flow through bandwidth-limited channels requires reliable, mobile, software agents traversing networks, performing functions and services on remote hosts, returning with processed data. Information is often exchanged with mobile agents, and must be trusted. Intelligent agents are currently under development for BC2, Log C2 and CPXXI ATDs. Their integrity must be protected and preserved enabling US military C4I systems to function anywhere, any time. This Information Technology (IT) effort includes the assessment of vulnerabilities and remedies necessary to protect software agents, their integrity and payloads; as a minimum, confidentiality, data integrity, authentication and authorization. Consider steganography for information hiding, with authentication and integrity for detection of tampering and forgery. Also, consider watermarking and fingerprinting for ownership control, copy tracing, and resistance to erasure. The protected, trusted, mobile, intelligent SW agents will be used to detect and respond to threats, perform data mining functions, exchange data, monitor and manage alerts, and other documented functions. The contractor should integrate Information Assurance into the agents and their data payloads with the most effective, efficient and expedient means possible, resulting in protected, trusted, agents, and trusted payloads. Other technologies including Information Security should be considered. This effort will be applied but not limited to the protection of the agents currently under development. Following enhancement of these software agents, similar enhancements will be applied to intelligent agents in other Command, Control, Communications, Computers and intelligence (C4I) systems. Innovative and creative approaches are encouraged.

PHASE I: For the referenced agents, propose a concept environment necessary to research, evaluate and demonstrate viable Information Assurance methodologies. Document the rationale for the concept environment with candidate viable solutions.

PHASE II: Utilizing the concept environment established in Phase I, complete the evaluation of viable Information Assurance solutions for the referenced software agents and payloads. Select prototype and demonstrate recommended approaches, both at the contractor's facility and at CECOM, Ft. Monmouth, NJ. Provide complete documentation and Final Report.

PHASE III DUAL USE APPLICATIONS: Provide developed software as deliverables. Provide software in commercially acceptable formats, for Windows NT, Solaris 2.6.x, IRIX 6.5.x and Linux 2.2.x, on Intel, SGI and Sun platforms. Third party software (e.g. SUN JDK) must be specified. Provide demonstrations of trusted agents running in the CPXXI and Log C2 environments, at CECOM, Ft. Leavenworth, and one other Battlelab, TBD. If appropriate, the delivered components shall be segmented and submitted for testing and inclusion into the Defense Information Infrastructure (DII) Common Operating Environment (COE) as an R&D segment. Product sales to commercial Internet market. Product sales to education, training, and performance-support markets. License agreement with DII COE for segmented products. Follow-on R&D contracts from government and industrial customers.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Trusted agents reduce costs through reduced need for retransmissions, increased protection of sensitive military information leading to reduced casualties on the battlefield.

KEYWORDS: Intelligent software agents, C2 systems, C4I, knowledge based, Information Assurance, Information Security, Information Technology.

A00-134 TITLE: Global Positioning System (GPS) Pseudolite Elevated Platform

TECHNOLOGY AREAS: Electronics

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Manager - Global Positioning System

OBJECTIVE: Global Positioning System (GPS) pseudolite effectiveness depends upon clear line-of-sight to ground based receivers. The objective of this topic is to design, build, and demonstrate an easy to operate elevated platform for the deployment of GPS pseudolites.

DESCRIPTION: A viable, cost effective way to improve the robustness of GPS to electromagnetic interference is to deploy pseudolites. Pseudolites are near terrestrial transmitters that emit GPS like navigation and timing signals. The signal received from the pseudolites is substantially greater then that received from interference. The main factor for pseudolite navigation is to insure line-of-sight from the pseudolite to the receivers. For ground vehicle applications this requires that the pseudolites be elevated several hundred meters (several thousand preferred) above the ground. There is a requirement that the pseudolites have fairly small and slow motions and the ability to lift about 70 kg. Innovative concepts for quasi-stationary airborne or low-cost terrestrial systems are required.

PHASE I: The purpose of Phase I is to conduct researches and does trade studies. The contractor will select the Pseudolite Platform technology and concept of operation.

PHASE II: The purpose of Phase II is to design, construct and demonstrate a working model of the Pseudolite Platform. This phase will include a demonstration of pseudolite navigation. A complete platform specification will be defined and a final report will be written.

PHASE III DUAL USE APPLICATIONS: The proposed platform will have dual use applications for Differential GPS transmitters as well as for GPS Pseudolites. There are many commercial applications requiring pseudolites such as harbors, canals, and airports. All of these applications can benefit from elevated platforms.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: This topic improves the commander's situational awareness by improving the performance of GPS receivers.

KEYWORDS: Navigation, Radio, GPS, Psuedolite

A00-135 TITLE: Knowledge-Access Portal Technology for Medium Brigade and Command Post XXI Decision Makers and Other Knowledge Warriors

TECHNOLOGY AREAS: Information Systems, Human Systems

OBJECTIVE: To develop, demonstrate, and transition innovative knowledge-access portal technologies for improved 'Cognitive Readiness' and knowledge-based decision making for Brigade Combat Team (BCT) and Command Post XXI staff and other Knowledge Warriors.

DESCRIPTION: Brigade Combat Team (BCT) units must accomplish the complex, multi-dimensional task of building knowledge in a very confusing, often unpredictable environment. They must build the knowledge base necessary to achieve Situational Understanding (SU), including an in-depth understanding of the local and regional non-military factors that typically influence the outcome of operations within an asymmetric environment. Command Post XXI (CPXXI) is working on the similar capability of providing its staff and other Knowledge Warriors with enhanced access to all types and sources of relevant information and knowledge, including battlefield, web-based, regional, CONUS, military archival, digital libraries, and even from their own personal knowledge bases. Individual warriors have the potential to become key elements of the 'Infosphere' by capturing their own knowledge (as they create it) in a personal repository, and then providing controlled access to others. Warriors also need to find, acquire, and utilize the knowledge of Subject Matter Experts (SME) or collaborative working groups. 'Cognitive Readiness' calls for advances in knowledge-based peformance, but since traditional training can no longer scale to the growing demands for warrior knowledge, Just-in-Time knowledge capabilities (via knowledge portals) are now being viewed as a solution to this challenge. Simple portals in the form of 'web search engines' currently provide some basic capabilities, but the potential is much greater, as too are the technical challenges. This is a fruitful area for innovation. While this topic is broad, some potential topics for proposals could be in the areas of unique portal capabilities for the Brigade Combat Team (BCT) or command post; mobile portals for the battlefield (where connectivity and bandwidth vary); Command and Control (C2) decision-centered portals; collaboration-centered portals; warrior-centered portals as elements of the Infosphere; portals to controlled-access knowledge sources; or other key components, products, or elements that could contribute to building the infrastructure to support such capabilities. This research work could include both engineering and psychology aspects, but should place greater emphasis on the former. Technical performance parameters will be defined in Phase I and will be based on the improved performance of users performing standard tasks that require access to various types of knowledge. If appropriate, Phase-II or III products could be segmented for trial incorporation into the Defense Information Infrastructure (DII) Common Operating Environment (COE). Offerors should demonstrate knowledge of the rapidly advancing state-of-the-art in portal technology and how they will leverage and build upon it.

PHASE I: Conduct study and/or develop early prototype of proposed innovation for purposes of showing technical feasibility, user benefits, cost feasibility, and commercial marketability. Establish technical performance paramters for Phase II.

PHASE II: Complete development of proposed innovation, technology, or product. Conduct technology demonstrations as part of Medium Brigade, Command Post XXI, or other warfighting experiments.

PHASE III DUAL USE APPLICATIONS: Depending on the proposed product, candidate dual-use applications could include plug-ins or ancillary products to existing commercial portals; servers or server add-ons to respond to portal requests; or person-centered knowledge management products or services.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Training (a major portion of O&S costs) is undergoing a paradigm shift, from classroom instruction to Distributed Learning and Just-in-Time Knowledge, which has vast potential for improved knowledge-based performance at reduced costs.

REFERENCES:

Medium Brigade – Commerce Business Daily, Posted in DBDNet on November 5, 1999 (Printed Issue Date: November 9, 1999), From the Commerce Business Daily Online via GPO Access (cbdnet.access.gpo.gov), Subject: Modification to Special Notice on Systems to Equip a New Brigade Organization. Note: Brigade Combat Team (BCT) is the new name for the Medium Brigade.

Karpinski, Richard, Friday, Tools Help Build Corporate Portals, January 29, 1999, http://www.internetwk.com/news0199/news012999-8.htm

Koulopoulos, Thomas, Sharing Knowledge - Corporate Portals: Make Knowledge Accessible To All, http://www.informationweek.com/731/31erall.htm

KEYWORDS: Knowledge Management, Decision Support, Portal, Cognitive Readiness, Digital Libraries, Infosphere, Collaboration, Training, Web, Search Engine.

A00-136 TITLE: Unmanned Aerial Vehicle (UAV) Antennas

TECHNOLOGY AREAS: Electronics

OBJECTIVE: Develop and test antennas suitable for an Unmanned Aerial Vehicle (UAV) with Signals Intelligence and communications payloads and the potential to be used with other systems.

DESCRIPTION: Finding suitable antennas to fit any particular air platform has been an intractable problem faced by the military and commercial users for years. With the advent of UAVs, the military and commercial communities are now faced with non-traditional platforms that are severely constrained in available space and weight capacity for payloads, including associated antennas. The Army and other services require antennas with sufficient gain for Signals Intelligence and communications payloads on a UAV. There is insufficient space on a UAV for all the antennas required. A helicopter borne system with a Signals Intelligence mission that UAVs will replace had 17 antennas. This amount of antennas cannot fit on a UAV with a wing span of 13 feet. The Army is looking for new ideas that will reduce the antennas weight and size due to the severe limitations of a UAV. Broader bandwidth antennas are required than normally are available to reduce the number of antennas needed. The antennas should cover the frequency range of 2 MHz to 40 GHz or some portion thereof. The antennas need to be interchangeable (easy on-easy off) and compatible with an aircraft "A kit" that remains the same no matter which particular antenna is installed. The "A kit" is those items that remain permanently attached to the airframe when installing a payload. For example, the box in a rack is part of the "B kit" (because it's easily replaced) while the rack itself is part of the "A kit", as is the cabling to the antennas. One possible approach is a family of interchangeable antennas covering different portions of the full frequency range. A particular antenna is chosen based on the current radio frequency environment of interest. But all antennas would use the same cabling and mounting hardware (the "A kit"). The antennas need to be as compact and aerodynamic as possible to reduce overall weight and drag so the UAV's flight performance is not substantially degraded.

PHASE I: Develop the antenna design(s) and build models suitable for laboratory testing. The antennas may be tested at a government facility to determine their suitability for UAVs or other efforts. The Very High Frequency (UHF) and Ultra High Frequency (UHF) bands are of primary interest for Phase I. Appropriate design and test reviews will be conducted.

PHASE II: Develop prototype flight worthy antennas and laboratory test them with Signals Intelligence and communications payloads. The antennas may be tested with other systems if appropriate. Appropriate design and testing reviews will be conducted.

PHASE III DUAL USE APPLICATIONS: Smaller, lighter weight antennas are in constant demand for commercial and military communications systems. Potential military applications are Signals Intelligence, communications, weather or any ground, fixed or mobile (including handheld), air and maritime systems that transmit or receive radio emissions. Commercial applications include general aviation, commercial UAV systems, fixed and mobile (including handheld) communications systems, ship board systems, weather, and laboratory systems. More capable antennas will offer greater value to commercial communications providers where tower space is limited. In Phase III, the antennas will be integrated and tested on a UAV or a surrogate aircraft.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Broader bandwidth and interchangeable antennas could reduce operating and support costs because fewer antennas would be required and potentially reduce the number of different Signals Intelligence payloads because the frequency range will not be limited by the available antennas. A more capable payload means fewer flights will be needed to cover the required frequency range. These antennas would also be applicable to UAV communications payloads, fixed and rotory wing aircraft and ground systems. There is the potential to reduce a large number of different types of antennas.

REFERENCES: Prophet and Tactical Unmanned Aerial Vehicle Operational Requirements Documents

KEYWORDS: Antenna, Unmanned Aerial Vehicle

A00-137 TITLE: Micro-Laser Transmitter

TECHNOLOGY AREAS: Sensors, Electronics

OBJECTIVE: The most expensive and complicated subsystem of a solid-state laser range finder is the laser transmitter. The objective of this topic is to simplify and greatly reduce the costs for an eye safe, solid-state micro-laser transmitter suitable for use as a rangefinder and illuminator. .

DESCRIPTION: Laser range finders and illuminators are a vital component of high precision targeting engagements. Precise and accurate range-to-target information is an essential parameter in the fire control solution of today's sophisticated weapons. In addition, future combat systems require this laser for gated illumination for low cost target identification systems. The range information is readily provided by the laser range finder, however, current fielded laser range finders are bulky, heavy, difficult to mount onto weapons, and very expensive. The US Army CECOM RDEC NVESD has addressed these laser range finder issues in the development of a Micro-Laser Range Finder which uses a novel "monoblock" construction to reduce parts count, eliminate most optical bench mounts and substantially reduce alignment requirements.
However, to meet illuminator requirements, a higher energy and higher repetition rate are required. The cooling and efficiency of electronics and laser pumping will need to be addressed to meet requirements.
The goals for this effort are:

1. Energy per pulse: 10 millijoules at 1.5 microns
2. Pulse repetion rate: 5 Hertz burst rate (25% duty factor)
3. Monoblock construction to reduce components and alignment requirements
4. Low cost construction
5. Lightweight and compact.

PHASE I: Demonstrate feasibility of proposed approach for a compact solid state laser transmitter in the laboratory.

PHASE II: Fabricate 2 prototype laser devices which meet requirements with electronics and power source required to operate the laser system.

PHASE III DUAL USE APPLICATIONS: There is a large and eager commercial market awaiting the development of a low cost, simple solid-state laser source. The most obvious is the law enforcement community, which is already purchasing laser range finders for their snipers (albeit in limited quantities due to cost, size and weight of the currently available units). Another community, which would benefit from the introduction of this product, is leisure and entertainment. Activities such as boating, hunting and orienteering, to name a few, are anxious for the introduction of a compact, long range performance laser range finder. The medical community would also benefit from the development of a low cost solid-state laser source. For example, an ultra-compact, very low-cost laser for use in treatment of glacoma would make this simple medical procedure widely available. The industrial community would also benefit from the availability of a low cost laser source. An example is the laser system used in removal of unwanted leads in an electronic chip. This electronic re-work station is currently very expensive and large. The introduction of a simple, low-cost laser would dramatically reduce size and lower costs. There are numerous other applications for this low-cost, simple laser source, too many to describe. The bottom line is that both the military and commercial markets are prime for the development of a low cost, simple solid-state laser source.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: The most expensive subsystem of a solid-state laser range finder is the laser transmitter. NVESD addressed this issue by developing a novel laser resonator, using the "monolithic" approach. The monolithic approach allows for a reduction in parts count, mitigates laser alignment complexity, and simplifies producibility. This makes the development, fabrication and then maintenance of a very compact and affordable laser range finder feasible.

Current laser range finder laser sources are very difficult and expensive to maintain. Maintaining alignment in the field evironment is very taxing. The laser sources consist of many optical components each mounted on a complex mechanical stage for precise alignment. When the laser goes out of alignment, this precise alignment cannot be done in the field environment. As such, the transmitter section or the entire laser system has to be removed to be sent back to depot and then to the factory for repair when problems with the unit occurs. This is a very costly scenario, not only monetarily but also in terms of operational readiness. There are many times when a laser system is not available (they are very expensive) for replacement so the military unit is without the range finding function which is critical for many military missions.

The development of a low cost solid-state micro-laser transmitter can reduce the Army's operating and support costs of laser systems in the field. First, since the micro-laser transmitter is a monoblock construct there are no complicated mechanical stages. The micro-laser transmitter is pre-aligned during fabrication. There are no 'parts' to go out of alignment. Second, if it breaks in the field environment it is possible that it may be replaced as an encapsulated module in the field or worse case at the depot. There would be no reason to send it back to the manufacturer for repair. The best feature of developing the low cost micro-laser transmitter is that sufficient quantities of available spares are viable due to the very low cost of the micro-laser. Use of the micro-laser transmitter would also reduce excess materiel in inventory for the laser source since multiple optical components, mechanical stages and mechanical fasteners are no longer required.

REFERENCES: "Micro-Laser Range Finder Development: Using The Monolithic Approach", Nettleton, Schilling, Barr & Lei, Feb 99, Proceedings for Active Sensors Military Sensor Symposia and Nov 99, Proceedings for National Military Sensor Symposia.
"Novel Monoblock Laser for a Low Cost, Eyesafe, Micro-Laser Range Finder", Nettleton, Schilling, Barr & Lei, Applied Optics, May 2000.

KEYWORDS: Micro-Laser Transmitter, Laser Range Finder, Solid-State, Monoblock, Monolith

A00-138 TITLE: Real-Time Image Intensifier Simulation

TECHNOLOGY AREAS: Information Systems, Sensors

OBJECTIVE: To develop a "first principles" Image Intensifier simulation model that can be integrated into the NVESD "Paint the Night" (PTN) real-time sensor simulation to provide reliable, physically realistic Night Vision Goggle (NVG) simulation as part of a simulated weapons or scout platform sensor suite for advanced sensor prototype studies and analysis.

DESCRIPTION: Realistic simulation of the Night Vision Goggle (NVG) visual experience poses significant challenges to the simulation designer. These challenges stem primarily from trying to capture the distinct behavior of today's 2nd and 3rd generation image intensifier tube assemblies.

Image intensifiers have a number of characteristics that make their real-time simulation difficult in practice. Intensifier assemblies can respond to extremely wide intra-scene dynamic range variations typically encountered in tactical scenes, from bright street and car lights to dark forest clutter and shadows. A car headlight can be as bright as 50,000 foot-lamberts (FL), while night sky measurements can be as dark as 10-8 FL and less. Automatic Brightness Control (ABC) and Bright Source Protection (BSP) circuits allow the intensifier to accommodate these input swings, but they produce a non-linear behavior that is characteristic to the NVG experience. In addition, bright source photons off the photo-cathode onto the micro-channel plate (MCP) give rise to a phenomenon known as "haloing", which is difficult to simulate in real-time.
This effort will develop a real-time simulation solution that models these unique NVG characteristics in the Paint-the-Night sensor simulator implementations hosted on SGIs, Datacube hardware, and low-cost PCs.

PHASE I: Perform detailed engineering analysis of Army image intensifier tube assemblies and their operating environments so as to establish practical technical specifications for components used in Night Vision Goggle (NVG) simulation or stimulation. Characterize scene signature inputs stimulating image intensifiers (NVGs) in typical tactical scenarios. Characterize key image intensifier behavior affecting the visual experience and sensor performance. Formulate simulation models for photo-cathode spectral responses, minimum detectable and resolvable contrast behavior, effective tube dynamic range, automatic brightness control (ABC), bright source protection (BSP), "haloing", system blur, and noise sources. Develop basic simulation architecture and component specifications. Develop an NVG simulation design for implementation in a Phase II follow-on effort.

PHASE II: Implement the Phase I simulation design. Demonstrate its realism by comparing corresponding live and virtual NVG simulations, and by performing metric analysis with the NVESD image metric libraries.

PHASE III DUAL USE APPLICATIONS: Realistic, low-cost NVG simulators offer considerable commercial potential both in the video gaming market and in law enforcement training.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Simulations can be more cost effective than field training exercises but simulator realism is critical to their usefulness. NVG simulation capability in PTN expands the night simulation capability into the near-IR. Simulators employing this capability can be used to train infantry soldiers as well as helicopter pilots. The cost savings are inherent in the use of simulators. Night pilotage training and currency experience will be significantly safer in simulators. Any decrease in aviation accident results in corresponding decreases in costs.

REFERENCES: Paint the Night - The US Army Communications-Electronics Command's Night Vision and Electronic Sensors Directorate (NVESD), located at Fort Belvoir, Virginia, has developed a High Level Architecture (HLA) compliant version of it's "Paint the Night" (PTN) thermal scene generation simulation. "Paint the Night" provides a realistic electro-optics simulation, which is used by the Research and Development community and in Distributive Interactive Simulation (DIS) compatible exercises. PTN provides the capability for real-time sensor effects, atmospheric effects, and other special effects as well as generation of a high-resolution synthetic thermal scene for ground and air applications.

PTN is composed of several physics based algorithms to provide the user with a natural and realistic real time thermal image. Currently, PTN includes: 3D modeling; 2D thermal texture generation; atmospheric effects; time of day effects; effects for first generation and second generation thermal sensors; optimized scene rendering; high fidelity terrain (down to one meter post spacing); and aspect-unique trees. The combination provides a state-of-the-art level of realism. On-going efforts are underway to expand PTN beyond the mid- and far-infrared regions into a true multi-spectral simulation while at the same time optimizing it

for a desktop platform (versions of PTN are currently running on a Silicon Graphics O2). By using the Defense Research and Engineering Network (DREN), a high bandwidth/low latency network, imagery can be exported and controlled by remote users. Presently NVESD is exploring this exciting capability with the Mounted Maneuver Battle Lab at Fort Knox, Kentucky.

Obvious uses are for sensor prototyping and Simulation Based Acquisition applications. Other potential uses of these capabilities include multi-sensor target acquisition, orienteering, mission equipment battlefield assessment, development of tactics & doctrine, training tools, education, and entertainment. These techniques are expected to provide a significant impact on future thermal database development and generation. Increased fidelity provides DIS users with the tools needed to address many of the concerns of the R&D and Test and Evaluation communities. PTN easily integrates into disparate simulators and provides the DIS community with a greatly improved night scene simulation capability.

KEYWORDS: NVG simulation, Image Intensifiers, Paint the Night

A00-139 TITLE: Sensor Effects Card for PC Based Simulators

TECHNOLOGY AREAS: Sensors

OBJECTIVE: To develop a PC based, single card hardware solution that applies sensor effects to graphical images. The current capability, as well as being costly, is a large stand-alone device. The objective is to miniaturize the hardware, reduce the cost, and improve its compatibility to PC simulation systems.

DESCRIPTION: There is considerable interest within the Government and Industry to move high performance, high fidelity, real time simulations from high- end and costly platforms to relatively inexpensive PC based computers. The current Paint the Night simulator uses a high-end device to calculate and apply sensor effects to simulated imagery. For each pixel, two 10x10 convolutions and a frame add are required. Currently, integer math is used but it is desired to migrate to floating point calculations. The minimum resolution that must be supported is 1280 x 1024 with multi-sampling to reduce aliasing. A 30 hertz frame rate is required and a 60 hertz frame rate is desired. It is also desired that the hardware solution be capable of overlaying symbols on the graphics.

PHASE I: After first observing and evaluating the current hardware implementation that applies sensor effects to simulated imagery, a feasibility study will be undertaken to identify acceptable hardware approaches to the problem. A minimum of three approaches (pipeline, FPGA, and DSP) will be thoroughly analyzed and considered. The contractor shall select the best approach based on:

1) Chances of meeting the requirements including the size constraint of a PC card.
2) Estimated costs including both development costs and production costs of the final hardware
3) Chances of meeting desired and future requirements
4) Upgradeability

In evaluating the approachs, the contractor shall consider issues related to developing a basic hardware design that includes but, is not limited to, the hardware architecture, circuit design, timing diagram, performance specifications, parts list, costs, etc. . . The end product of the feasibility study is an overall design at a sufficient level of detail such that an independent feasibility assessment will be possible.

PHASE II: The contractor will build on the overall design formulated in Phase I, proceed with the detailed design, and continue with the development of hardware prototypes. Specifically, single card hardware prototypes shall be fabricated, assembled, tested, and demonstrated. The demonstration shall include a side-by-side comparison to the existing capability for purposes of evaluation. In addition, updated production costs shall be provided.

PHASE III DUAL USE APPLICATIONS: The hardware developed under this topic is applicable to both military and commercial applications. All applications that require high resolution graphics processing or simulations in general can benefit. One example is computer/video gaming.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: The current capability costs approximately $30,000 per unit and interfaces to a high-end computer. Training simulators or other systems for which this would be applicable need to be affordable so that they can be fielded in large quantities. By developing a PC based sensor effects card that costs an order of magnitude less than the existing device would allow similar cost savings in fielded systems. Also, there exist systems that have not been fielded due to their costs. Those systems could now be reconsidered for fielding and other systems could be fielded in higher quantities.

REFERENCES: Paint the Night - The US Army Communications-Electronics Command's Night Vision and Electronic Sensors Directorate (NVESD), located at Fort Belvoir, Virginia, has developed a High Level Architecture (HLA) compliant version of it's "Paint the Night" (PTN) thermal scene generation simulation. "Paint the Night" provides a realistic electro-optics simulation, which is used by the Research and Development community and in Distributive Interactive Simulation (DIS) compatible

exercises. PTN provides the capability for real-time sensor effects, atmospheric effects, and other special effects as well as generation of a high-resolution synthetic thermal scene for ground and air applications.

PTN is composed of several physics based algorithms to provide the user with a natural and realistic real time thermal image. Currently, PTN includes: 3D modeling; 2D thermal texture generation; atmospheric effects; time of day effects; effects for first generation and second generation thermal sensors; optimized scene rendering; high fidelity terrain (down to one meter post spacing); and aspect-unique trees. The combination provides a state-of-the-art level of realism. On-going efforts are underway to expand PTN beyond the mid- and far-infrared regions into a true multi-spectral simulation while at the same time optimizing it for a desktop platform (versions of PTN are currently running on a Silicon Graphics O2). By using the Defense Research and Engineering Network (DREN), a high bandwidth/low latency network, imagery can be exported and controlled by remote users. Presently NVESD is exploring this exciting capability with the Mounted Maneuver Battle Lab at Fort Knox, Kentucky.

Obvious uses are for sensor prototyping and Simulation Based Acquisition applications. Other potential uses of these capabilities include multi-sensor target acquisition, orienteering, mission equipment battlefield assessment, development of tactics & doctrine, training tools, education, and entertainment. These techniques are expected to provide a significant impact on future thermal database development and generation. Increased fidelity provides DIS users with the tools needed to address many of the concerns of the R&D and Test and Evaluation communities. PTN easily integrates into disparate simulators and provides the DIS community with a greatly improved night scene simulation capability.

KEYWORDS: Sensor effects, graphics processors, PC based simulation

A00-140 TITLE: Dynamic Bandwidth, Delay, and Delay Variation Management for Supporting of Quality of Service

TECHNOLOGY AREAS: Information Systems, Sensors, Human Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Manager, Warfighter Information Network - Terrestrial

OBJECTIVE: Investigate, analyze, design, develop and test an efficient Integrated Services architecture to handle the integration of multimedia applications (voice, video and data) over the integrated Army tactical network with the capability to support predictable Quality of Service (QoS.)

DESCRIPTION: Increasing demand for inter-network access, technology advancement at both the desktop and the network, and increasing use of multi-media and other interactive technologies are burdening the core network devices and Local Area Network/Wide Area Network (LAN/WAN) boundary routers and switches in the commercial and Army tactical networks. Service quality will continue to suffer without QoS mechanisms or Class of Service (CoS) traffic classification schemes. QoS typically means users can define various levels or classes of service on their network (e.g. priority, type of service). QoS network essentially let users carve up their dedicated Internet access bandwidth into different priority classes. This lets users guarantee that certain applications, Universal Resource Locators (URLs) or Internet protocol (IP) addresses get a predefined amount of bandwidth and a predefined maximum delay, which provides better quality of service in handling voice, video and data traffic during network bottlenecks and peak traffic. Current Army tactical network is using best effort service to support all applications. That means all applications, real time and non-real time, get the same treatment, which may result in unacceptable quality of service to mission critical applications. Therefore, a necessity exists for the Army to conduct studies, perform tests and develop reliable, efficient, and embedded schemes to enhance effective system operations thus evolving US Army Communications systems.

PHASE I: Conduct feasibility study and trade of analysis, which will define an efficient architecture to handle the integration of voice video and data over the integrated Army tactical networks with predefined end-to-end QoS. The study will result in an overall design plan that includes specifications of the system architecture to achieve the required objectives.

PHASE II: Develop and demonstrate a prototype system in a realistic environment. Conduct testing to prove feasibility of the system to be developed in the tactical operating conditions.

PHASE III DUAL USE APPLICATIONS: This technology will provide the industries the ability to efficiently integrated real time and non-real time applications over the integrated LAN and WAN network with predefined QoS. The application is critical to the Army's Warfighters Information Network program. Product of this SBIR will also have application to any application requiring the transmission of large amounts of data or video traffic over a wireless link or wired networks with very high traffic.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Improvements in the QoS performance of Army Tactical Systems will greatly enhance the ability to perform telemaintenance and telemedicine functions greatly increasing the capability to support remote medicine and to bring casualty care more quickly.

REFERENCES: Joint Tactical Architecture (JTA) available at http://www-jta.itsi.disa.mil/jta/jtav3-final-19991115/finalv3.html

KEYWORDS: QoS, packet switch, Differential Service, RSVP, MPLS, IP, ATM, ToS, ISDN. PSTN

A00-141 TITLE: Scalability of Advanced Network Protocols

TECHNOLOGY AREAS: Information Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Manager, Warfighter Information Network - Terrestrial

OBJECTIVE: Develop a product which can be used to assist in evaluating the performance of large-scale communications networks on common desk top computers. The technical objective is to research and develop a capability to assess quantitatively up to 10,000 communications nodes which are mobile and operate isn a realistic military environment to include terain, propagation and other effects.

DESCRIPTION: Future military communications networks will be highly dependent upon sophisticated protocols. These protocols will route information among highly mobile users, be independent of a backbone infrastructure and provide wideband communications services. There are many initiatives in process both in the military and commercial sector addressing sophisticated protocols to suport ad hoc networks. A key evaluation criterion is how the protocols scale to large number of users. Current technology is computation intensive and requires cost prohibitive time to develop and perform. In addition current methods are unreliable and lack confidence in results. Technology advancements are needed to assist in the assessment.

Ad hoc networks are characterized by nodes with varying mobility patterns and limited bandwidth. Most transmissions require multiple hops from source to eventual destination. The growing use of wireless communications in the home, office, law enforcement, and military contexts indicates that such networks will span large areas and extend to include many thousands of units. The current generation of ad hoc routing protocols for unicast and multicast use a variety of techniques including distance vector, link state, reactive on-demand, and location based.

Methodologies and techniques to scale these networks are needed. However, there is relatively little understanding of their behavior as the network size is scaled up.

Unicast and multicast routing protocols that can be scaled up to networks with many thousands of heterogeneous nodes present a hard challenge particularly for traffic with strict Quality of Service (QoS). A thorough understanding of the scalability properties of future unicast and multicast protocols must be obtained; their shortcomings identified, and appropriate remedies proposed and demonstrated via detailed and validated assessments.

PHASE I: Develop methodologies and techniques for evaluating the characteristics of large networks of up to 10,000 nodes. Develop a prototype evaluation methodology, which demonstrates feasibility. Document results in a technical paper.

PHASE II: Building upon the results in Phase I develop an abstracted technique for a scaled ad hoc network of up to 10,000 nodes. The technique should have sufficient detail to determine the feasibility of performing assessments of scalability with a more complete network with the goal of performing the assessment in real time on common desktop type computers anticipated to be available in 2002 - 2005.

PHASE III DUAL USE APPLICATIONS: Develop a product which has the assessment capability into an integrated suite of evaluation tools which can be used by the military in evaluating tactical and strategic communications networks as well as by commercial telecomunications providers such as Internet Service Providers (ISP's), backbone communications providers and wireless communications network operators.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Design of an optimum network can only be achieved through a thorough understanding of the issues associated with scaling a network to its ultimate size. Through understanding of the network efficiencies can be obtained by optimum use of bandwidth thus minimizing the need for capital intensive infrastructure and reducing the operating and support costs by being able to rapidly tailor a network to a specific application. An optimum network will also provide higher levels of reliability and meet quality of service expectations.

KEYWORDS: communications, networks, protocols

U.S. Army Construction Engineering Research Laboratory (CERL)

A00-142 TITLE: Field-Portable Infrastructure Fiber-Reinforced Polymer Composite Inspection & Evaluation System using Ultrasound Technologies

TECHNOLOGY AREAS: Materials/Processes, Space Platforms

OBJECTIVE: Design, develop and demonstrate a portable fiber-reinforced polymer (FRP) composite inspection and evaluation system that can be used in the field to assess infrastructure composites. The system must utilize ultrasound technologies and must be capable of inspecting 1/2" thick glass, carbon and aramid reinforced polymer composite systems used as upgrades to existing infrastructure or as new structural elements (e.g. All-composite I-beam). The inspection and evaluation system should be able to identify flaws or damage 0.05" in size in multiple damage situations including debonding between composite and concrete/masonry substrate, delamination within the composite or cracking that can lead to incipient failure. Part of the inspection and evaluation system includes a simple cable-free, battery powered, hand-held device for rapid repair and replacement assessment of structural composites.

DESCRIPTION: Much work has focused on various techniques for the non-destructive inspection and evaluation (NDI/NDE) of fiber-reinforced composite systems. Many of these applications have focused on the inspection of metallic or non-infrastructure FRP composite systems (e.g. aerospace). The recent push to use FRP composites in a variety of infrastructure applications has driven the need to develop (or tailor) these technologies to meet the NDI/NDE requirements of infrastructure composites. However, most of the proposed systems to date involve bulky equipment and/or wiring that makes routine inspection and evaluation impractical in the field.

A field-portable, battery powered ultrasound inspection system would allow field engineers to routinely inspect FRP composite systems in a minimal amount of time. Ultrasonic technologies have been used extensively to inspect metallic welds and aerospace FRP composites by providing distributed damage information in A-, B- and C-scan modes. Such a system would also provide distributed QA/QC information and damage detection capabilities. A hand-held display of the inspection results must be able to identify the location and type of damage within the 0.05" resolution requirements specified in the objective. SBIR proposals must also meet the following five criteria: The system must 1) use ultrasound technologies with the ultrasound sensor completed contained within a single unit assessment system; 2) use battery power sufficient for continuous 14-day operation; 3) weigh 2.0 pounds or less and be 6" x 6" x 2" or less in size; 4) contain PCMCIA interface capabilities for data storage and later computer retrieval, and 5) be designed for the assessment of infrastructure composites and contain built-in infrastructure composite assessment tools with built-in alarms.

PHASE I: Develop and demonstrate the manufacturing techniques to fabricate a field-portable FRP composite NDI/NDE system based on ultrasound technologies. The system must contain a hand-held interface to provide the user with a quick assessment of an inspection. The technique must be validated on an FRP composite system conforming to the criteria established in the objective. Such a system will assist in establishing Army standards on inspecting infrastructure composites.

PHASE II: Develop a lightweight, portable infrastructure FRP composite NDI/NDE system. The prototype ultrasound inspection/evaluation system will be used to inspect an Army infrastructure FRP composite upgraded system. Equipment inspection and data assessment procedures are to be documented in a report.

PHASE III DUAL USE APPLICATIONS: Like the Army, other DoD branches are utilizing FRP composites for infrastructure applications. Therefore, the inspection and evaluation system developed in this SBIR offers enhanced inspection capabilities to the Triservices community. In addition, the entire civilian sector that utilizes FRP composites in a variety of aerospace, marine or sporting applications can benefit from the portability of this technology. Developing a technique that is portable and provides composite inspection and evaluation information, opens the market for further use of FRP composites in infrastructure. A hand-held inspection interface saves on the cost of lengthy FRP composite inspection analyses. This program will provide the principal researchers with a unique opportunity to develop a standard for the in-service inspection of infrastructure composites. OPERATING AND SUPPORT COST (OSCR) REDUCTION: A portable FRP composite inspection and evaluation system will allow the field to use FRP composites in infrastructure applications with confidence. Demonstrations using FRP composites have shown dramatic cost savings over traditional methods and materials. However, a lack of confidence in long term durability and inspection techniques has made designers and engineers reluctant to utilize these materials. This portable inspection and evaluation system will allow the field to take advantage of these cost savings by giving them the ability to asses the structural integrity of the FRP composite materials.

REFERENCES:

Klinkhachorn P., S. Nomani, W. Chatwiriya, U.B. Halabe and S. Petro. 1998. "Development of a Portable Ultrasonic Timber Properties Monitoring Device," IEEE Proceedings of Thirtieth Southeastern Symposium on System Theory (Cat No. 98EX148), New York NY, pp. 467-71.

Stanley B.D., L. Bustemante and J.C. Earthman. 1996. "Novel Instrumentation for Rapid Assessment of Internal Damage in Composite Materials," TMS Nondestructive Evaluation and Materials Properties III, Warrendale PA, pp. 97-100.

Long, E.R., S.M. Kullerd, P.H. Johnston and E.M. Madaras. 1990. "Ultrasonic Detection and Identification of Fabrication Defects in Composites," NASA Technical Report #CP3104, First NASA Advanced Composite Technology Conference, Seattle WA, 29 Oct - 01 Nov 1990.

Anastasi, R.F., A.D. Friedman, M.K. Hinders, and E.I. Madaras. 1997. "Nondestructive Evaluation of Damage in Stitched Composites using Laser Based Ultrasound," International Workshop on Structural Health Monitoring, Stanford CA, 18-20 September 1997.

KEYWORDS: sensor, structural health monitoring, fiber-reinforced polymer composite, infrastructure, and ultrasound technologies

A00-143 TITLE: Microencapsulated Phase Change Materials (MPCM) in Thermal Energy Systems

TECHNOLOGY AREAS: Materials/Processes, Space Platforms

OBJECTIVE: The objective of this work is to develop novel micro-encapsulated Phase Change Materials (MPCM) for use in PCM slurries. The PCM slurries will be employed in Thermal Energy Systems to reduce thermal losses, reduce initial construction costs and improve the fluidity and transient thermal behavior of the slurry through micro-encapsulation of the PCM.

DESCRIPTION: The use of novel Phase Change Materials (PCM), in either solid or encapsulated form, in heating and cooling systems has the potential of reducing initial system construction costs and ongoing distribution systems losses. PCMs produce a fundamental change in the fluid dynamics resulting in laminar flows. PCMs also provide a significantly increased heat transfer coefficient as compared to water. This allows thermal energy plants to reduce flow rates for comparable heating and cooling levels. In addition PCMs allow for either smaller pipes in new systems or increased thermal capacity for existing distribution systems. By operating at lower extremes of temperatures, savings will be realized for a reduced potential for transmission energy loss and/or a decreased need for insulation. The current problems associated with PCMs are heat exchanger fouling and maintaining fluidity of the PCM slurry. This research seeks to overcome these obstacles by microencapsulating the PCM to improve fluidity and heat transfer properties associated with the phase change.

PHASE I: A. Based on a survey of the current state of the art novel materials will be developed and optimized for microencapsulation PCMs. This includes development and optimization of candidate phase change materials with regard to their heat capacity, conductivity, material compatibility, heat transfer rate and fluid dynamics. Prime parameters include the Froude number, particle/pipe diameter ratio, particle diameter/boundary layer thickness ratio, and particle/fluid thermal conductivity ratio.

B. Perform laboratory bench scale experiments to optimize parameters for system wide application. Included in this effort will be the optimal sizing of the particles relative to the transport boundary layer thickness to achieve the greatest reduction in pressure drop. For system designs that normally employ a low temperature drop (i.e. small “delta-T”) and high flow the amount of PCM slurry loading will be investigated to determine if essentially identical pressure drops can be achieved relative to a pure, conventional working fluid. If achievable this would allow existing design tools and simulations to be used. Also investigated will be PCM slurry loading of system designs employing high temperature drops. It is expected that minimal loading will serve to relaminarize the flow while minimizing the impact on thermal density. This will in turn reduce the convective heat transfer coefficient and thus thermal losses associated with system wide distribution. Needed modifications of heat exchanger design will also be investigated to ensure turbulent flow conditions when PCM slurries contact heat transfer surfaces.

PHASE II: A. Perform a pilot scale test at an installation and quantitatively measure most critical performance parameters. This effort will include the production of adequate quantities of a prototype micro-encapsulated PCM material. A test plan for the pilot scale testing will be developed and will include full quantitative details of PCM performance evaluation. Included will be measurements of sensible heat transfer, both in transit and at delivery, as well as flow characteristics. The Phase II report will fully document the effort and include any and all start up or shut down problems. Also included in the report will be a detailed cost benefit analysis relative to current conventional technology as well as a preliminary commercialization plan.

PHASE III DUAL USE APPLICATIONS: This technology has the potential to increase efficiencies and reduce costs of heat transfer systems. This is applicable to thermal energy systems in both the federal and private sectors.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: To put the potential benefits in perspective, a simplified economic analysis based on data from Ft. Bragg and Ft. McClellan was done. In this analysis it was assumed that a relaminarized slurry flow has heat transfer characteristics similar to that of the pure fluid in laminar flow. This optimistic assumption was balanced by the use of a pessimistic estimate of the cost of the slurry based on using a MPCM consisting of a paraffin wax in a cross-linked polymer shell, which currently costs about $1000/gal and is expected to drop to about $100/gal in

production quantities. The results of this analysis indicate that the simple payback is in the range of 2.5 to 25 years, depending on which cost is used for the PCM material.

REFERENCES:

Kasza, K.E., and Chen, M. M., "Assessment of Impact of Advanced Energy Transmission Fluids on District Heating and Cooling Systems," Argonne National Laboratory, Argonne, Illinois, DE88 001589, September 1987.

Liu, K. V., Chois, U. S., and Kasza, K. E., "Measurements of Pressure Drop and Heat Transfer in Turbulent Pipe Flows of Particulate Slurries," Argonne National Laboratory, Argonne, Illinois, DE88 013622, May 1988.

Park, J. T., Mannheimer, R. J., Grimely, T. A., and Morrow, T. B., "Experiments on Densely-Loaded Non-Newtonian Slurries in Laminar and Turbulent Pipe Flows," Southwest Research Institute, San Antonio, Texas, DE88 006209, February 1988.

McLain, H. A., and Wasserman, D. M., "Test of WHDP at Fort Bragg, North Carolina," Oak Ridge National Laboratory, DOE contract # DE-AC05-84OR21400, February 1990.
Van Wylen, G. J., and Sonntag, R. E., "Fundamentals of Classical Thermodynamics," John Wiley & Sons, New York, 1978.

Colvin, D. P., Bryant, Y. B., Mulligan, J. C., and Duncan, J. D., "Microencapsulated Phase Change Material Heat Transfer Systems," Triangle Research and Development Corp., WRDC-TR-89-3072, August 1989.

KEYWORDS: Phase Change Materials, Thermal Energy Systems

U.S. Army Cold Regions Research and Engineering Laboratory (CRREL)

A00-144 TITLE: Electro-Osmotic Pulse Demolition of Concrete Structures

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: To develop a technology that weakens obsolete concrete structures for subsequent demolition with minimum use of machinery or explosives in an environmentally safe manner. The technology would apply to the demolition of such structures as obsolete missile silos, buildings, dams, etc.

DESCRIPTION: A method of demolishing concrete materials through the principle of electro-osmosis, a process that uses electric potential through a porous medium, such as clay or concrete, to move water across the electrical field. The electro-osmotic pulse (EOP) method entails applying a voltage waveform that reverses the polarity of the field across a ceramic coated anode embedded in the concrete portions of a structure and one or more cathodes in the ground or in the structure. The pulse assures continuity of flow, as moisture passes through the concrete in a controlled direction. The proposed technique would apply sufficient current and potential to cause dehydration of the concrete to substantially weaken the material and permit easy removal of the structure. This application of the technology is only in the conceptual phase and involves significant problems about delivering the required power into the concrete structure. No proof of concept exists even at a bench level.

PHASE I: Determine the electrical currents and potentials required to demonstrate feasibility of concept at the laboratory scale. If the concept is possible, develop and test on a small scale EOP system for demolition. Develop single-point and distributed electrodes and EOP controls. Determine through experiments and modeling the current and signal parameters that optimize demolition for various sizes and shapes of structures.

PHASE II: Study the effectiveness of the technology on a full-scale structural mockup or isolated structural segment. Upon successful demonstration on one structural type, e.g. a retaining wall, experiment with other configurations, e.g. walls, ground floor slabs, and elevated floor slabs. Document the effectiveness in such varied situations as aboveground and underground portions of the structure, and for walls, columns, and slabs. Provide narrative, specification, or process options for potential incorporation into manuals for concrete demolition.

PHASE III DUAL USE APPLICATIONS: Provide technology and manuals for commercial application that encompass a representative variety of demolition conditions. Provide training and expertise for contract demonstrations of the controlled demolition of 1) military structures, such as abandoned missile silos and control buildings and 2) civil works structures, such as concrete dams, buildings, etc.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Typical use of EOP demolition should result in the reduction of hundreds of equipment hours that would apply to the noisy mechanical demolition of structures.

REFERENCES: The following patents and references are relevant to the process:

RELEVANT PATENTS

Acar, Yalcin. Electrochemical stabilization of soils and other porous media, Pat. No.: 5,616,235. Filed 97/4/1.
Chang, Hsueh-Rong; Su, Tah-Mun. Surfactant Augmented In-Situ Removal of PCB's from Soil by Electro-osmosis, Pat. No.: 5,240,570; Assignee: General Electric Company. Filed: 92/01/29.
Christenson, Lowell B. Method of Directing Water by Electro-Osmosis to an Electrically Conductive Pile, Pat. No: 4,305,800. Filed: 81/01/13.
Fremont, Henry A.; Dorman, William C. Continuous Dewatering Apparatus. Pat. No.:4,671,874; Assignee: Champion International Corporation. Filed: 82/03/15.
Fremont, Henry A.; Dorman, William C. Continuous Dewatering Method, Pat. No.: 4,755,305; Assignee: Champion International Corporation. Filed: 86/04/11.
Kristiansen, Hans. Method for Dehydrating Capillary Materials, Pat. No.: 5,755,945; Assignee: Electro Pulse Technologies of America, Inc. Filed: 96/10/11.
Marks, Robert E.; Acar, Yalcin B.; Gale, Robert J. In-Situ Bio-Electrokinetic Remediation of Contaminated Soils Containing Hazardous Mixed Wastes, Pat. No.: 5,458,747; Assignee: Board of Supervisors of Louisiana State University and Agricultural and Mechanical College. Filed: 96/06/03.
Miller, John B. Method for Electrochemical Treatment of Porous Building Materials, Particularly for Drying and Re-Alkalization, Pat. No.: 5,015,351; Filed: 89/06/09.
Oppitz, Hans. Electro-Osmotic Movement of Polar Liquid in a Porous Structural Material, Pat. No.: 4,600,486; Assignee: ELTAC Nogler & Daum KG. Filed: 84/10/26.
Utklev, Kjell. Method and Apparatus for Controlling the Relative Humidity in Concrete and Masonry Structures, Pat. No.: 5,368, 709; Assignee: Elcraft A/S. Filed 94/4/12.

RELEVANT REFERENCES

Cairo, George; Larson, Dennis L; Slack, Donald C. Electro-osmotic removal of nitrates from soils. Management of Irrigation and Drainage Systems: Integrated Perspectives Manage Irrig Drain Syst Integr Perspect. Publ by ADCE, New York, NY, USA, 08-1998. Pg. No: 629-635.
Eikerling, M.; Kharkats, Yu I.; Kornyshev, A.A.; Volfkovich, Yu M. Phenomenological theory of electro-osmotic effect and water management in polymer electrolyte proton-conducting membranes. Journal of the Electrochemical Society, 1993. V 145, No 8. Pg. No: 2684-2699.
Gazbar, S.; Abadie, J.M.; Colin, F. Combined action of electro-osmotic drainage and mechanical compression of sludge dewatering. Water Science & Technology, 08-1991. V 30, No. 8, Pt. 8. Pg. No: 169-175.
Gedalin, Konstantin. Electro-osmotic oscillations. Physica D., 12-1997. V 110, No 1-2. Pg. No: 154-168.
Glasstone, S., Textbook of Physical Chemistry, 2d ed., D. Van Nostrand Company, Inc., Princeton, NJ, 1946.
Ho, Sa V.; Athmer, Christopher J.; Sheridan, Wayne P.; Shapiro, Andrew P. Scale-up aspects of the Lassagna TM process for in situ soil decontamination. Journal of Hazardous Materials, 08-197. V 55, No 1-3. Pg. No: 39-60.
Lenney, J.P.; Goddard, N.J.; Morey, J.C.; Snook, R.D.; Fielden, P.R. Electro-Osmotic flow system with integrated planar optical waveguide sensing. Sensors & Actuators B-Chemical, 02-1995. No 1-3, Pt. 2. Pg. No: 212-217.
Mishchuk, N.A. Electro-osmosis of the second kind near the heterogeneous ion-exchange membranes. Colloids & Surfaces A-Physicochemical & Engineering Aspects, 06-1993. V 140, No 1-3. Pg. No: 75-89.
Schoeman, J. J.; van Staden, J. F. Electro-osmotic pumping of sodium chloride solutions. Journal of Membrane Science, 04-1996. V 132, No 1. Pg. No: 1-21.
Shang, J Q. Electrokinetic dewatering of clay slurries as engineered soil covers. Canadian Geotechnical Journal, 08-1997. V 34, No 1. Pg. No: 78-86.
Shang, J Q.; Lo, K Y. Electrokinetic dewatering of phosphate clay. Journal of Hazardous Materials, 03-1997. V 55, No 1-3. Pg. No: 117-133.
Tikhomolova, K.P., Electro-Osmosis, Ellis Horwood Limited, Chichester, West Sussex, England, 1993.
Van Gassen, Wim; Sego, D C. Electro-osmosis in a frozen soil. Cold Regions Science & Technology, 09-1998. V 19, No 3. Pg. No: 253-259.
Vane, Leland M.; Zang, Gwen M. Effect of aqueous phase properties on clay particle zeta potential and electro-osmotic permeability: Implications for electro-kinetic soil remediation processes. Journal of Hazardous Materials, 08-1997. V 55, No 1-3. Pg. No: 1-22.
Weng, D.; Wainright, J S.; Landau, U.; Savinell, R F. Electro-osmotic drag coefficient of water and methanol in polymer electrolytes at elevated temperatures. Journal of the Electrochemical Society, 08-1997. V 143, No 4. Pg. No: 1260-1263.
Yoshida, H. Practical aspects of dewatering enhanced by electro-osmosis. Drying Technology, 1994. V 11, No 4. Pg. No: 787-814.
Zawodzinski, Thomas A.; Davey, John; Valerio, Judith; Gottesfeld, Shimshon. Water content dependence of electro-osmotic drag in proton-conducting polymer electrolytes. Electrochimica Acta,08-1997. V 40, No 3. Pg. No: 297-302.

KEYWORDS: electro-osmosis, demolition, concrete, structures

Edgewood Chemical Biological Center (ECBC)

A00-145 TITLE: Nontoxic Biodegradable Nanomaterials and Biomaterials Signature Reduction

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop nontoxic nanomaterials and/or biologically derived nontoxic fibers that can be used as aerosols to attenuate electromagnetic radiation.

DESCRIPTION: High aspect ratio fibers and flakes composed of electrically conductive materials are known to attenuate electromagnetic radiation in the millimeter and infrared regions of the spectrum, respectively. Examples include conductive metal flakes for IR screening, conductive carbon fibers or metal coated fiberglass chaff for millimeter screening, and submicron diameter conductive filaments or whiskers for broadband screening. In the first and last of these examples increased screening efficiency is generally associated with increased aspect ratio (i.e. very thin flakes and very long fibers). Aerosolization of these materials produces an obscurant cloud, or "smoke screen" that can protect warfighters from weapon systems based on electromagnetic sensors. (See Optical Engineering 22(1)071-077, 1983.) Often incorporation of the same particles in films and coatings can provide a low observable effect, reducing the target signature of assets to protect them from threat sensors. Current obscurant materials suffer from high cost, inhalation toxicity, environmental impact and non-optimal performance. Recent advances in nanotechnology, biotechnology and genetic engineering, particularly in the areas of biotics, biomimetics, and self-structuring materials provide new opportunities for the design and manufacture of optimized obscurant materials. A major contribution to the figure of merit for smoke materials is mass extinction coefficient at the wavelength(s) of interest. The goal of this topic is to reach extinction coefficients exceeding 4m2/g . The advantages of biologically derived materials are particularly noteworthy from the standpoint of toxicology and environmental impact. Biological materials are also of significant interest because of the well-controlled uniformity between particles, the possibility of product tailoring via bioengineering and the

potential for manufacture via bioprocessing. In use these materials would be aerosolized via munitions, pyrotechnics, or smoke generators. Volume, weight and attainable dissemination efficiency are important considerations and a system which takes advantage of atmospheric materials is a significant bonus. An example of taking advantage of atmospheric materials is the phosphorous smokes, in which dispersed phosphorous reacts with atmospheric constituents to yield, by weight, more screening material than was carried to the battlefield.

PHASE I: Demonstrate the technology for manufacturing materials with appropriate physical parameters and conduct initial dissemination and attenuation screens. Identify general toxicity and environmental effects. The deliverables for Phase I will be a report on the manufacture process and materials characteristics, including the potential for parametric control of particle morphology, and small (0.5 gm or 1cc) quantities of the materials for evaluation.

PHASE II: Optimize material based on attenuation, toxicity, environmental compatibility and price. Scale-up to production of kilogram quantities of optimized material. Forecast ultimate manufacture costs. Deliverables for Phase II will be a comprehensive final report and kilogram quantities of optimized materials.

PHASE III DUAL USE APPLICATIONS: Phase III will involve final optimization, testing, scale-up and packaging. Dual use will include low observable and stealth applications, primarily of a military nature. In the commercial sector applications will include powder manufacturing applications, such as powder metallurgy and nanocrystalline ceramics, in which nanoparticulate precursors provide valuable controls over product characteristics. There is potential for application in the microelectronic field where nanowires are critical to the continuing miniaturization of components.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Reducing cost, improving performance, eliminating toxicity and reducing environmental impact will provide significant reductions in the cost of battlefield operation by requiring less material, less expensive material, and fewer logistic expenses associated with smoke operations. Resultant increased survivability of assets provide additional savings. Success in this project will provide operational capabilities that are safe and cost effective as training materials as well, eliminating the need for smoke items that are specific to training purposes and realizing associated cost reductions. Similar cost reductions can be expected from the applications of this technology to signal reducing coatings.

KEYWORDS: biomaterials, fibers, biotics, obscurants, nanomaterials, nanofibers, nanowhiskers, obscurants

A00-146 TITLE: Stabilization of Enzymes for the Destruction of Toxic Materials and Chemical Agents

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: To develop methods for the protection and stabilization of enzymes, which can be used to degrade toxic materials and chemical threat agents or in detection of toxic materials.

DESCRIPTION: The potential utility of enzymes and biocatalysis in the detoxification of contaminated surfaces and toxic spills is widely accepted.1,2 Several factors limit the practicality of the broad employment of enzymes as decontaminants or in detectors. The acute sensitivity of enzymes to environmental conditions is the foremost shortcoming. The development of a mechanism to protect and stabilize enzymes from adverse conditions is desired. Relevant environmental factors detrimental to enzyme systems include enzyme oxidation and alkylation as well as deviations from optimal pH conditions for enzyme activity. Numerous enzymes having catalytic activity on chemical warfare agents (G-series and V-series agents) have been isolated. The susceptibility of enzymes to alkylation by mustards or other alkylating agents critically limits their practical utility as decontaminants or as a means of protection from chemical warfare agents. Mustards are reported to react with many functionalities within proteins, including carboxyl, thiomethyl, sulfhydryl, and amino groups depending upon environmental conditions such as pH or temperature.3 These modifications cause numerous changes in a protein's physico-chemical properties including increased sulfur content, altered isoelectric points, and enhanced susceptibility to denaturation. Specifically the catalytic activity and substrate specificity of enzymes needs be retained in the presence of mustard type alkylating agents and oxidizing bleaches. Oxidative solutions such as traditional decontaminants including hypochlorite bleaches and emulsions are commonly used to detoxify surfaces.4,5 Enzymes may be used with oxidative solutions for the degradation of agents that are not enzyme substrates. Unfortunately many enzymes are susceptible to oxidation and are denatured in the presence of bleaches. The goal of this work would be to develop methods using approaches such as PEGylation, protein cross-linking or nanoencapsulation for the protection and stabilization of enzymes being used for destruction of toxic materials and threat agents.

PHASE I: Design a protection vehicle for enzymes known to have potential utility in decontamination. The proposed research must address a). resistance to pre-incubation with and exposure to mustard and other alkylating agents while defining limitations with respect to mustard concentration and exposure time, b). feasibility of incorporating enzymes within oxidative solutions for the decontamination of toxic materials, and c). broadening the pH range acceptable for enzyme catalysis.

PHASE II: Assess the performance of the stabilized enzymes on chemical warfare grade agents including Sarin, Soman, Tabun, and VX in the presence of Mustard (HD). This phase requires implementing live agent testing.

PHASE III DUAL USE APPLICATIONS: Phase III includes identification and development of conditions for utilization of the protected enzyme systems with current reactive chemistries. The catalytic activity and substrate selectivity of enzymes make them interesting catalysts for a broad variety of industrial and commercial processes. An effective means of minimizing protein denaturation due to chemical modification via oxidation and alkylation or due to extremes in pH would have far-reaching implications. Organophosphorus compounds are generated in substantial quantities in the private sector and have lead to the contamination of ground water from organophosphorus pesticides or waste streams generated by industry. The similarity of chemical agents to commercially important organophosphorus products means that the techniques developed in this topic are directly applicable to industry. The modified enzymes would be commercially relevant to the destruction of organophosphorus pesticides and using enzymes in organic synthesis because of their enantiomeric selectivity.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Current decontamination systems utilize rather hazardous reactive solutions (DS2) which require a significant cost in transport, maintenance, and storage. Enzyme-based systems would consist primarily of dry powders which would be added to available water or water-based liquids in the field. Since they will have long storage life without special handling, it will greatly reduce storage, maintenance and transportation costs. Since they would be inherently less hazardous operational expenses would also be reduced.

REFERENCES: Longwell, P. (Chairman) National Research Council Commission on Engineering and Technical Systems. 1993. Alternative technologies for the destruction of chemical agents and munitions. 2101 Constitutions Ave., Washington, DC.
1. (a) Cheng, T.-c., Rastogi, V.K., DeFrank, J.J., and Sawaris, G.P., 1998, "G-type Nerve Agent Decontamination by Alteromonas prolidase", Annals of the New York Academy of Sciences, 864, 253-258; (b) K.E. LeJeune, J.R. Wild, and A.J. Russell, 1998, "Nerve Agents Degraded by Enzymatic Foams", Nature, 395, 27-28; and (c) K.E. LeJeune and A.J. Russell, 1999, "Biocatalytic Nerve Agent Detoxification in Fire Fighting Foams" Biotechnology and Bioengineering, 62, 659-665.
2. Papirmeister, B. et al., Medical Defense Against Mustard Gas (1991) CRC Press, Inc. p. 111-114.
3. Yu-Chu Yang, James A. Baker, and J. Richard Ward, 1992, "Decontamination of Chemical Warfare Agents", Chem. Rev., 92, 1729-1743.
4. Yu-Chu Yang, 1999, "Chemical Detoxification of Nerve Agent VX" Acc.Chem.Res. 32, 109-115.

KEYWORDS: Oxidation, Alkylation, Mustard, Protein modification, Enzymes, Chemical warfare agent, Organophosphate, Hypochlorite, Bleach.

A00-147 TITLE: Compact, Lightweight, Modular Infrared Spectroscope For Chemical And Biological Agent Detection

TECHNOLOGY AREAS: Materials/Processes

Objective: Develop a compact infrared spectrometer that can be used for point and standoff chemical and biological detection

Description: Advanced warning of the presence of chemical and biological materials may be monitored spectroscopically using instruments that operate in the infrared region. However, currently fielded sensors that take advantage of the infrared spectral signatures of chemical agents to effect detection are heavy, bulky, and expensive. Compact, lightweight sensors are fielded, but these are point samplers that must be in the presence of the agent in order to effect detection and warning. Recent advances in materials science and technology present opportunities for the design and construction of a modular, compact spectrometer that can perform both functions - point sensing and remote sensing - alleviating the need for two or more types of sensors in the inventory. The sensor may either employ a local source and multipass cell for point sensing, or switch to passive remote sensing employing collection optics. Alternatively, a small, unmanned aerial vehicle may be employed to transport the sensor in point sensing configuration to probe the atmosphere for contamination.

PHASE I: Demonstrate the technology and design and model a proposed spectrometer. Model the ability of the spectrometer to record infrared spectra of gases and aerosols using both a local sampler including, for example, a source and detector, and using an optical interface for passive remote sensing, such as an infrared telescope. The deliverable from phase I will be a report of the proposed design of the spectrometer and a validation of the principle of operation in the form of actual experimental data and system performance modeling.

PHASE II: Construct and test the hardware platform, and develop the construction and component selection so as to propose a means of large-scale manufacture of inexpensive multiple modular sensors. Develop algorithms for detection of chemical and biological agents with the spectrometer in both point and standoff modes of operation.

PHASE III DUAL USE APPLICATIONS: In the operational military setting, the end state should be a competitive device capable of autonomous monitoring for chemical and biological agents in a modular system, easily converted to either point or remote sensing operation with minimal operator knowledge and training. This device would be of immediate value to the chemical industry for process monitoring, to educational institutions looking for low-cost spectrometers for programs in chemistry and remote sensing, and to a number of government and state agencies and emergency with a requirement for a compact field spectrometer for chemical identification.

OPERATING AND SUPPORT COST REDUCTION (OSCR): By replacing several types of devices currently in the chemical detection inventory with a single modular, convertible sensor, the innovative compact infrared spectrometer would reduce costs involved in outfitting troops with both remote and point detection and alarm systems for chemical and biological agents.

REFERENCES: Hoffland, L.D., Piffath, R.J., and Bouck, J.B. "Spectral signatures of chemical agents and simulants," Opt. Eng, 24, 982 (1985); Naumann, D., Schultz, C.P., and Helm, D. "What can infrared spectroscopy tell us about the structure and composition of bacterial cells?" in Infrared Spectroscopy of Biomolecules, H.H. Mantsch and D. Chapman, eds., Wiley-Liss, New York, 1996.

KEYWORDS: Chemical and Biological detectors, Chemical and Biological agents, infrared spectrometry, IR spectrometer.

U.S. Army Missile Research, Development, and Engineering Center (MRDEC)

A00-148 TITLE: Mixing And Combustion Of Gel Propellants

TECHNOLOGY AREAS: Materials/Processes, Weapons

OBJECTIVE: Develop experimental and modeling capabilities to characterize the mixing and combustion of gels in a bipropulsion engine. The goal is to correlate the spray and mixing patterns with engine test results including chamber pressure, thrust, and specific impulse.

DESCRIPTION: The key elements of this program are to: 1) develop the experimental capability to characterize the spray and combustion patterns within gel engines at 14 MPa and 3000° C; and 2) to develop a model that correlates the mixing process with engine test results.

PHASE I: Develop a top level model of gel propellant mixing including gel flow, spray development, mixing, combustion, and flow through the combustion chamber, throat, and nozzle. This will be semi-quantitative composed of approximations and possibly unsubstantiated assumptions of the processes involved. Using the results of this model to identify key parameters, design a test apparatus that will accurately determine component mass concentrations and temperatures within the combustion zone.

PHASE II: Refine the model to include quantitative and substantiated descriptions of the processes. Fabricate and validate the operation of the test apparatus designed in Phase I. Characterize the mixing and combustion of gel propellants at the previously stated conditions. Use the test results to confirm or correct the quantitative descriptions and update the model. Confirmation and evaluation testing will be performed to demonstrate the updated model.

PHASE III DUAL-USE APPLICATIONS: Gel bi-propulsion systems can be used by NASA on launch vehicles, spacecraft, and satellites. They are applicable for simple boosters as well as where variable thrust is required. The increased safety of gels over hypergolic liquids decreases the hazards of manned space flights. The versatility of gel engines can reduce the number of engines on spacecraft. For instance, a single engine could be used for changing from low to high earth orbits as well as precision positioning of the satellite for operational purposes, such as detecting leaking dams or mapping crop infestations.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: A verified tool that optimizes gel engine designs will minimize the cost and schedule for the development of a single advanced missile that could replace several single use systems currently deployed. Such a system would greatly reduce logistics and training costs. The precision of the thrust control provided by gel engines increases kill probability and multi-mission flexibility, thereby reducing the number of missiles needed in the arsenal. The savings to the government could exceed 1 billion dollars if a single missile using a gel propulsion system replaces several existing systems. If multiple systems are to be retained, a common set of engine hardware could be horizontally integrated into TOW, Javelin, Hellfire, and possibly Stinger type missile systems.

REFERENCES:

George P. Sutton "Rocket Propulsion Elements: an introduction to the engineering of rockets" 6th Edition, John Wiley & Sons, 1992

KEYWORDS: Gelled Propellants, Propellant Mixing, Combustion Efficiency, Modeling

A00-149 TITLE: Development of Universal, Inexpensive Optics for Uncooled Infrared Commercial and Military Applications

TECHNOLOGY AREAS: Sensors, Electronics

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Executive Officer, Tactical Missiles

OBJECTIVE: Development of a universal, optical test bed specifically designed for uncooled infrared technology for use in Army aviation and missile platforms, missile systems, and commercial applications. The test bed will demonstrate state-of-the-art performance of emerging technology advancements ongoing at DARPA with a major emphasis on affordable optical packages for use in both the commercial and military sectors.

DESCRIPTION: Uncooled imaging infrared technology has emerged in recent years with numerous applications in the commercial industry. Transportation, law enforcement, and surveillance industries are leading the way in applying this novel technology. However, the use of uncooled detectors in military applications has been slow to emerge primarily due to performance limitations and the required use of expensive optical designs. DARPA has an ongoing initiative to improve detector-level performance, but the need still exists regarding the design and development of inexpensive optics. The development of a universal, optical test bed will exploit a more conventional approach to optics design coupled with improved detector performance enabling a broader use of the technology in commercial sectors, and providing for the first time a stronger basis for satisfying military requirements. Results of this effort will provide a more economical approach to satisfying commercial needs and the Army's mission objectives in the area of infrared sensors.

PHASE I: Investigate innovative techniques for inexpensive long wavelength infrared optics for use in Army uncooled infrared applications. Develop a design approach to standardize optical interface requirements among the industries' leaders in uncooled technology and, establish technology transfer requirements with DARPA.

PHASE II: Using the results of Phase I, design, develop, and demonstrate to the U.S. Army Aviation and Missile Command an universal, optical test bed demonstrating the uncooled infrared performance improvements from DARPA, and novel / configurable optics packages for system specific application on commercial and Army sensors.

PHASE III DUAL-USE APPLICATIONS: The desire to utilize uncooled infrared technology among commercial and military applications is self-evident. The ability to improve performance while lowering optical costs only strengthens the desire to exploit this novel technology.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: One of the major benefits of uncooled technology is the ability to operate a passive, imaging infrared sensor without the aid of open or closed cycle cooling, which require Nitrogen or Argon gases. The temperature stabilization for this technology is achieved through inexpensive, reliable thermal electric coolers. For those thermal-imaging systems that use closed cycle cooling, the mean time before failure is driven by the life of the cooler. For those systems that utilize open cycle cooling, only one opportunity exists to operate the sensor. Once cooling is initiated, the system must fired or expended due tot he limited gas supply provided for the sensor. Uncooled technology eliminates the need for open and closed cycle cooling, resulting in a tremendous impact toward reducing operating and support cost for thermal imaging sensors.

REFERENCES:

1) "Sensitivity Improvements in Uncooled Microbolometer FPAs," 1999 Meeting of the IRIS Specialty Group on Passive Sensors, Volume 1, May 1999, Unclassified.

2) "Laboratory Evaluations of competing Uncooled FPA Technologies," 1999 Meeting of the IRIS Specialty Group on Passive Snesors, Volume 1, May 1999, Unclassified.

3) "Microbolometer Uncooled Infrared Camera with 50 mK NEDT," 1998 Meeting of the IRIS Specialty Group on Passive Sensors, Volume 1, July 1998, Unclassified.

4) "Modeling and Analysis of Uncooled IR Applications," DARPA Conference on Advanced Imaging Devices, March 1999, Unclassified.

5) "Microbolometer Technology Capabilities," DARPA Conference on Advanced Imaging Devices, March 1999, Unclassified.

6) "ARL Uncooled Infrared Detector Program," DARPA Conference on Advanced Imaging Devices, March 1999, Unclassified.

KEYWORDS: Imaging Infrared, Uncooled Infrared Technology, Microbolometers, Long Wavelength Infrared optics.

A00-150 TITLE: Sensor Data Fusion for Target Classification and Identification

TECHNOLOGY AREAS: Information Systems, Sensors

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Manager Shorad

OBJECTIVE: The ability to provide beyond visual range, positive hostile, Non-Cooperative Target Recognition/Identification (NCTR) has become mission critical for all U.S. Army air defense weapons systems. The complexity of this problem is enormous due to the high confidence that the NCTR ID decision must achieve, to the diverse target set that the NCTR algorithm must work against, and to the widely varying battlefield situations that the NCTR must operate in. The objective of this topic is to solve the difficult air defense target ID problem by developing and implementing a real time, robust data fusion algorithm for Non-Cooperative Target Recognition/Identification (NCTR) of airborne targets. The airborne target set for the ID fusion includes cruise missiles, Unmanned Aerial Vehicles (UAVs), Tactical Ballistic Missiles (TBMs), air-to-surface missiles, rockets, helicopters, and aircraft (commercial and military). This algorithm should be able to accept target identification information from multiple sensors and sources, which use different NCTR techniques. The data fusion process should improve the probability of correct target identification, reduce the time to ID targets, and increase the range at which the ID occurs.

DESCRIPTION: Extensive NCTR research and development has been done for many different sensor systems with good results. However, to achieve desirable performance (long range ID, short time to ID, and high probability of correct ID) these individual ID techniques require that the threat target operate within a certain parameter envelope. Given a specific target behavior, one technique may have distinct advantages over other techniques to make a positive target ID. Therefore, fusing data from multiple sources will provide complete ID capability regardless of the target characteristics. Additionally, fusing lower confidence target ID data from multiple sensors will produce one higher confidence target ID at longer ranges and in less time. The goal of this topic is to develop an algorithm that will improve the probability of correctly identifying targets by fusing information obtained from multiple NCTR techniques.

PHASE I: This phase will consist of the designing and developing a prototype fusion algorithm for target identification. The stand alone target ID techniques to be fused should include, but are not limited to, High Range Resolution (HRR) radar, Radar Signal Modulation (RSM), and Electronic Support Measures (ESM).

PHASE II: The contractor shall implement the algorithm developed in phase I. Experiments to exercise the prototype algorithm will be conducted using Government furnished ID data. The purpose of these experiments will be to evaluate performance for different prototype algorithm configurations and different target loading. This evaluation would be used to implement algorithm improvements.

PHASE III DUAL-USE APPLICATIONS:

This technology may be commercially used for air traffic control. Current air traffic control systems rely on interrogation of target transponders, which respond with aircraft identification information. Because the NCTR fusion technology does not rely on transponder communications to establish positive aircraft identification, it would provide the ability to make positive aircraft identification in the event of transponder failures. This technology may also be used for medical diagnostic purposes by providing the ability to fuse data from multiple imaging and diagnostic techniques to achieve a more accurate and timely diagnosis.

OPERATING AND SUPPORT COST (OSCR) REDUCTION:

More reliable target identification achieved by this technology will enable better battle field resource management. This technology will allow the user to match available weapon systems to the given threat. Improved resource management will provide cost savings by enabling the execution of a given air defense mission with minimal resource expenditure.

REFERENCES:

1) B.V. Dassarathy, "Information Fusion Benefits Delineation on Off-Normal Scenarios", Proceedings of the SPIE, Sensor Fusion: Architecture, Algorithms and Applications III, Volume 3719, pp. 2-13 Apr 99.

2) B.V. Dassarathy, "Decision Fusion Strategies for Target Detection with a Three-Sensor Suite", SPIE volume 3706, pp. 14-25, 1997.

3) Proceedings of the SPIE, Automatic Target Recognition IX, Volume 3720, April 1999.

KEYWORDS:

Data Fusion, Non-Cooperative Target Recognition.

A00-151 TITLE: Semi-active Laser Simulator for Multi-mode Hardware-in-the-Loop Simulations

TECHNOLOGY AREAS: Information Systems, Sensors, Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Manager, Air to Ground Missile Systems, Tactical Missils Program Executive Office

OBJECTIVE: The objective of this topic is the development of a novel laser projection system for dual-mode hardware-in-the-loop (HWIL) testing of seekers which utilize near-infrared (NIR) semi-active laser (SAL) for acquisition and terminal homing. In addition to generating the SAL target returns, the proposed technique must be compatible with a flight motion simulator. In addition to military uses, such technology would be applicable to many commercial uses involving the development and testing of collision avoidance systems and property protection systems.

DESCRIPTION: Emerging missile weapon systems are using common-aperture, multi-mode seekers for acquisition and terminal homing. These seekers use a combination of two or more sensor technologies including radio frequency (RF), millimeter wave (MMW), imaging infrared (IR), laser detection and ranging (LADAR), and SAL seekers.

A new capability must be developed to support realistic HWIL testing of seekers which utilize a SAL sensor in combination with other sensor technologies. The SAL projector must be capable of generating a realistic in-band scene that is indiscernible from the real-world scene as viewed by a SAL sensor. The SAL projector must also be capable of projecting this scene in combination with an IR projector and/or in an anechoic chamber to support multi-mode testing. Anticipated SAL projector requirements are: a. 200 Hz frame rate b. 1024x1024 spatial resolution c. > 400:1 contrast ratio, d. 8-bit amplitude resolution, e. realistic intensity levels, f. realistic temporal waveforms, g. variable spot size, and h. interface to a real-time control computer.

PHASE I: Explore the feasibility of developing a SAL projector system, which meets the specifications above. Evaluate innovative technologies which may be used to build the SAL projector system. Perform trade-off analysis to determine the best approach for each subsystem, and develop a preliminary design for the SAL projector system.

PHASE II: Perform detailed design of the concept selected in Phase I, and fabricate a prototype SAL projector system. Demonstrate the SAL projector technology and characterize its performance in an actual HWIL environment.

PHASE III DUAL-USE APPLICATIONS: The SAL projector technology developed under this effort may be used in manufacturing/production testing as well as flight line testing of multi-mode weapon systems. In addition, commercial applications for this technology might be found in the automobile, home security, and air craft industries. The novel SAL projection technique developed under this topic would provide an excellent test bed to support the development of single mode and multi-mode collision avoidance systems and intrusion detection systems.

OPERATING AND SUPPORT COST (OSCR) REDUCTION:
This technology would fit within the OSCR by drastically reducing the typical cost for the development of state of the art weapon systems by allowing testing of critical hardware and software components in a non-destructive manner. This repeated virtual flight testing can greatly increase the speed of system development thus reducing procurement costs. Stockpile reliability testing can be achieved in such a simulation facility in a non-destructive manner, thus allowing the flight article to be re-introduced the inventory with a substantial cost savings to the government.

REFERENCES:

1. Technologies for Synthetic Environments: Hardware-in-the-loop Testing, Proc. SPIE, Vol. 2741, April 1996.

2. Technologies for Synthetic Environments: Hardware-in-the-loop Testing III, Proc. SPIE, Vol. 3368, April 1998.

3. Technologies for Synthetic Environments: Hardware-in-the-loop Testing IV, Proc. SPIE, Vol. 3697, April 1999.

KEYWORDS: SAL Projector, Laser, Near-Infrared, Hardware-in-the-loop simulation, multi-mode, seeker

A00-152 TITLE: Selective Application of Electromagnetic Interference (EMI) Protection and Electromagnetic Compatibility (EMC) Conformal Coatings Onto Circuit Card Assemblies

TECHNOLOGY AREAS: Materials/Processes, Electronics

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Executive Officer, Air and Missle Defense

OBJECTIVE: Develop material formulations and low cost dispensing processes for electronic circuit card assembly (CCA) conformal coatings that have electromagnetic interference (EMI) protection and electromagnetic compatibility (EMC) enhancement capabilities.

DESCRIPTION: Conformal coatings are commonly applied to military CCAs to provide protection from moisture, contaminants, and chemicals that may be encountered in operation or storage conditions. Previous work performed for the Army by Penn State resulted in polymers with EMI shielding properties in the 40-45 dB attenuation range that are compatible with CCAs. Incorporating EMI protection capabilities into conformal coatings could potentially reduce shielding requirements by 50%, reducing mass and volume in manportable and other military systems. The coatings may also eliminate the need for additional shielding that may be required as lower voltage (ie more EMI sensitive) integrated circuits are designed into military systems.

New formulations of the polymer are needed to produce a 100% solids mix, which will permit selective coating application on the surface of the CCA. Selective application will reduce or eliminate the need for time consuming and expensive masking/demasking steps. What is needed is the pairing of EMI protective conformal coatings with advanced methods of material formulation and deposition to provide electromagnetic protection as well as environmental protection to military CCAs.

PHASE I: Determine material development status of EMI shielding polymer materials. Experiment with innovative formulations that provide 100% solids content with elasticity and viscosity characteristics that permit selective thickness and area control via air-assisted nozzle deposition. Curing methods should be low temperature heat and/or ultraviolet. Curing techniques should allow for trends in electronic packaging size reductions and density increases. Conduct tests to show properties of material deposited on a sample CCA to include thickness control, adhesion, ease of removal for CCA repair, moisture/solvent resistance, and EMI attenuation. Demonstrate compatibility with a commercially available conformal coating deposition system. Determine commercial applicability and potential sales estimates beyond military system usage.

PHASE II: Finalize formulations for best tradeoff between performance and ease of application. Enhance shielding capabilities to 60dB or greater via investigation of multiple coatings/formulations. Work with materials supplier and coating equipment vendor to optimize material characteristics and synthesis cost. Demonstrate material coating application/curing on a fabrication or repair line owned by a DoD Depot or prime military systems contractor. Fabricate test vehicles to perform baseline environmental/electromagnetic testing versus control coating(s).

PHASE III DUAL-USE APPLICATIONS: Conformal coating is applied to nearly all-military circuit card assemblies during fabrication. This topic would increase performance and decrease metal shielding requirements (reduction in weight and volume) by the innovative addition of EMI shielding capabilities within the conformal coating. New and improved application techniques will be developed to assure low cost, industry compatible coating deposition. Commercial applications are numerous, but the largest markets are in the cellular phone industry (reduce reception interference) and in laptops and desktop computers (reduce radio frequency emmissions).

OPERATING AND SUPPORT COST (OSCR) REDUCTION: The materials and techniques developed in this topic could allow military depots to provide a higher performance conformal coating after repairing/refabricating CCAs.

REFERENCE:
1. "Contemporary Conformal Coating Application Techniques - 'Swirl It On'", D. Selestak, et al, Nordson Corporation web site (http://www.nordson.com/electronics/reprints.htm)

KEYWORDS:
conformal coating
electromagnetic interference (EMI)
electromagnetic compatibility (EMC)
selective deposition

A00-153 TITLE: Demonstration of Advanced Detection Techniques Against Low Probability of Intercept Avionics Waveforms

TECHNOLOGY AREAS: Sensors

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Project Manager Sentinel

OBJECTIVE: As the radar cross sections of both threat and friendly airborne platforms become smaller, the ability for passive receivers to use the RF avionics emissions of these platforms for detection, tracking, and target classification becomes increasingly important. Unfortunately, these signals are becoming increasingly difficult to use as Frequency Modulation Continuos Wave (FMCW) waveforms and other Low Probability of Intercept (LPI) techniques become more widely proliferated. Recently proposed signal processing architectures now make it practical to begin researching the detection and processing of these signals using ground based platforms. Additionally, other new research has indicated that most RF emitters likely have

unique signal characteristics that can be detected and recognized much like the patterns in fingerprints. This technology is generically known as Specific Emitter Identification (SEI). The objective of this topic will be to develop a first of it's kind, receiver-signal processor combination that is capable of detecting and processing these LPI signals; as well as, fingerprinting them using SEI technology.

DESCRIPTION: The goal of this effort shall be to develop, simulate, fabricate, and test a ground based receiver-signal processor architecture capable of detecting, measuring the angle of arrive of, and uniquely identifying the emissions of a modern LPI radar altimeter. The system shall have a minimum detectable signal (MDS) of –118 dBm, with an azimuth angle of arrive accuracy that is less than +1 deg; and the system shall correctly distinguish different copies of the same emitter system with an accuracy of greater than 95%. Waveform parameter data for altimeters of interest can be provided from the Government if requested.

PHASE I: The goal during Phase I shall be to develop and simulate a realizable design for the above-described receiver-signal processor. This effort shall include extensive computer modeling to predict the system's performance against a variety of emitters and flight profiles.

PHASE II: Phase II will have two parts. The first part shall be to actually fabricate the receiver-signal processor designed during Phase I. The second part shall be to test the system during Government run flight exercises in order to quantify its achieved performance and to identify areas that require additional research.

PHASE III DUAL-USE APPLICATIONS: This technology would be widely applicable to both the Air Force and the Navy. It would have direct application to a wide variety of existing systems. Additionally, this technology has the potential to increase the effectiveness of the electronic intelligence gathering activities of all U.S. law enforcement and intelligence agencies.

OPERATING AND SUPPORT COST (OSCR) REDUCTION:
The use of passive sensing to detect and process RF avionics emissions offers several operating and support cost reduction opportunities. The continued reduction in the radar cross sections of airborne threats will force the air defense community to employ either expensive radar system upgrades or to procure additional systems beyond their original plans. The addition of passive RF sensing to current air defense systems would be less costly and provide additional capabilities that the other options do not offer. Additionally, this increase in system effectiveness can be accomplished with no increase in either personnel or transportation requirements. The use of passive sensing to supplement air defense radars also increases the survivability of those radars. This translates directly to a life cycle cost reduction by reducing the number of repair parts needed to maintain the systems during wartime and reducing the total system inventory since fewer systems would need to be held in reserve.

REFERENCES: None

KEYWORDS: Passive sensing, Specific Emitter Identification (SEI), Frequency Modulation Continuous Wave (FMCW), Low Probability of Intercept (LPI)

A00-154 TITLE: Onboard Flight Digital Data Recorder for Measuring the Shock and Vibration Environment Associated with the Dispense and Flight of Missile Submunitions

TECHNOLOGY AREAS: Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Project Manager, Air to Ground Missile Systems, Tactical Missils Program Executive Office

OBJECTIVE: Design, build, and demonstrate an onboard high frequency data recorder applicable to missiles or submunitions at least three inches in diameter. The data recorder will be used to record selected measurements during the flight of the missile or submunition. The measurements will be downloaded from the data recorder after the completion of the flight.

DESCRIPTION: The data recorder shall be a self-powered, autonomous unit capable of measuring 15 channels of data at up to 100,000 samples per second for each channel. It shall package into a cylindrical volume no larger than 2.75 inches in diameter and 5.0 inches in length. The data recorder shall have direct connection ports for piezoelectric voltage mode accelerometers. It shall be capable of event triggering and shall record no less than two minute of data. The data recorder shall provide user adjustable gain and an analog anti-aliasing low pass filters. The data recorder shall be capable of measuring maximum amplitude of 10,000 G's with a resolution of 0.3 G's. The data should be stored in non-volatile memory. The data recorder shall be capable of withstanding the missile shock, vibration, temperature, and acoustic environments in both the operating and the nonoperating condition. The unit shall be capable of withstanding ground impact so that data can be downloaded from it after completion of the missile or submunition flight. The data recorder must be capable of being powered and operated with external power using standard 110 VAC. Software to remove the data from the recorder must be developed. The software must function on a portable computer that can be carried into the field to extract the data from the recorder at a remote site.

PHASE I: The first phase will determine the availability of commercial off the shelf (COTS) components, and assess the feasibility of fitting the components into the desired volume. The ability of the COTS components to survive the pyrotechnic shock, vibration, and temperature environments and ground impact of a missile must be assessed. These assessments will determine which components will require redesign to meet the environmental hardness and volume constraints. This phase will also identify which components could be miniaturized to meet the size constraints. Power requirements will be defined in this phase of development, and possible power sources identified. In addition, triggering the initiation of the autonomous power will be addressed in phase I. Electronic board design and layout will be performed during this phase. Methods to survive impact shock of the missile striking the ground at the end of flight must be identified, and structural analyses performed.

PHASE II: The second phase will demonstrate and validate prototype hardware. In this phase, the design established in phase I, will be developed and tested. This will be done at the component and system levels to validate the design. The tests will demonstrate sample rates, memory size, triggering functions, anti-alias functions, and power requirements under as many plausible scenarios as can be identified. Environmental hardness will be tested to demonstrate performance under pyrotechnic environments. This testing will result in identifying fragility levels of the data recorder and associated components.

PHASE III DUAL-USE APPLICATIONS: The design of an onboard missile data recorder capable of surviving pyrotechnic environments and ground impacts would have considerable military, space, and commercial applications. The ARMY TACMS/BAT program would use this type of recorder to measure the pyrotechnic environments associated with its flight. A high-speed data recorder would be a valuable asset for hypersonic sled track facility such as Holloman Air Force's sled track. This onboard data recorder would also have considerable value to the aviation and automotive industry. For example, commercial aircraft can use onboard digital recorders to monitor stresses and vibrations of key components, thereby diagnosing a potential future failure. Military high-speed aircraft can similarly benefit. Also, vibration and shock data can determine the overall placement and design of rack mounted missile systems on aircraft.

Currently, the resolution of the data recorded is greatly limited by the recording methods; allowing the data to be recorded onboard a moving platform will yield a greater understanding of the platform environment and performance. This technology research would provide a low cost, versatile, and robust method of acquiring high quality digital data.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: A flight data recorder that can accurately identify the ARMY TACMS/BAT submunition pyrotechnic shock environments would increase effectiveness associated with test flights. This would be accomplished by allowing submunitions to be instrumented and shock environments assessed. At the present time, since submunition shock data is not available, carrier shock data is used to extrapolate an implied shock level on the submunition. This approach is of limited usefulness and has hampered the Army TACMS Block II development program. The data recorder would be installed on Tactical Instrument Vehicle Assembly BAT submunitions utilized during operational test flights. The pyro-shock data gathered during flight test would more accurately define the pyro-shock environment and reduce the cost associated with redesign efforts, design modifications, and upgrades.

REFERENCES:
1. "Onboard Digital Recorders Improve Flight Vibration Tests," Scott Fling, Test Engineering and Management, August/September 1997.

KEYWORDS: Data Recorders, sample rate, analog low pass anti-aliasing filter, volatile memory, accelerometer, pyro-shock, shock isolation, frequency.

A00-155 TITLE: Large Aperture Trichroic Window for Multi-mode Hardware-in-the-Loop Simulations

TECHNOLOGY AREAS: Information Systems, Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Project Manager, Air to Ground Missile Systems, Tactical Missils Program Executive Office

OBJECTIVE: The objective of this topic is the development and fabrication of a large aperture electromagnetic window that is transparent to a Radio Frequency (RF) signal and reflective to Infrared (IR) signals for application in multi-mode Hardware-in-the-loop (HWIL) simulations. In addition to military uses, such technology would be applicable to many commercial uses involving the development and testing of collision avoidance systems and property protection systems.

DESCRIPTION: The Army has a requirement for a large aperture electromagnetic window that is transparent to a 35 and/or 94 GHz RF signal and reflective at Near IR (NIR), Mid-Wave IR (MWIR), Long Wave IR (LWIR), and visible frequencies. The window does not necessarily have to cover both RF bands and all IR Bands, but must cover one RF Band, the Near IR, and either the MWIR or LWIR simultaneously. In order to avoid edge effects at RF, the aperture dimensions must exceed 60 inches. In addition, novel edge treatments are required to further reduce undesired phase perturbations in the transmitted RF signal. The RF insertion loss for plane wave transmission must be less than 1.0 dB at 20-25 degree incidence angles over a bandwidth of 1.0

GHz. The difference in insertion loss between orthogonal linear polarizations must be less than 0.1 dB over the band. The reflectance at IR and visible wavelengths must exceed 98 %. The window must be mechanically rigid, optically flat and suitable for use in an anechoic chamber.

PHASE I: Explore the feasibility of developing a large aperture electromagnetic window which meets the specifications above. Evaluate innovative technologies which may be used to build the window. Perform trade-off analysis to determine the best approach for each subsystem, and develop a preliminary design for the window. Perform modeling and analysis to establish the proof-of-principle and predict the performance specifications for the final system.

PHASE II: Perform detailed design of the concept selected in Phase I, and fabricate a prototype electromagnetic window. Demonstrate the laser projector technology and characterize its performance in an actual HWIL environment.

PHASE III DUAL-USE APPLICATIONS: Commercial applications for this technology might be found in the automobile, home security, and air craft industries. The novel electromagnetic window developed under this topic could be used with RF and IR signal generation hardware to provide an excellent test bed to support the development of single mode and multi-mode collision avoidance systems and intrusion detection systems.

OPERATING AND SUPPORT COST (OSCR) REDUCTION:
This technology would fit within the OSCR by drastically reducing the typical cost for the development of state of the art weapon systems by allowing testing of critical hardware and software components in a non-destructive manner. This repeated virtual flight testing can greatly increase the speed of system development thus reducing procurement costs. Stockpile reliability testing can be achieved in such a simulation facility in a non-destructive manner, thus allowing the flight article to be re-introduced the inventory with a substantial cost savings to the government.

REFERENCES:

1. Technologies for Synthetic Environments: Hardware-in-the-loop Testing, Proc. SPIE, Vol. 2741, April 1996.
2. Technologies for Synthetic Environments: Hardware-in-the-loop Testing III, Proc. SPIE, Vol. 3368, April 1998.
3. Technologies for Synthetic Environments: Hardware-in-the-loop Testing IV, Proc. SPIE, Vol. 3697, April 1999.

KEYWORDS: Electromagnetic window, multi-mode, seeker, radio frequency (RF) millimeter wave (MMW), infrared (IR), hardware in the loop (HWIL), simulations

A00-156 TITLE: Low Temperature Catalyst for Reduced Toxicity Monopropellant

TECHNOLOGY AREAS: Materials/Processes, Weapons

OBJECTIVE: Develop a catalyst that will spontaneously decompose the Aviation and Missile Command (AMCOM) CINCH (Competitive Impulse Non-Carcinogenic Hypergol) fuel at temperatures as low as -40oF. Demonstrate a gas generator using this catalyst and the AMCOM CINCH fuel.

DESCRIPTION: AMCOM has been pursuing the development of gel propulsion systems for tactical missiles. Gel propulsion systems can be pressurized using either liquid or solid gas generators. A liquid gas generator would operate at a lower temperature than a solid and would produce no soot. Hydrazine is the current monopropellant under consideration for this need. However, hydrazine is a suspected carcinogen. AMCOM has demonstrated a reduced toxicity gas generator using the CINCH fuel. This fuel will decompose using the same catalyst as the state-of-the-art monopropellant hydrazine. However, the catalyst bed must be heated to 300-400oF so that the CINCH fuel will decompose. Hydrazine will decompose on this same catalyst at -40oF. Heating the catalyst prior to initiation would be an additional cost incurred in the development of gas generator systems. It would be desirable to have a catalyst that is specific to the CINCH fuel that would cause it to decompose at -40oF.

PHASE I: Conduct a catalytic material study and demonstrate that the catalysts will decompose CINCH at -40oF. Design a prototype gas generator based on the results of the catalyst material study.

PHASE II: Develop and demonstrate several prototype devices to be tested in accordance with AMCOM specifications. Chemical Analysis of the gas effluent will be required as part of the experimental protocol. The testing will be conducted to validate operation of the hardware at –40oF.

PHASE III DUAL-USE APPLICATIONS: Several dual-use applications will be demonstrated in FY00. Edwards Air Force Base will conduct engine testing with hydrogen peroxide and the CINCH fuel. Allied Signal is the hardware developer for the F-16 Auxiliary Power Unit (APU) which uses a hydrazine liquid gas generator. Allied Signal will test the CINCH fuel with a liquid gas generator to evaluate CINCH as a replacement for hydrazine. Marshall Space Flight Center (NASA) has funded AMCOM to deliver ten pounds of the CINCH fuel to be fired in an engine test with liquid oxygen. TRW will test the CINCH fuel with

inhibited red fuming nitric acid (IRFNA). The following companies have also expressed interest in testing the fuel: Marquardt, Aerojet, Primex and Boeing. The CINCH fuel could be used domestically in satellites for thrust vector control (TVC) and in reaction control systems (RCS) to replace hydrazine thrusters.

OPERATING AND SUPPORT COST (OSCR) REDUCTION:
Handling a carcinogenic material requires special procedures and equipment that increase the lifecycle cost of a weapon sytem. NASA has estimated that handling hydrazine and monomethylhydrazine adds an additional $500,000 to the cost of each space shuttle mission. The launch pad must be vacated and all other operations cease while hydrazine and monomethylhydrazine are added to the fuel tanks. The replacement of a suspected carcinogenic material with a reduced-toxicity fuel should significantly decrease the lifecycle costs of a gel propulsion system.

REFERENCES: "Hydrazine and Its Derivatives: Preparation, Properties and Applications", Eckart W. Schmidt, John Wiley and Sons, 1984

KEYWORDS: hydrazine, monopropellant, gas generator

A00-157 TITLE: Laser Detection and Ranging (LADAR) Simulation Techniques for Multi-mode Hardware-in-the-Loop Simulations

TECHNOLOGY AREAS: Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Project Manager, Air to Ground Missile Systems, Tactical Missils Program Executive Officce

OBJECTIVE: The objective of this topic is the development of a novel LADAR projection system for dual-mode hardware-in-the-loop (HWIL) testing of seekers which utilize laser detection and ranging (LADAR) for acquisition and terminal homing. In addition to generating the LADAR target signals, the proposed technique must be compatible with a flight motion simulator. In addition to military uses, such technology would be applicable to many commercial uses involving the development and testing of collision avoidance systems and property protection systems.

DESCRIPTION: Emerging missile weapon systems are using common-aperture, multi-mode seekers for acquisition and terminal homing. These seekers use a combination of two or more sensor technologies including radio frequency (RF), millimeter wave (MMW), imaging infrared (IR), LADAR, and semi-active laser (SAL) seekers.

A new capability must be developed to support realistic HWIL testing of seekers which utilize a LADAR sensor in combination with other sensor technologies. The LADAR projector must be capable of generating a realistic in-band scene that is indiscernible from the real-world scene as viewed by a LADAR sensor. The LADAR projector must optically represent time-delayed laser returns to a seeker during closed-loop weapon testing. The weapon system will provide a timing reference in the form of either a laser pulse or an electronic signal, and the scene projector will provide temporally and spatially accurate laser return pulses. Data describing the time-delays and reflected pulse shapes for all points within the field-of-view of the projector will be provided by a scene generation computer in-real time based on the relative distances between scene entities and the seeker. Relative time-delay accuracy for the projector pulses must be on the order of 0.5 nanoseconds.

PHASE I: Explore the feasibility of developing a laser projector system which meets the specifications above. Evaluate innovative technologies which may be used to build the system. Perform trade-off analysis to determine the best approach for each subsystem, and develop a preliminary design for the laser projector system. Perform modeling and analysis to establish the proof-of-principle and predict the performance specifications for the final system.

PHASE II: Perform detailed design of the concept selected in Phase I, and fabricate a prototype laser projection system. Demonstrate the laser projector technology and characterize its performance in an actual HWIL environment.

PHASE III DUAL-USE APPLICATIONS: The LADAR projector technology developed under this effort may be used in manufacturing/production testing as well as flight line testing of multi-mode weapon systems. In addition, commercial applications for this technology might be found in the automobile, home security, and air craft industries. The novel LADAR projection technique developed under this topic would provide an excellent test bed to support the development of single mode and multi-mode collision avoidance systems and intrusion detection systems.

OPERATING AND SUPPORT COST (OSCR) REDUCTION:
This technology would fit within the OSCR by drastically reducing the typical cost for the development of state of the art weapon systems by allowing testing of critical hardware and software components in a non-destructive manner. This repeated virtual flight testing can greatly increase the speed of system development thus reducing procurement costs. Stockpile reliability testing

can be achieved in such a simulation facility in a non-destructive manner, thus allowing the flight article to be re-introduced the inventory with a substantial cost savings to the government.

REFERENCES:

1. Technologies for Synthetic Environments: Hardware-in-the-loop Testing, Proc. SPIE, Vol. 2741, April 1996.
2. Technologies for Synthetic Environments: Hardware-in-the-loop Testing III, Proc. SPIE, Vol. 3368, April 1998.
3. Technologies for Synthetic Environments: Hardware-in-the-loop Testing IV, Proc. SPIE, Vol. 3697, April 1999.

KEYWORDS: LADAR, laser radar, scene generation, scene projection, hardware-in-the-loop, simulations, multi-mode, seeker

A00-158 TITLE: Compact Range Implementation of RF Target Glint Signatures for multi-mode Hardware-in-the-loop simulations

TECHNOLOGY AREAS: Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Manager, Air to Ground Missile Systems, Tactical Missils Program Executive Officce

OBJECTIVE: The objective of this topic is the development and application of novel compact range techniques to multi-mode Hardware-in-the-loop (HWIL) simulations of millimeter wave (MMW), Infrared (IR), and semi-active laser (SAL) target signatures. In addition to generating the MMW target glint signals, the proposed technique must be compatible with a 5-axis motion simulator and also must include methods for folding in the IR and SAL bands. In addition to military uses, such technology would be applicable to many commercial uses involving the development and testing of collision avoidance systems and property protection systems.

DESCRIPTION: In the past, HWIL simulations of MMW target glint signatures have been implemented on a matrix array of triads of antennas located in the far field of the missile seeker system under test. These arrays are expensive and require large anechoic chambers to fulfill the far field requirement. It is desired to generate the glint signatures using lower cost compact range techniques in which a small array is imaged onto a reflector, producing a plane wave signal at the seeker aperture from each array antenna. In addition, this technique should allow more easily implemented options for folding in signals from the IR and SAL bands of interest. Also, the compact range will be mountable on a flight motion simulator. The individual array antenna signal amplitudes and phases must be controlled at up to 10 MHz rates to vary the instantaneous angle of arrival of the composite signal incident on the seeker antenna in synchronism with the seeker waveform sampling. A 1.0 GHz instantaneous bandwidth is required to accommodate wideband waveforms. A glint position accuracy of +/- 1.5 milliradians is required.

PHASE I: Explore the feasibility of developing a compact range system which meets the specifications above. Evaluate innovative technologies which may be used to build the system. Perform trade-off analysis to determine the best approach for each subsystem, and develop a preliminary design for the compact range system. Perform modeling and analysis to establish the proof-of-principle and predict the performance specifications for the final system.

PHASE II: Perform detailed design of the concept selected in Phase I, and fabricate a prototype compact range system. Demonstrate the SAL projector technology and characterize its performance in an actual HWIL environment.

PHASE III DUAL-USE APPLICATIONS: Commercial applications for this technology might be found in the automobile, home security, and air craft industries. The novel compact range technique developed under this topic would provide an excellent test bed to support the development of single mode and multi-mode collision avoidance systems and intrusion detection systems.

OPERATING AND SUPPORT COST (OSCR) REDUCTION:
This technology would fit within the OSCR by drastically reducing the typical cost for the development of state of the art weapon systems by allowing testing of critical hardware and software components in a non-destructive manner. This repeated virtual flight testing can greatly increase the speed of system development thus reducing procurement costs. Stockpile reliability testing can be achieved in such a simulation facility in a non-destructive manner, thus allowing the flight article to be re-introduced the inventory with a substantial cost savings to the government.

REFERENCES:

1. Technologies for Synthetic Environments: Hardware-in-the-loop Testing, Proc. SPIE, Vol. 2741, April 1996.
2. Technologies for Synthetic Environments: Hardware-in-the-loop Testing III, Proc. SPIE, Vol. 3368, April 1998.
3. Technologies for Synthetic Environments: Hardware-in-the-loop Testing IV, Proc. SPIE, Vol. 3697, April 1999.

KEYWORDS: Compact range, multi-mode, seeker, millimeter wave (MMW), infrared (IR), semi-active laser (SAL), hardware in the loop (HWIL), simulations

A00-159 TITLE: Composite Aeroshells with Integral Heat Shield Designs

TECHNOLOGY AREAS: Materials/Processes, Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Manager, Army Tactical Missile System

OBJECTIVE: The Propulsion and Structures Directorate, Structural Analysis and Design Function has the mission to analyze and design thermal protection systems for tactical missiles. This includes supersonic to hypersonic environments imparting significant aerothermal heating to composite airframes and motor cases. Typical composite materials used in these structures utilize epoxy matrices that show significant reductions in strength when exposed to temperatures over 250°F. The objective of this SBIR topic is to identify potential methods of designing integral heatshields for composite airframes and motorcases to minimize fabrication, weight, and cost while enhancing thermal protection capabilities. Additionally, this topic will develop and test candidate heatshield designs that function as both the structural and thermal components of tactical missile composite airframes.

DESCRIPTION: The current process for providing thermal protection to tactical missile airframes is to utilize a bonding agent to adhere an external heatshield material to the structural airframe. The risk associated with this technique is the potential for debonding due to bondline temperature rise and aerodynamic shear resulting in the overheating of the airframe structure. Additional risk associated with this approach is fabrication cost. The attachment of the heatshield material represents a separate process requiring curing at elevated temperatures. If the airframe is the motorcase, temperature curing can represent concerns with respect to the propellant loading process. The technology development for this topic includes fabrication techniques and thermodynamic response of heatshield materials. It is desirable, in the fabrication process for composite airframes, to integrally wind or co-cure the heatshield to the airframe in one process without the use of temperature limited bonding agents. Additionally, it is desirable to utilize lightweight insulating materials while maintaining strength and stiffness for flight loads.

PHASE I: This phase will involve the identification of existing fabrication techniques and current research in the area of composite heatshield design and analysis. Concentration will be directed toward lightweight integral heatshield/airframe designs that reduce or eliminate the requirement for the heatshield bonding process. Additional research will be performed to identify new approaches to design and fabrication of integral and co-cured heatshield concepts. Parametric analyses will be performed to provide a relative performance ranking for the various heatshield design techniques to identify the most promising approaches for further research in a Phase II effort.

PHASE II: This phase will involve the implementation of the most promising techniques for an integral heatshield design. Proof of principle will be demonstrated through prototype hardware fabrication and test. Thermostructural experimentation will be performed to assess the relative performance of the various fabrication techniques. Fabrication processes and heatshield material designs will be identified and recommendation provided for Phase III implementation.

PHASE III DUAL-USE APPLICATIONS: The dual-use applications for this technology include any system design requiring the use of composite airframes with insulative external or internal layers. Since this proposal centers on optimization of the fabrication process for composite materials, new and innovative techniques will be identified that may have application to the passenger aircraft industry, the space plane program, automotive industry, as well as any other industry employing the use of composites.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Current heatshield designs in tactical missiles utilize thermally protective materials that are bonded to the missile airframe as a secondary manufacturing operation. These heatshields are often damaged during handling, and are also susceptible to debonding over time. Integrally fabricated or co-cured composite structures and heatshields would provide tougher material systems that are free of bondlines. This would eliminate the support costs associated with repairing damaged or debonded heatshields over the life cycle of the round.

REFERENCES:

1. Reynolds, R.A, Nourse, R.N, and Russell, G.W, Aerothermal Ablation Behavior of Selected Candidate External Insulation Materials, 28th AIAA Joint Propulsion Conference and Exhibit, July 1992.

2. Reynolds, R.A., Russell, G.W, and Nourse, R.N., Ablation Performance Characterization of Thermal Protection Materials for High Speed Tactical Missiles Using a Mach 4.4 Sled Test, 28th Annual AIAA Joint Propulsion Conference and Exhibit, July 1992.

3. B.C. Yang, F.B. Cheung, and J.H. Koo, Numerical Investigation of Thermochemical and Mechanical Erosion of Ablative Materials, 29th AIAA Joint Propulsion Conference, June 1993.

4. Y. Fabignon, Ablation Rate Calculation of Thermal Insulations in Segmented Solid Propellant Rocket Motors, 29th AIAA Joint Propulsion Conference, June 1993.

5. W.A. Leuhmann and J.F. Lyon, Aerothermal Ablative Characterization of Selected External Insulator Candidates, 29th AIAA Joint Propulsion Conference, June 1993.

6. Russell, Gerald W., 29th AIAA Joint Propulsion Conference and Exhibit, Kinetic Decomposition and Thermal Modeling of Chartek 59C, June 1993.

7. M. Fabrizi and G. La Motta, Thermo-Ablative and Fluid Dynamic Analyses for the Design of Thermal Protection for Solid Propellant Rocket Motors, 32nd AIAA Joint Propulsion Conference, July 1996.

8. Investigation of Thermal Performance of an Epoxy Composite Using a Complex Charring Model, 32nd Annual AIAA Joint Propulsion Conference and Exhibit, July 1996.

9. H.S. Sun, et al, Numerical Calculation of Nose Erosion Shape of Hypersonic Vehicle, 7th AIAA Joint Thermophysics and Heat Transfer Conference, June 1998.

10. Yen, Cassin, Patterson, and Triplett, Progressive Failure Analysis of Thin Walled Composite Tubes under Low Energy Impact, 39th AIAA Structures, Structural Dynamics, and Materials Conference, April 1998.

11. Yen, Cassin, Patterson, and Triplett, Analytical Methods for Assessing Impact Damage in Filament Wound Pressure Vessels, 44th Society for the Advancement of Material and Process Engineering International Symposium and Exhibition, May 1999.

12. Triplett, Progressive Failure Analysis of Fiber Composite Structures, Society of Plastics Engineers 1999 Annual Technical Conference, May 1999.

KEYWORDS:
Composites, Motorcase, Airframe, Fabrication, Materials, Filament, Winding, Thermal Protection, Heatshields, Co-Cured Composites

U.S. Army Medical Research and Materiel Command (MRMC)

A00-160 TITLE: Generation of Serum Carboxylesterase Deficient Mice

TECHNOLOGY AREAS: Biomedical

OBJECTIVE: The development of biological scavengers as a next generation mode of medical protection against chemical warfare threats is a current Army DTO. To accelerate the completion of a milestone 1 transition deadline in FY 2002, a small, inexpensive animal test platform must be developed. Such an animal model would greatly facilitate the evaluation of candidate scavengers. To accomplish that goal, we propose to create genetically modified mice that lack a functional copy of the gene encoding serum carboxylesterase, for use as a model animal system to test prophylactic and therapeutic interventions against organophosphorus (OP) nerve agents.

DESCRIPTION: Mice are an inexpensive, convenient animal model to test the efficacy of OP protectants and antidotes. However, unlike humans and non-human primates, mice express a serum carboxylesterase enzyme (Es-1) (1-4); due to the capacity of Es-1 to act as an endogenous bioscavenger of OPs, mice are substantially more resistant to OP toxicity than primates (5). We propose to generate genetically modified mice in which the gene encoding the Es-1 serum carboxylesterase has been inactivated by homologous recombination (6-8). Es-1 knockout mice are expected to have similar susceptibility to OPs as primates, but at a dramatically reduced cost per animal. Further, results from these Es-1 deficient mice will be more directly relevant to humans than those from existing small animal models.

PHASE I: The generation and characterization of Es-1 knockout mice requires the assembly of a homologous recombination construct encoding a version of the Es-1 gene (6-8) interrupted by stop codons (making the Es-1 gene non-functional). This construct will then be transfected in an embryonic stem cell line, and recombinant stem cells will be implanted into a mouse uterus (in mixed normal/recombinant blastocysts) where they will develop into chimeric offspring mice. Chimeric animals will be screened for germ line transmission of the interrupted, non-functional Es-1 gene in order to generate heterozygous knockout mice. Finally, heterozygous Es-1 knockouts will be bred to produce homozygous knockout mice that lack a functional copy of the Es-1 gene, and thus will be unable to produce serum carboxylesterase. These mice will then be examined for carboxylesterase activity in the serum, and for increased susceptibility to OPs (proof of concept). Although unlikely, it is

possible that elimination of Es-1 from the serum will have adverse effects on mice, including reduced viability or infertility. If such problems arise, heterozygous Es-1 knockout mice (which retain one functional copy of the Es-1 gene) will be analyzed for OP susceptibility. We are capable of supplying the necessary DNA constructs for development of chimeric animals, but an industrial partner capable of the necessary manipulation of stem cells, and subsequent development of chimeric animals is required to accomplish the goal of this project. These techniques are in most cases not yet standardized or routine, and we will defer to the experience and advice of the small business partner with respect to experimental protocols and approaches.

PHASE II: After large-scale mouse breeding to produce a sufficient working stock, OP-neutralizing bioscavengers such as mutated butyrylcholinesterase (developed in-house at USAMRICD) will be tested for their ability to protect Es-1 knockout mice against OP toxicity. Additionally, the efficacy of other anti-OP interventions such as anti-convulsants and acetylcholinesterase reactivating agents will be tested using the Es-1 knockout mice model system.

PHASE III DUAL USE APPLICATIONS: After fully characterizing Es-1 knockout mice and establishing their utility as a animal model system for studying pretreatments and antidotes for OP exposure, these mice will be made available to researchers and companies working in related areas. For commercial applications, these mice will present a financially viable animal model for the study of pesticide toxicity and the efficacy of treatments for pesticide exposure. In primary research fields, Es-1 knockout mice will be of interest to researchers studying carboxylesterase pharmacology and metabolism, as well as the metabolism of xenobiotic compounds.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Current cost estimates for the purchase and per diem housing of a rhesus monkey are $4000 and $4.79 per day, respectively. Es-1 knockout mice will be bred in our animal facility (no purchase cost), and the per diem for a mouse is only $0.74 per day. Thus, the use of Es-1 knockout mice in place of rhesus monkeys in appropriate experiments will generate a substantial operating cost reduction while still fulfilling research mission objectives.

REFERENCES:

1. Ovnic, M., Tepperman, K., Medda, S., Elliott, R.W., Stephenson, D.A., Grant, S.G. and Ganschow, R.E. (1991) Characterization of a Murine cDNA Encoding a Member of the Carboxylesterase Multigene Family. Genomics, 9, 344-354.
2. Medda, S. and Proia, R.L. (1992) The Carboxylesterase Family Exhibits C-terminal Sequence Diversity Reflecting the Presence or Absence of Endoplasmic-reticulum-retention Sequences. Eur. J. Biochem., 206, 801-806.
3. Robbi, M. and Beaufay, H. (1992) Topogenesis of Carboxylesterases: A Rat Liver Isozyme Ending in -HTEHT-COOH is a Secreted Protein. Biochem. and Biophys. Research Comm., 183, 836-841.
4. Kadner, S.S., Katz, J. and Finlay, T.H. (1992) Esterase-1: Developmental Expression in the Mouse and Distribution or Related Proteins in Other Species. Arch. Of Biochem. And Biophys., 296, 435-441.
5. Maxwell, D.M., Brecht, K.M. and O'Neill, B.L. (1987) The Effect of Carboxylesterase Inhibition on Interspecies Differences in Soman Toxicity. Toxicology Letters, 39, 35-42.
6. Capecchi, M.R. (1989) Altering the Genome by Homologous Recombination. Science, 244, 1288-1292.
7. Galli-Taliadoros, L.A., Sedgwick, J.D., Wood, S.A. and Korner, H. (1995) Gene Knock-Out Technology: A Methodological Overview for the Interested Novice. J. Immunol. Meth., 181, 1-15.
8. Shastry, B.S. (1998) Gene Disruption in Mice: Models of Development and Disease. Mol. And Cell. Biochem., 181, 163-179.

KEYWORDS: Organophosphorus Nerve Agents, Carboxylesterase, Knockout Mice, Bioscavengers

A00-161 TITLE: Dry System for Thawing Frozen Blood

TECHNOLOGY AREAS: Biomedical

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Office of the Surgeon General

OBJECTIVE: To develop a dry system for rapid thawing of frozen blood, and warming IV fluids. Topic also includes improved blood bags, shipping containers, and investigations to optimize the deglycerolization protocol to increase speed and reduce processing fluid quantities.

DESCRIPTION: This SBIR topic has several integrated goals to improve the military frozen blood system. One of these goals is to replace the existing water bath with a pressurized heated plate system that will reduce thaw time from the current one hour to approximately twenty minutes. In addition to reducing thaw time, this will eliminate the problem of sloshing within the water bath aboard ship in heavy seas. It also eliminates messy clean up if the water bath becomes contaminated with a blood bag that bursts during thawing (estimated to occur 20% of the time). This system should be designed to feed directly into an existing deglycerolization device; or thaw up to 10 units in preparation for deglycerolization that can be physically removed by the operator. Another necessary feature of the dry warming system is to preheat IV solutions for surgery. Other goals of this topic include replacing the existing frozen bags with a stronger material that withstands freezing (-80 C) without breakage, and is shaped with a thin profile to enhance heat conduction and thus reduce thaw time. And to develop an inexpensive disposable shipping container to match the new blood bag. The final goal of this SBIR Topic is to investigate optimization of current deglycerolization protocol to increase speed and reduce processing fluid quantities. SBIR candidates should have experience with frozen blood technology, the FDA process, and design of medical devices.

PHASE I: Design and fabricate a laboratory prototype warming device for thawing blood and preheating IV solutions. Identify a new blood bag material and an inexpensive shipping container. Do preliminary investigations on improving the deglycerolization protocol to reduce time and the amount of wash fluids.

PHASE II: Continue to develop the dry warming device through a series of improved prototypes until a pre-production model is finalized. Fully develop the new blood bag and shipping container. Apply improvements to the existing deglycerolization protocol by demonstration on one of the existing commercial deglycerolization devices.

PHASE III DUAL USE APPLICATIONS: These improvements will be utilized in both the military and civilian markets. The military currently has tens of thousands of frozen blood units prepositioned aboard ships, and in major blood depots such as Korea. Future use of frozen blood is probably going to increase because blood born infection rates in areas of the world such as Korea are too high for local blood collections. U.S. Commercial Blood bankers would also benefit because they process approximately 60,000 units of frozen blood per year.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: There will be significant reduction in both costs and manpower requirements. Eliminating the unacceptable breakage of frozen units estimated at 20%, will reduce costs and valuable time during emergencies. Costs and manpower will also benefit from faster thawing and simpler automation.

REFERENCES:

Red cell freezing and thawing by the American National Red Cross. Am. J. Med. Tech. 41:265,1975.

Prevention of hemolysis during freezing and thawing of red blood cells. Lancet 2:910,1950.

A Simplified Procedure for Deglycerolizing Red Blood Cells. Transfusion, Vol.17. No 5, Sept. 1977.

KEYWORDS: Blood Thawing System, Dry Heater, Heated Plate Warming Device

Natick Soldier Center (NSC)

A00-162 TITLE: Flexible Photovoltaics for Fabric Structures

TECHNOLOGY AREAS: Materials/Processes, Human Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Manager Soldier Support

OBJECTIVE: Advance new flexible photovoltaic technology to enable its incorporation into textile products, specifically military tentage providing a renewable energy source for powering lights, mission equipment environmental control and chemical/biological warfare chemical filtering systems. Ideally, the goal is to achieve a tent skin that acts as an environmental barrier in addition to generating mission power. This technical advancement will reduce the logistics burden of power generation systems including weight, cube and fuel by incorporating lightweight flexible photovoltaics into military tentage systems.

DESCRIPTION: Mission electrical power requirements continue to increase for shelter-housed operations such as command & control and medical treatment. Where protection from chemical/biological agents is required, filtering and environmental control equipment adds a tremendous increase in logistics burden in terms of power generation equipment. This equipment adds significant weight and cube to lightweight tentage systems in addition to requiring refueling and maintenance/repair.

Various new materials and processes have improved the manufacturability of thin-film, flexible photovoltaic panels opening the door to new applications such as textile-based power generation systems. This effort will assess the current state-of-the-art and implement modifications required for installation on and into military tentage to maximize efficiency and affordability without compromising current tentage characteristics. The goal is to integrate the solar capability into the tent skin as much as possible. Key areas to be explored include alternative substrates for improved flexibility and durability to withstand multiple deployments and allow integration into fabric substrates (e.g. heat/radio frequency welding) and camouflaging issues. This work could also be transitioned into soldier garments or backpacks for power generation.

PHASE I: Identify technical barriers associated with integrating the current state-of-the-art flexible photovoltaics with new and existing tent fabrics. Evaluate the properties of existing coatings, films, and fibers used in tentage fabrics that will influence the selected approach used to incorporated flexible photovoltaics. Develop suitable materials, interface methods (e.g. deposition, lamination, adhesion) and continuous manufacturing technology for applying photovoltaics to tent fabrics. Demonstrate the success of the chosen approach through fabrication and testing of laboratory samples.

PHASE II: Identify remaining technical issues and shortcomings from phase I. Further mature the necessary materials and processes. Scale up the continuous process demonstrated in phase I to ensure consistency and affordability. Demonstrate the capability through the use of full-scale prototyping and testing.

PHASE III DUAL-USE APPLICATIONS:
Military tentage programs that can immediately benefit from this technology include the Joint Transportable Collective Protection System (JTCOPS) and Force Provider. NASA has multiple fabric space structure applications that could utilize these flexible photovoltaics.

For commercial applications, flexible photovoltaic panels could be incorporated into commercial tensioned fabric structures (e.g. Denver airport, stadiums, concert and special event tents) for power generation of items such as fans and lights. They would also be useful for disaster relief efforts where commercial power generation plants have become inoperable or remote exploration projects where cumbersome power generation systems are undesirable. Non-shelter textile applications include garments and backpacks to provide power/charge batteries for items such as laptops, communication systems, microclimate cooling and flashlights and space structures.

OPERATING AND SUPPORT COST REDUCTION (OSCR): A renewable power source such as solar power could have a significant impact on the logistics burden of current systems and result in reduced operating and support costs. Successful implementation would reduce reliance on fuel and disposable batteries as well as reducing or eliminating power generation and environmental control units.

REFERENCES:
www.ttcorp.com/upvg/record/rc298ndm.htm A commercial concept demonstration of incorporating flexible photovoltaics into a fabric structure.

www.nrel.gov/ncpv U.S. Department of Energy, National Center for Photovoltaics web site with useful links.

www.ttcorp.com/upvg Utility Photovoltaic Group, an international nonprofit group including 150 organizations. Web sites contains many photovoltaic links.

KEY WORDS: photovoltaics, tents, shelters, power

A00-163 TITLE: Self-Deploying Tentage for Smart Cities

TECHNOLOGY AREAS: Materials/Processes, Human Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Manager Soldier Support

OBJECTIVE: Explore innovative materials and structural technologies to produce a lightweight structural support system and/or deployment technique that enables large tent complexes to be set up using minimal time and labor while still enabling operation in climatic extremes.

DESCRIPTION: In today's fast moving military, the capability to rapidly establish shelter complexes using minimal personnel for functions such as medical, command & control, and billeting are needed. The ability to set up large shelter complexes in a clean or CB contaminated environment using minimal time and personnel must be improved for operations such as medical treatment, billeting, maintenance and command and control. Traditional aluminum or steel structures do not provide the level of mobility and reduced logistics burden required for future Army needs. Also, collective protection to enable operations to continue on a chemically/biologically contaminated battlefield is currently available to only a small portion of the military. This lack of availability is primarily due to the excessive cost and logistical burden that Chemical Biological (CB) protection incurs to shelter systems. Many non-CB shelter structural support concepts exist although are often criticized for their weight and deployment time. Faster deployable structures are emerging, however, their ability to perform as collective protection shelters must be examined. Characteristics unique to collective protection structures such as interfaces, airlocks, leakage, the use of continuous fabrics, and use of CB materials are often incompatible to allow simple incorporation. This investigation will serve as the framework for planned programs within PM Force Provider, PM Soldier Support and the Joint Transportable Collective Protection System (JTCOPS).

PHASE I: New materials, configurations and techniques for achieving lighter and faster structural concepts will be explored. Once the most promising approach is identified, the focus will be on maturing the technology incorporating necessary performance characteristics. Subscale components of critical features will be fabricated and tested to demonstrate the structural capacity of the proposed system.

PHASE II: Further mature the concept and technologies demonstrated in phase I. Integrate components to achieve an optimized structural design. Address the development of any manufacturing technology issues. Fabricate and test a full-scale prototype system to ensure satisfactory performance in all operational and environmental extremes

PHASE III DUAL-USE APPLICATIONS: The goal is to transition this technology into future military shelter complexes requiring rapid deployment such as the Joint Transportable Collective Protection System and the next generation Force Provider. Rapidly deployable structures/shelters have commercial applications ranging from disaster relief, emergency response and rental/special event tents. Also, NASA is interested in easily deployed structures for space applications and may benefit from advances in this area.

OPERATING AND SUPPORT COST REDUCTION (OSCR): The goal of this program is to reduce OSCR costs by reducing the logistics trail of shelters. Weight and cube reduction will result in reduced transportation costs. Rapid deployment will eliminate many labor hours reducing cost and freeing up personnel for more important assignments.

REFERENCES:
www.sbccom.army.mil/products/shelters provides an overview of existing tentage items

KEY WORDS: shelter, tent, fabric, structures

U.S Army Space and Missile Defense Command (SMDC)

A00-164 TITLE: MMW 95 GHz Intermediate Power Amplifier

TECHNOLOGY AREAS: Sensors, Electronics

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Executive Officer-Air and Missile Defense

OBJECTIVE: Advance the state-of-the-art in millimeter wave power amplifier electronics. Develop, test and field a wide-band millimeter wave medium power amplifier.

DESCRIPTION: Advancements in new electronic materials and microfabrication technologies offer opportunities for significant breakthroughs in millimeter wave electronic systems. A particular need exists for high reliability, medium power amplifiers, which operate in the 90-100 GHz range. Existing millimeter-wave technology provides small-signal processing components such as attenuators, switches, and isolators, power dividers and couplers that are fabricated by precision machining techniques. Vacuum tubes are also available for high power applications (> 100 W). Commercial semi-conductor components for W-Band applications have lagged behind these other products and are just now becoming commercially viable. These devices, in particular, could be used to provide medium power functions such as driver amplifiers for high power tubes or to provide compact solutions to satisfy less demanding requirements. Active semi-conductor devices also promise drastic improvements in frequency response, linearity, bandwidth, size, cost and maintainability over the technologies now in use. Solutions that meet even the primary requirements have not yet been developed in any technology and it is by no means certain that all primary requirements can simultaneously be met. The best available solutions to date rely on IMPATT- or GUNN-diode devices and are lacking in bandwidth, peak power and signal linearity. In addition, commercial amplifiers using diodes have been unreliable, expensive and difficult to manufacture and adjust.

PHASE I: Analyze and compare the predicted performance of candidate technologies, detailing significant advances needed and predicted risks. Develop designs for selected technologies.

PHASE II: Based on the results of Phase 1, develop a prototype design, and conduct laboratory and field demonstrations of the prototype system. The MMW radar at Kwajalein Atoll may be utilized as a demonstration test-bed. This 95GHZ radar is an example of a medium power driver application and could provide a platform on which to demonstrate reliability and ruggedness. For this purpose, the proposed amplifier would need 4 GHz bandwidth, 1 W peak power, 50 microsecond pulsewidth and 20% duty cycle. Demonstration in the MMW radar would also require WR-10 input and output connections, 1.8:1 input and output VSWR and unconditionally stable operation.

PHASE III DUAL USE APPLICATIONS: Transition the design of Phase II to meet commercial needs. Possible high volume uses include transmit amplification for collision avoidance radars and transmit amplification for interceptor/seeker applications. The underlying technology might also be adapted to other center frequencies, allowing applications in communications, networking, navigation or imaging to be developed. The confluence of semiconductor device technology, millimeter wave applications and emerging specialty manufacturers make this product area ripe for successful development.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: A goal of this project, second only to proper electrical performance is to produce reliable, maintainable, medium power amplification at 95 GHz. Such technology will transfer the difficult diagnosis and repair of device failures to industry and eliminating the need to provide internal support at remote locations.

KEYWORDS: Millimeter wave, mm-wave, W-band, radar, power amplifier, driver amplifier, wideband.

U.S. Army Simulation, Training, and Instrumentation Command (STRICOM)

A00-165 TITLE: Innovative Synthetic Natural Environment Database Design Methodology and Tool

TECHNOLOGY AREAS: Information Systems, Human Systems

OBJECTIVE: To research, design, prototype and demonstrate an innovative database design methodology and tool that can support Army's future modeling and simulation Synthetic Natural Environment (SNE) Database requirements efficiently. The proposed solutions shall focus on providing technical solutions that address STRICOM's Science & Technology Objective (STO) program requirements.

DESCRIPTION: The Synthetic Natural Environment (SNE) database is the foundation of all modeling and simulation applications. Interoperability between heterogeneous, multi-domain simulation systems in a distributed environment is one of the most challenging topics of the Army's M&S research and development efforts. The thrusts to support Simulation Based Acquisition (SBA) have added more challenges to the interoperability requirements. In order to support the Simulation Based Acquisition (SBA) initiative, it is essential to provide a high quality SNE database that can address the requirements of ACR, RDA and TEMO domain of users. New SNE database design methodology will be required to answer this multi-domain, multi-resolution interoperability challenge.

SNE Databases used today for M&S application are adapted to work with specific function, such as visual simulation, and/or semi-automated forces (SAF). It is necessary to convert databases between different applications. Further, methodologies to generate these databases are limited in their ability to incorporate diverse sources of data. The U.S. Army STRICOM seeks an innovative database design that can address multi-domain and multi-resolution with diverse data sources. The proposed methodologies shall be able to integrate and correlate multiple sources of data, e.g. NIMA products, multi-spectrum imagery, text

information, and metadata, in separate files or other databases. In addition, the database should handle in an efficient manner the objects that exist on, above, and below the earth's surface. These objects may be very stable, semi-stable, and/or dynamic in nature. And the objects may interrelate. The design must allow the user to input, update, maintain, and use the information in a natural fashion in near real time. And it needs to incorporate capabilities for verification and validation of data content and relationships in the context of its own data. If significant inconsistencies appear in the data, the methodology should flag them so the user has a chance to resolve them. And the database should have a natural, user-friendly human-computer interface that makes it easy to use. Most of all, the database design shall support Synthetic Environment Data Interchange and Representation Specification (SEDRIS) as the native method for data interchange.

PHASE I: Investigate database designs and human-machine interface designs to efficiently handle SNE database requirements. Identify those database designs and human-machine interface designs that show the most promise in terms of system performance, ease of population, ease of change, ease of maintenance, and ease of use. Also, investigate methodologies to identify, locate, access, filter, fuse, reason about, and present information in response to queries on the data in this database and other data sources. Identify those methodologies that show the most promise in terms of completeness, accuracy, efficiency, and utility.

PHASE II: Develop and demonstrate a prototype database and human-machine interface that implements the best designs identified in Phase I. Assess the usefulness of the prototype database and human-machine interface in terms of system performance, ease of population, ease of change, ease of maintenance, and ease of use. Also, develop and demonstrate a prototype SNE database generation capability that implements the methodologies identified in Phase I. Assess its usefulness in terms of completeness, accuracy, efficiency, and utility.

PHASE III DUAL USE APPLICATIONS: In addition to military applications, the design methodology and tool described above are necessary to revolutionize civilian modeling and simulation functions, such as the entertainment and education applications.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: This Synthetic Natural Environment Database Design Methodology and Tool will reduce the operating and support cost that can address the requirements of ACR, RDA and TEMO domain of M&S users. New SNE database design methodology will be required to answer this multi-domain, multi-resolution interoperability challenge.

REFERENCES:
1. Synthetic Environment Data Representation & Interchange Specification (SEDRIS) Background (http://www.sedris.org/abt_trpl.htm)
2. STRICOM Synthetic Environment & Technology Management Division (ES) (http://www.stricom.army.mil/STRICOM/E-DIR/ES/)

KEYWORDS: Synthetic Natural Environment, Simulation Based Acquisition, ACR, RDA, TEMO, Synthetic Environment Data Interchange and Representation Specification (SEDRIS)

A00-166 TITLE: Advanced Technology for Real-Time Image Generation

TECHNOLOGY AREAS: Information Systems, Human Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Project Manager for Combined Arms Tactical Trainer

OBJECTIVE: To identify technology advances required to enable the use of lower cost PC graphics as the real time image generation for military virtual simulation; to develop tools and integrate the required capabilities using PC image generators.

DESCRIPTION: The entertainment industry has driven the development of sophisticated, powerful graphics for image generation However, the commercial graphics market has not developed key features which are essential for real time military visual simulation. These include: rigorous scene management to ensure deterministic image update rates; screen fill optimization; state change independence; texture precision sufficient to properly render high resolution, narrow field of view magnified imagery for simulated sighting devices; and military sensor effects such as automatic gain and level control; hot spot and target tracking; and programmable, sensor-peculiar effects such as ac coupling, noise, and line dropout. Further, commerically available PC graphic systems do not package well for multi-channel military virtual simulation applications, do not allow flexible load leveling across channel boundaries, and lack important video control techniques such as head tracking, channel independent sync offset, video reversal, image mirroring, non-linear image mapping, and variable resolution area of interest imagery. Commerical systems additionally lack other features which must be integrated for military simulation, such as pixel rate fog and sufficient levels of translucency to allow proper simulation of military obscurants. Commercial PC graphics addtionally lack other capacity related features such as subpixel z calculation accuracy; adequately sized texture memory, texture paging bandwidth; and sufficient dynamic range for rendering of luminance levels for image intensification device simulation.

PHASE I: Proof of principal demonstration of cost effective, multiple channel, PC based image generation system to address one or more of the issues described above. The demonstration should provide a real-time simulation for sensors, or rotary wing or ground vehicles, with basic capabilities for military simulation. Include a market survey and recommendations for solution of remaining problem areas with application of evolving technology.

PHASE II: Perform the full integration of a PC based image generation capability for a complex military simulation application (sensor/rotary wing/ground vehicle). This phase will address the implementation of capabilities required for real time image generation for a military training system, including channel synchronization, fixed frame rate capability, scene management tools, mission function capabilities, and video control techniques.

PHASE III DUAL USE APPLICATIONS: Commercial sales for PC based image generation systems for the military and commercial simulation market and simulation based acqusition for operational military systems.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Image generation systems for current military virtual simulation cost from $30,000 to $300,000 per channel (viewport) depending on feature set and update rate. The proposed system would cost $10,000 to $25,000 per channel (viewport), depending on feature set and update rate. The proposed system is a candidate for the "technology insertion through spares" program for a wide variety of military programs which have image generation systems ending their supportable service life, since the acquisition cost of the proposed PC based image generation system compares with the operating and maintenance cost of the image generation current system.

REFERENCES:

1. http://www.stricom.army.mil/PRODUCTS/PC_BASED_TECH/

2. "Preliminary Testing of Low Cost Visualization Systems Using Public Domain Benchmarks", by Rodney Rogers, Gary Green and Brian Goldiez; 1 Feb 1998, Institute for Simulation and Training, prepared for contract number N61338-97-K-0010

3. "A Characterization of Low Cost Simulation Image Generation Systems", by Curt Lisle and Michelle Sartor; Sep 1997, Institute for Simulation and Training (IST-CR-98-02).

4. "Comparison of Military and Commercial Specifications for Visual Systems", by Gary Green and Brian Goldiez; 29 Aug 1997, Institute for Simulation and Training, prepared for contract number N61339-97-K-0010

KEYWORDS: simulation, PC, graphics

A00-167 TITLE: Analysis and Design Tools for Live Instrumentation Infrastructures and Processes

TECHNOLOGY AREAS: Information Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Project Manager – Instrumentation, Targets, and Threat Simulator

OBJECTIVE: Research, design, prototype, and demonstrate a novel approach in the area of collaborative, distributed data modeling and simulation environment, capable of supporting the design and analysis of live instrumentation infrastructures and processes.

DESCRIPTION: United States Army Simulation, Training and Instrumentation Command (STRICOM) develops, acquires, fields and supports simulations and instrumentation for test and evaluation (T&E) and training ranges. While these range simulations and instrumentation consist of a quite diverse set of technologies, one core capability is the error free transmission of multimedia data traffic to include voice, video, audio, telemetry and the allocation of bandwidth required for this capability. T&E live ranges requires large amount of data in the gigabit range, to be collected, analyzed, distributed and processed in near real-time for test control and "after review action" to support various range operations. Live training simulation requires real-time casualty assessments, in either centralized or decentralized, requiring accurate data analysis and processing. These transmissions are raw data and reports to and from live training of thousands of instrumented soldiers and vehicles. In both scenarios, live testing and training mandate accurate, error free transmission of the data with equally strenuous effort applied to the near real time analysis and final reports. STRICOM is fielding state-of- the-art communications systems at White Sands Missile Range, and Yuma Proving Ground, based on Synchronous Optical Network (SONET), and Asynchronous Transfer Mode (ATM) technology. Future acquisition of similar systems is envisioned and planned at Aberdeen Test Center, the Combat Training Center, White Sands Missile Range, Yuma Proving Grounds and home stations worldwide to meet growing demand in our data network traffic requirements. The Project Manager for Instrumentation, Target and Threats Simulators (PM ITTS), and the Project Manager for Training Devices (PM TRADE) seek innovative and creative modeling capability to support the concept, design, acquisition, fielding and support of multi-million dollar high speed communication networks conformed to the open system interconnection (OSI) architecture, and supporting various protocols and equipment vendors. It is envisioned that

this effort will lead a larger effort to establish a modeling and simulation environment that will support simulation based acquisition of these range systems. Therefore, these approaches need to be expandable to the entire array of technologies present in accomplishing T&E and training complex functions. Commercially available research and development network simulation tools like OPNET Modeler may be used in this effort. The project offices desire linking the design effort to Enterprise Resource Planning products such as those from Iona, Baan, SAP, and PeopleSoft. This will demonstrate the complex management structures requiring an advanced integrating infrastructure to support increased competitiveness and decreased time-to-market for such complex products as communications systems.

PHASE I. Develop, model and simulate an integrated and distributed high speed data network architecture based on current range configurations and requirements, and capable of supporting the design, analysis of live instrumentation infrastructure and processes and compliant with Government architecture requirements and Open System Interconnection (OSI) standards.

PHASE II: Taking the results of Phase I, prototype, test and demonstrate the applicability of the conceptual simulation and modeling approach at one of the Army's premier live training centers, including player instrumentation, mobile and fixed communications, knowledge base management, and knowledge utilization. The same methodology would also be applied to one of the Army's premier live test ranges.

PHASE III DUAL USE APPLICATIONS: The proposed development will have application to many commercial markets, including the design of systems for mobile and fixed communications, education distribution and management, emergency management, enterprise management, entertainment, inventory visibility and management, knowledge engineering, navigational, project management, range instrumentation, and transportation. It will be extended in capability and used for system engineering and configuration management during development, fielding and subsequent modification of the Army's test range and training center live instrumentation complexes throughout the early 21st Century.

References:
1. Operational Requirements Document, "White Sands Missile Range Test Support Network", US Army Test and Evaluation Command, 1 October 1992
2. Operational Requirements Document, "National Training Center - Objective Instrumentation System", US Army Training and Doctrine Command, 13 May 1995.
3. The Honorable Jacques S. Gansler, Under Secretary of Defense Acquisition and Technology, "Modeling and Simulation: Designing Affordable Weapon Systems for the 21st Century", Defense Modeling and Simulation Office (June 2, 1998)
4. The Joint Simulation Based Acquisition Task Force, "Executive Summary A Road Map for Simulation Based Acquisition", the Acquisition Council of the Department of Defense Executive Counsel for Modeling and Simulation (4 December 1998).
5. Listing, Simulation Based Acquisition Contacts, Related Internet Sites.
6 ANSI T1.106-1998 Specifications for Optical Parameters.
7. ANSI T1.102-1993 Specification for Electrical Parameters
8. ANSI T1.105-1991 Specifications for Multiplexing Methods to Map Existing Digital Signals (e.g., DS1) into SONET Payloads Signals.
9. ANSI T1.105-1991 Specifications for Criteria for Optical Line Automatic Protection Switching.
10. ANSI T1.105-1991 Specification for Overhead Channels to support Standard Operation, Administration and Maintenance, and Provisioning (OAM&P)
11. OSI reference model
12. ATM forum
13. MIL3 web's site for OPNET: www.Mil3.com/products/library.

KEYWORDS: acquisition, affordability, analysis, communications, complex systems, computing, design, information technology, instrumentation, knowledge management, modeling, simulation, software, systems engineering, and tactical engagement systems, OSI, ATM, SONET

A00-168 TITLE: Automated Interoperability Evaluation Systems

TECHNOLOGY AREAS: Information Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Project Manager for Combined Arms Tactical Trainer

OBJECTIVE: To research, design, prototype and demonstrate a non-invasive, PC-based software tool capable of evaluating levels of interoperability between heterogeneous distributed simulation systems to assist in planning and operation of test/training events.

DESCRIPTION: Disparate simulations use different terrain databases, data models, architectures, man-machine interfaces, and simulation protocols to satisfy varying training related requirements. A software tool that predicts and describes the level of interoperability that exists between simulations will be tremendously useful in planning/executing training and testing events.

The evaluation of how simulations may be used together to satisfy specific test/training and/or research objectives will save a significant amount of time and money. What is needed is a set of test matrices, organized by area of simulation capability, which can provide an objective, measurable level of interoperability between simulations. The levels of interoperability are as defined by the Simulation Interoperability Standards Organization (SISO). For instance, each simulation, communication model, and/or simulation management system would enter system data into a matrix for input into the tool. The tool would then provide an objective evaluation of unique data that could be shared, passed, and understood by the appropriate individuals participants. Such evaluations will provide a blueprint of the weak links that exist between simulations and the standards by which interoperability is evaluated, e.g., the High Level Architecture (HLA). This comparison will define the issues that need to be confronted to provide for fully correlated interoperability in modeling and simulation, in test/training and many other fields.

PHASE I: Develop and demonstrate a prototype test application capable of measuring the level of interoperability that exists between simulations in the areas of terrain databases, Computer Generated Forces (CGF) interactions, simulation protocols, data models, and architectures for a Federation.

PHASE II: Taking the results of Phase I, evolve the prototype into a full test suite that objectively evaluates the interoperability of simulations under controlled conditions.
Develop autonomous software testing capability to identify the level of interoperability for any category of simulation capability according to the SISO.

PHASE III DUAL USE APPLICATIONS: The automated software testing capability has application to many commercial markets, to determine potential connectivity between heterogeneous systems to expand their use. These include the design of systems for mobile and fixed communications, computer based gaming, distributed learning, emergency management, entertainment, inventory visibility and management, knowledge engineering, project management, range instrumentation, and transportation.

REFERENCES: PM CATT Interoperability Interface Connection Description (ICD), www.stricom.army.mil, October 1999

KEYWORDS: architecture, automated, computer generated forces, data model, high level architecture, interoperability, model, simulation, simulation protocol, software, terrain database, test environment

A00-169 TITLE: Next Generation Distributed Simulation Technology -- Capability to Scale Up Networking of Simulations

TECHNOLOGY AREAS: Information Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Manager, Warfighter Simulation

Objective: Develop and demonstrate next generation distributed simulation technology to transfer 100,000 entities from a constructive (e.g., wargaming) or a virtual (e.g., man-in-the-loop) simulation to live operational systems in the field (e.g. National Training Center (NTC), Combat Maneuver Training Center (CMTC), Joint Readiness Training Center (JRTC)) while maintaining data transfer rates that support realistic training and mission rehearsal.

Description: Currently, there are performance risks with both Distributed Interactive Simulation (DIS) and High Level Architecture (HLA) for supporting the next generation distributed simulations. Based upon extrapolating information from current experiments and published data: 1) entities associated with a brigade require 4960 DIS Protocol Data Units (PDUs) per second or 5.9Mbps transfer rate and a T2 line. A simulation or exercise for a core with 100,000 entities is 20 times the size of a "brigade only" simulation or exercise. This means a T4 line is now required and is a significant increase in expense. 2) an HLA experiment has determined that a 200 entity exercise (with no voice channels) requires 1Mbps transfer rate or a T1 line. This means a 100,000 entity exercise will require 1000 times more Mbps or 1000Mbps. The current max line available is a T4 line with 274.76Mbps and this cannot support 1000Mbps. Even with the newly available 1 Gigabyte or 1000Mbps Ethernet, the ability utilize 100 % of that capability is historically not possible. Today, data transfer rates in tightly coupled simulations such as high performance aircraft have a maximum acceptable latency of 100 miliseconds between any two hosts. Also, today's HLA requirement is for many-to-many transmission of object attributes at rates in excess of one update per object per second. There has been no demonstration to date that shows 100,000 entities can be distributed to multiple systems with acceptable data transfer rates. The need for this tecnology is now. For example, one new system acquisition, Intelligence and Electronic Warfare Tactical Proficiency Trainer (IEWTPT) is expected to join a constructive simulation (e.g., Warfighter Simulation (WARSIM)/WARSIM Intelligence Module (WIM)) with brigade and above numbers of entities to ninety operational embedded training simulations operating with intel systems at NTC, CMTC, and JRTC. In summary, new approaches are needed to support increased amounts of network traffic and real time response times that will support any brigade and above exercises utilizating simulations to provide a synthetic battlefield and that also directly interface with operational equipment.

Phase I: The performer of the Phase I effort will develop and provide a proof of principal demonstration of next generation distributed simulation technology. The research shall focus on the area of algorithms for the management of emerging high performance networks. The research will evolve new techniques for information flow and control. While protocols and standards are available for lower performance data flow, the emergence of high performance networks presents new capabilities that can only be harnessed if new protocols are developed first for native stream communications and deployed over Asynchronous Transfer Mode (ATM) infrastructures and integrated as transparent in all-optical core network fabrics. The contractor shall investigate all of the routing services and network and signaling issues, but pay particular attention to reliable, low-latency modes for network performance and assured communication of 100,000 constructive or virtual entities to a live system while maintaining data transfer rates support realistic training and mission rehearsal.

Phase II: Phase II will implement the concepts developed in Phase I and produce a prototype of the next generation distributed systems technology for networking a constructive or virtual simulation to multiple live systems. This will demonstrate the ability to scale up the transfer of information using the new distributed generation technology concepts.

Phase III Dual Use Applications: Distributed systems are used in commerce, industrial automation, and information services. These systems are among the largest and most complex systems in existence. The development of the next generation distributed systems technology developed under phase I and phase II are applicable to these system domains as well as the simulation domain.

References:

Distributed Systems -- Doug Lea
http://gee.cs.oswego.edu/dl/html/encyc.html

"Analysis of a Real-Time HLA Distributed Mission Training Federation"
-- Robert E. Murray, Steve L. Monson, The Boeing Company
(I/ITSEC 99)

Limitations of Internet Protocol Suite for Distributed Simulation
in the Large Multicast Environment -- M. Pullen, George Mason
University; M. Myjak, The Virtual Group; C. Bouwens, SAIC
http://saturn.caps.maine.edu/rfc/rfc2502.txt

Performance Issues for the Light-Weight RTI -- J. Mark Pullen,
Nagesh Kakarlamudi, George Mason University
http://netlab.gmu.edu/RTI/papers/98F-SIW-067a.html

Design for High DIS PDU Traffic Rates -- Jim Keenan, Lockheed Martin
(I/ITSEC 99)

Keywords: simulation, distributed systems, operational embedded training systems

U.S. Army Tank, Automotive, and Armament Research Development and Engineering Center (TARDEC)

A00-170 TITLE: User Interaction Tools Supporting Collaborative Applications in Immersive Virtual Environments

TECHNOLOGY AREAS: Information Systems, Human Systems

OBJECTIVE: To develop software and/or hardware tools which facilitate improved interaction between virtual vehicle representations, vehicle users/developers, and a vehicle operating environment(s) from within a 3-dimensional immersive virtual environment for use in collaborative vehicle development and support processes. These processes include design reviews, operational evaluations, maintenance procedure evaluation, and review of information associated with the various simulation activities used in vehicle development. The following aspects of interaction are of particular interest: (1) user friendly navigation; (2) wireless tracking with improved accuracy; (3) devices to enable natural interaction like gestures using alternate sensory devices to augment or replace vision such as aural and haptic/tactile sensory devices; (4) real-time motion generation and vehicle subsystem behavior models; and (5) means to capture and enter auxiliary data which summarize a collaborative session within the virtual environment. Other aspects of interaction which enhance collaboration and vehicle evaluation processes within an immersive virtual environment will also be considered.

DESCRIPTION: TACOM has developed a capability to utilize virtual prototypes of vehicle systems (which include three dimensional visuals, sound and haptic inputs) within a 3D immersive virtual environment. This capability makes use of TACOM's Cave Automated Virtual Environment (CAVE) devices, located at multiple sites, a Powerwall, and a 180 degree front projection screen to immerse the user and observers within the virtual prototype and environment. This capability facilitates virtual design reviews of developing vehicle systems, both in static configurations and in dynamic operational scenarios. This capability is based on the merger of high-end visualization, 3-D sound, integrated haptic devices, and physics-based system dynamics simulations which combine to place an operator in the virtual vehicle system, allowing operator input to affect system behavior, and providing operator feedback in the form of sight, sound, and motion generated from the system and the environment. In order to improve the robustness and fidelity of the virtual prototype within an immersive environment, new tools are needed which enhance user interaction with the vehicle system and environment. The improved tools are necessary to facilitate early evaluations of developing vehicle systems in a virtual environment. This capability is based real-time simulation, high-end graphic displays, and computer models that provide sufficient fidelity for engineering evaluations and can be implemented to support real-time execution..

PHASE I: Will investigate innovative user interaction hardware devices or software tools used to improve the ease-of-use and robustness of a virtual prototype with an immersive environment. The new device or software will be prototyped and all necessary hardware/software interfaces will be documented. The prototype will be installed within a virtual environment similar to those in use at TACOM-TARDEC and tested with a virtual prototype of a vehicle system. This test should clearly demonstrate the tools functionality, the improvements over existing technology and its potential performance within such an environment.

PHASE II: The contractor shall fully develop the hardware/software tool and interface it with multiple virtual environment devices and software environments (e.g., PTC Division, MPI Vega) in use at TACOM-TARDEC. As part of this development activity, the contractor will conduct related user surveys to specify the types of tools and functionality in demand within the virtual environments market. The contractor will also conduct testing of the new tool using TACOM-TARDEC supplied models and scenarios of representative military vehicle systems and processes. The contractor shall report on the results of the testing to quantify the improvements realized with the fully developed tool.

PHASE III DUAL USE APPLICATIONS: A follow-on dual use program would apply the developed capability to a variety of commercial applications using virtual environments. In this phase, commercialization of the device/software would take place. The functionality of the tool could be extended to meet the particular needs of other commercial applications.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: The use of virtual prototypes and virtual environments are key enablers to implementing DoD's SBA and Army SMART initiatives. Their use in the support of new and developing systems will significantly reduce the time and cost of identifying problems, analyzing alternative fixes, and implementing the selected solution. The routine use of such a capability will reduce operating and support costs such as vehicle replacement and repair.
REFERENCES: SimTLC Web site: www.simtlc.org

KEYWORDS: Virtual Environments, Virtual reality, virtual prototype, immersive environment, collaborative design.

A00-171 TITLE: Advanced Military Diesel Engine, High Temperature Tribology

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

OBJECTIVE: The objective is to investigate and develop high temperature tribological solutions for advanced low heat rejection military diesel engines. Technologies to be considered should include high temperature capable lubricants and friction and wear reduction materials in components where high temperature durability becomes an issue due to borderline lubrication.

DESCRIPTION: Future low heat rejection military diesel engines are anticipated to operate at power density levels of 1.5 HP/CU. IN. and specific heat rejection levels below 18 BTU/HP-MIN. These operating parameters will drive top ring reversal temperatures on the liner and under-crown piston temperatures above 700 F. In order to meet engine power density performance requirements, high temperature tribological solutions will be required. High temperature capable lubricants that have bulk thermal and oxidative stability above 400 F and low deposit forming tendencies above 700 F are desired. Advance friction and wear reduction materials will be necessary for components receiving only borderline lubrication (i.e., piston ring/liner, valve stem/guide, etc.). Engine durability goal of 1000 hours means time between overhauls shall be pursued in all material/design approaches. Lubricant change intervals greater than 200 hours are desired. All approaches considered shall be consistent with Army initiatives to reduce operating and support costs.

PHASE I: The contractor shall research promising engine technologies and provide concepts from a feasibility standpoint. Concepts designs shall be presented and substantiated via analytical calculations, drawings or in the case of hardware initial bench friction and wear type testing under high temperature conditions.

PHASE II: Concepts shall be demonstrated in Phase II on a single or multi-cylinder engine with operating conditions similar to those of a high output low heat rejection military engine. Steady state as well as transient testing for 100-hours or more may be required.

PHASE III DUAL USE APPLICATIONS: Future commercial diesel engine concepts coming forth in the Dept. of Energy "Advanced Diesel Engine Programs" are operating at very high temperatures due to the high brake mean effective pressure levels. These commercial designs of the future will likely require high temperature lubricants and low friction and wear tribological materials for successful long life operation.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: There is potential in this area if lubricant and or materials involved extend service life. Evaluations would have to be made on a case to case basis to determine if service life cost savings offset initial procurement costs. The primary objective here is performance enhancement.

REFERENCES: "Research Needed for More Compact Intermittent Combustion Propulsion Systems for Army Combat Vehicles". AD301691 Nov 1995 Blue Ribbon Committee Report.

KEYWORDS: Lubricants, High Temperature, Tribology

A00-172 TITLE: Architecture Based Integrated Development Environment

TECHNOLOGY AREAS: Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Manager, Future Scout & Calvalry System

OBJECTIVE: Design and develop an open, integrated development environment (IDE) for developing, maintaining, and evolving large-scale weapon system software suites based on architectural design, and suitable for product line development using common architectures. The IDE should effect major measurable improvements in software quality and productivity by integrating case tools which address multiple, disparate, large-scale software design issues concurrently, and permits rapid development, assessment, and evolution of designs.

DESCRIPTION: Current and evolving weapon systems contain large, complex software suites that embody wide assortments of functionality and connectivity. However, available IDEs address only low-level, isolated issues. Current IDEs fail to scale to high level abstractions, simultaneously treat disparate issues, or cross lifecycle processes.

These IDE limitations cause irresolvable integration problems that drastically reduce software reliability, prevent the integration of government-off-the-shelf (GOTS), commercial-off-the-shelf (COTS), and reuse components, and limit the incorporation of important capabilities such as embedded diagnostics and prognostics, embedded training, graceful degradation and limp home capabilities, thereby increasing maintenance and logistic requirements. Software development, maintenance, and upgrade, particularly testing, are problematic and impose excessive costs and delay due to the non-transference of design data between issues and phases, and subsequent incompatibilities. This often forces premature reengineering. Extensive low level coupling between modules, and to hardware, prevent reusing components on variant weapon systems, forcing duplicate development for each weapon system. These problems are growing with the ever-increasing demand for weapon system functionality, and integration into tactical and global command and control systems.

We require an IDE which concurrently handles a wide range of software design and development issues. It should support a process which begins at and scales to high-level abstractions and architectures, and which facilitates systematic and concurrent decomposition to concrete artifacts. The IDE should allow design decisions to be evaluated at all architectural levels. Potential software issues that might be addressed include modularization, functionality, behavior, data handling, performance, timing, reliability, safety, and security. It should provide a basis for specification and validation of quality goals. The IDE should facilitate the development of complete and precise interfaces.

A desirable goal is to enable component-based architecture design and development of a family of weapon systems compliant with emerging standards such as the Joint Technical Architecture (JTA). Although the JTA implementation goals have not been achieved, such architectures are intended to allow the use common components across multiple weapons or platforms, and to be able to "mix and match" weapons and platforms on a "Plug and Play" basis. A useful feature would be facilitation of constrained decompositions for integration of pre-existing GOTS, COTS, and reuse components, and assistance in the resolution of mismatches between existing components and the common architecture.

The IDE should handle a wide range of lifecycle processes. Potential processes include design, implementation, testing, maintenance, and evolution. Stochastic and statistical analysis, evaluation, and testing capabilities are of interest. Design models and artifacts should be integrated across IDE elements (tools) and across lifecycle processes, reducing work duplication, errors, and minimizing unanticipated interactions and consequences. The IDE should facilitate teamwork by specialists concentrating on disparate software issues.

The IDE itself should be built utilizing these principals, facilitating its own evolution, and that of its component tools. The IDE should support the integration of COTs tools. Other potential IDE components and tools may be derived from enhancements and integration of technologies explored in previous DARPA programs focused on evolutionary development of complex systems (EDCS). The success criteria will be in the achievement of major and measurable improvements in software quality and productivity.

PHASE I: CONCEPT EXPLORATION AND DEFINITION: Successful completion of the steps below shall prove that the solution is feasible to take it into Phase II.
- Identify the abstractions, techniques, and supporting tools applicable to the desired design capabilities.
- Identify the abstractions, supporting tools and techniques required build the IDE.
- Demonstrate a design and integration model of the IDE, including user interfaces and data repositories.

PHASE II: DEMONSTRATION AND VALIDATION:
- Produce a prototype IDE based on phase I.
- Demonstrate that the IDE prototype can address the requirements of commercial/military system architectures and satisfy the interests of diverse stakeholders.

PHASE III DUAL USE APPLICATIONS:
- Phase III military applications include items with similar purposes or functionality. Examples of weapon categories with similar or overlapping concerns include guns, artillery, and missiles, which may service similar or multiple target types. Examples of platform categories with similar or overlapping concerns include wheeled and tracked vehicles, and ground and air robotic vehicles.
- Phase III civilian applications are vehicles with similar functionality, such as a manufacturer's line of products, or components used by multiple manufacturers, such as power train controls, brake and suspension controls, communications, and navigation equipment. Many of these commercial items could be adapted by the military if compatibility issues could be resolved (which would be facilitated by the proposed IDE).

OPERATING AND SUPPORT COST (OSCR) REDUCTION: The system should demonstrate the to ability to reduce operating and support costs by:
- Creating systems which fewer inherent constraints and defects.
- Integrating multi-mode capability into products, including diagnostic, prognostic, embedded training, and graceful degradation capability, thereby reducing maintenance and logistic requirements.
- Integrating interchangeable sub-components including GOTS, COTS and reuse components.
- Reduce the cost of integrating expert knowledge into product design and maintenance.
- Reduce the cost of maintaining a software trouble report and software upgrade system.

PRESIDENT'S INITIATIVES: The systems should support the following presidential initiatives:
- This project will provide tools necessary to produce large systems quickly and efficiently.
- This project will enhance the use of product line architectures and reuse.
- This project will enhance the ability to construct systems of systems.

REFERENCES:
1. Fischer, G. Redmiles, D., Williams, L., Puhr, G., Aoki, A., and Nakakoji, K. Beyond Object-Oriented Technology: Where Current Approaches Fall Short, Human Computer Interaction, Vol. 10, No. 1, 1995, pp. 79-119.
2. Medvidovic, N., Richard N. Taylor. Exploiting Architectural Style to Develop a Family of Applications. IEE Proceedings Software Engineering, 144. Number 5-6, pp 237-248 (October/December 1997).
3. Richardson, D.J., and A.L. Wolf, "Software Testing at the Architectural Level", N.S. Eickelmann and Debra J. Richardson, Evaluating Software Testability based on Software Architecture", ISAW-2: Proc. Of the 2nd Int. Software Architecture Workshop, San Francisco, October 1996.
4. Robbins, J., Hilbert, D., and Redmiles, D. Extending Design Environments to Software Architecture Design, Automated Software Engineering, Vol. 5, No. 3, 1998, pp. 261-290.
5. Rosenblum, D.S., "Reconciling Software Architecture Models and Software Component Standards", Politecnico di Milano, Milan, Italy, and Tech. Univ. Wien, Vienna, Austria, Jan, 1999.
6. Taylor, Richard N.. Integrating Architecture Description Languages with a Standard Design Method, The Twentieth International Conference on Software Engineering (ICSE'98, Kyoto, Japan), April 1998.

KEYWORDS: software, development, architecture, integration

A00-173 TITLE: Lightweight Durable Titanium Tank Tracks

TECHNOLOGY AREAS: Ground/Sea Vehicles

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Deputy Project Manager, Crusader

OBJECTIVE: Develop a low-cost manufacturing process using low-cost titanium, fabricate and assemble a lightweight durable track for a 50 to 55-ton combat vehicle.

DESCRIPTION: Combat vehicles use a track drive system for better maneuverability. The track components are usually made from high-strength 4340 steel. Appreciable weight savings can be realized by going to titanium track components. For a ground combat vehicle, the Army is not willing to pay a high premium for the titanium-based tracks. Material cost premiums will be off-set by: a cost effective manufacturing process, reduction in life-cycle cost (through improved durability) and a reduction in fuel consumption through reduced track weight (Ti = 60% weight of steel).

PHASE I: Develop titanium tracks, taking into consideration the unique mechanical and physical characteristics of titanium. The track shoes also use rubber pads; decreased heat dissipation from the track shoe body can cause rubber blowout. This factor must

also be considered in the design of the track. Due to a lower elastic modulus and poor galling characteristics of titanium, a complete titanium track may not be feasible, as is the case in steel. A detailed analysis must be conducted to establish what parts of the track can be made of titanium and what parts have to be made of other materials, without sacrificing performance or durability. This may involve an innovative approach to solving the problem of wear resistance of the track center guide vanes and track shoe grouser. The concurrent development of a cost-effective manufacturing process to offset any increase in either materials or current manufacturing costs is essential to Phase I.

PHASE II: Manufacture track pitch assemblies for lab and field-testing. Conduct lab testing to assure material properties are met including fracture toughness, fatigue life and wear. Wear test should simulate actual wear life of the parts, which should include grouser, center guide vanes, end connectors, rubber bushings etc. Fabricate, assemble and test a vehicle track set with and without the rubber pads. Conduct cost analysis capturing the production cost of the track.

PHASE III: DUAL-USE APPLICATIONS: The major obstacle to the widespread use of titanium in the commercial market is it's cost. The evaluation of a low-cost titanium from the standpoint of their use for transportation and military application is of substantial interest to the commercial automotive and transportation industry. This effort would benefit automotive, transportation, and military markets.

KEYWORDS: Titanium, Tank Tracks, Durability, Pitch Assembly, Track Strand, Track Fatigue Life, Track Wear.

REFERENCE: 1. Kinas E. N., "Titanium alloy for T-109 Medium Tank Track Development of Processing Procedures and Manufacturing Techniques", Watertown Arsenal Laboratories Technical Report, Technical Report No. WAL TR 401.5/1, 1961.

A00-174 TITLE: Increased Service Life, Performance and Durability of Filtration System Components For Military Vehicles

TECHNOLOGY AREAS: Ground/Sea Vehicles

OBJECTIVE: The objective of this effort is to study, design, develop and test filtration system components which will lead to reduced spare parts purchases and overall military vehicle cost savings. High military vehicle's density fleets will show increased savings. Individual efforts will focus on improvements in the three following filtration areas: (1) increased air cleaner service life and air filter increased number of cleanings capability, (2) develop new technology engine oil filter with increased performance and extended life, and (3) develop new technology engine fuel filter which provided increased capacity for extended service intervals and increased performance and efficiency to reduce maintenance.

DESCRIPTION: New technology filtration concepts will be studied, designed, developed and evaluated to determine where cost savings can be best realized from the three specific filtration areas of engine induction air, engine oil filter/filtration and engine fuel filter/filtration. Air filtration system improvements will look at increasing the service life interval will maintaining requirements of current military vehicle air cleaner specifications. Air filtration media technology areas will focus on filtration system design where barrier filter media will exhibit long life before requiring servicing or has long life properties or toughness for repeated cleanings without failure. Fuel filter/filtration and oil filter/filtration technologies will be developed to show increased life extension, cleaner and more efficient oil and fuel filters. Oil and fuel filtration technologies for military vehicles require smart innovations to determine when oil and fuel filters should be replaced based on being used up or in contaminated condition rather than being replaced on a mileage or time period. Fuel filtration technologies for military application have a need to exhibit a temporary by-pass fuel system to reduce fuel system failures in war time where completing a mission is essential. Oil filter/filtration technologies will exhibit a capability to increase the engine oil change interval. All these filtration technologies in addition to cost savings will have an environmental impact by reducing the number of filters currently being dumped into landfills.

PHASE I: In Phase I the Contractor will become knowledgeable of filtration systems on current military vehicle fleets and military vehicle operational annual mileage and usage conditions. The new proposed filtration system concept must consider military environments, and performance specifications that military vehicles operate in. The proposed filtration concept must consider engine manufacturer requirements for induction air, fuel and oil as applicable to a particular engine design and be able to interface and fit within tight volume constraints of existing filtration components. The contractor will establish preliminary design, performance and sizing of new filtration concept to verify if the new design concept is doable. Preliminary performance lab testing or obtained data of existing filtration system components either on or off a particular military vehicle will verify compatibility and increased performance of new filtration concept. Design goals will be to provide hybrid adaptability, flexibility and commonality with current vehicle filtration systems. As appropriate, an economic analysis will be performed to verify cost savings potential using the new filtration concept. At the conclusion of Phase I the proof of principle must be demonstrated and enough evidence presented to verify the new filtration system design (may be up to three candidate design concepts nominated) improves service life and/or operation and support cost (OSCR) reduction to military vehicles.

PHASE II: In Phase II the contractor's filtration concept design or designs will be extensively lab tested at his facility to verify best design concept (for example three slightly different fuel filter designs may come out of Phase I). The contractor will down select to the best design concept based on lab findings and trade-off analysis. The selected filtration concept design will be re-engineered where necessary to substantiate service life improvements and reliability. The contractor will continue to harden the filtration concept design by making additional design changes to fine tune where necessary to meet service life extension goals and demonstrate a continued operation and support cost (OSCR) to military vehicles. The filtration concept design will be lab tested repeatedly by contractor until it's durability is equal to or better than the production filtration system it is replacing or being added to. The contractor will also study the new filtration prototype to produce a new component with a projected design to cost equal or better than current production filtration components used in military vehicles. Upgrades will include design hardening to withstand rigorous contractor lab testing which will simulate future field testing of the filtration prototype in Phase III. The Phase II prototype will demonstrate an increased technical capability verified by lab tests and technical assessment. At the conclusion of Phase II the contractor will deliver one prototype filtration component.

PHASE III DUAL USE APPLICATIONS: If the above programs are successful they will lead to direct application to the military and the commercial market. Commonality includes commercial Hummer and military HMMWV. Also the M915/M916 Series trucks are a commercial vehicle which the Army buys and dual-use application would directly apply. At this time partnering with another company who is in development and manufacturing of a similar component should be considered. This may lead to obtaining skills and expertise in future manufacturing efforts.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Any time you can increase the service life of a filtration component albeit (air, oil or fuel) the maintenance time for servicing drives the operating and support cost (OSCR) reduction. Fewer components are also needed through the supply system resulting in cost savings. Re-cycling savings are realized because of less used filters whether it be through direct costs paid to a contractor service or direct landfill costs.

REFERENCES: (1) National Training Center (NTC) Looking to Oil Life Extension, Through On-Board Filtration, AMC-FAST Semi-annual Report Oct 88 - Mar 99.

(2) Filter Element Performance Spec MIL-PRF-46736E, 20-Hour Minimum Desired Service Life vs. HMMWV's Present Capability of 16 Hours.

(3) HMMWV TM Manual Limits HMMWV Air Filter (Paper Media) to Maximum of Three Cleanings, Requires More Durable Filter Media to Increase Cleaning Capability.

(4) M939 Truck Lubrication Order, Replace Engine Fuel Filter Every 3,000 Miles or 3 Months Whichever Occurs First, Need Extended Interval.

KEYWORDS: Filtration, Service Life, Oil Filter, Fuel Filter, Air Filter, and Extended Service Interval

A00-175 TITLE: Suppression of Thermal Emission from Exhaust Components Using an Integrated Approach

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

OBJECTIVE: Develop an integrated approach to obtaining cooler exhaust temperatures which has minimal impact on vehicle weight, power, and internal space.

DESCRIPTION: It is desirable to reduce the thermal emissions from external exhaust components of military ground vehicles without impact on other vehicle systems. This program will investigate exhaust suppression virtual design, and exhaust suppression optimization using modeling techniques and hot flow testing. There are a number of suppression approaches that could be explored including ambient air mixing, convective cooling the exhaust components, exhaust outlet physical design, venturi effects, placement of intake and coolant air grills, obscuration shielding, and other innovative technologies.

PHASE I: This phase will investigate innovative exhaust design approaches by developing virtual design models and computer prediction of exhaust system performance. Virtual geometry changes and hardware modifications will model to quantify the relative performance of virtual hardware designs.

PHASE II: This phase will expand the exhaust system virtual design study by fabricating R&D test models for Government testing in Government hot flow test facilities. This phase will quantify hardware performance and provide optimization of the virtual designs.

PHASE III DUAL USE APPLICATIONS: A follow-on dual use program would apply the exhaust outlet virtual modeling to commercial applications in thermal energy control, heat shielding, exhaust flow analysis, and engine cooling system design.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Optimization of the exhaust and cooling air systems on combat vehicles can reduce exhaust system back pressures and provide reduced vehicle fuel consumption. Reduced thermal signatures will increase vehicle survivability and combat effectiveness.

REFERENCES: Combat Vehicle Exhaust Characteristics and Exhaust Suppression Techniques: A medium-sized combat vehicle has a 300 horsepower diesel engine. The primary thermal signature source is the engine exhaust gas outlet, which requires a flow area of 15 to 25 square inches and averages 100 to 300 degrees Centigrade above ambient air temperature. The secondary thermal signature source is the engine cooling air exhaust outlet, with an unobstructed area of 200 square inches which averages 20 to 40 degrees Centigrade above ambient air temperature. An exhaust suppression system reduces the infrared radiation from the exposed exhaust components and secondarily reduces the temperature of the exhaust gas flow. This is accomplished by hiding the hot internal components from view and reducing engine exhaust gas temperatures by mixing with engine cooling air and external ambient air. Exhaust nozzles, ejectors, high performance insulations, air gaps, and radiation shields are some of the approaches used to keep visible exhaust components as close as possible to ambient air or terrain background temperatures. Thermal suppression design innovation is required due to limited internal volume, cooling system requirements for desert operation, and exhaust outlet armor requirements.

KEYWORDS: Signature management, signature reduction, automotive exhaust, ground vehicles, thermal management, thermal modeling.

A00-176 TITLE: Prediction of Time to Failure of Automotive Tires Using Remote Sensing

TECHNOLOGY AREAS: Ground/Sea Vehicles

OBJECTIVE: Design and build a portable thermal imaging diagnostic system that is capable of detecting faulty or damaged tires on moving trucks.

DESCRIPTION: Recent advances in thermal imaging cameras, image/data capture boards, and software development makes it feasible to detect faults in tires before they fail. Two accidents, one fatal, resulted from tire failure on two military vehicles assigned to the Arkansas National Guard. Applying commercially available thermal imaging technology could avert such accidents. Tire failures are typically preceded by excessive and/or localized heat generation; a direct result of increased localized strain, which causes increased heating within the rubber compound. It may be possible to estimate the mean time to failure of a tire having an observable anomaly based on data from the thermal imager. What is required is the application of current thermal imagery technology to tire diagnostics; it is already being used in medical and manufacturing settings.

PHASE I: Conduct a feasibility study for using Thermal Imagery and the analysis of the data from the imager as tools to differentiate between good tires and defective tires while they are truck mounted and at operating temperatures. This Thermal Imagery system should be capable of diagnosing the defective tires.

PHASE II: Develop a prototype thermal imaging tire diagnostic system and demonstrate its effectiveness. This requires the establishment of failure modes that are recognizable to the software processing the data transmitted from the thermal imager. Develop and execute a test plan. Capture data from good tires and from tires with known faults, analyze the data and incorporate the results into a model for predicting time to catastrophic tire failure. Evaluate the ability of the software to identify and signal thermal signature anomalies in real time. The project will demonstrate the capability of the software, in conjunction with available thermal imaging systems, computer and recording equipment. This effort will take approximately 15-24 months. This technology application is based on the utilization of commercially available components for the capture, recording and baseline comparison analysis of military truck tire generated thermal signatures. The system should be portable and capable of operating in either a field or laboratory environment.

PHASE III DUAL USE APPLICATIONS: This technology will have application to both military and commercial tires. The results could be incorporated into automated test facilities, which could be installed near weigh stations and in commercial trucking facilities. Weigh stations could identify trucks having tires that are near failure and could estimate when the failure is expected.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: This technology has the potential to significantly reduce Operating and Support Cost for both military and commercial vehicles by aggressively identifying componet flaws prior to catastrophic failure, and allowing for planned and scheduled maintenance, rather than vehicle downtime, loss of performance while awaiting necessary parts or repair facilities, and the tremendous costs due to injury or death as a result of catastrophic accidents.

REFERENCES: Paper, "Determination of Failure Modes of Truck Tires Using a Thermal Imaging Inspection Section (TIIS), Mr. Douglas Miller, U.S. Army Tank-automotive and Armaments Command, and Mr. Ferdinand Zegel, Radian, Inc., Aug 99.

KEYWORDS: Operating and Support Cost Reduction, Processes Improvement for System Maintainability and Life Extension.

A00-177 TITLE: Innovative Design for Light Tactical Vehicle Brake Rotors & Pads

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Manager-Ground Combat Sysytems Support

OBJECTIVE: Innovative approaches in design of wheeled vehicle braking components with advanced/exotic materials and creative manufacturing processes to enhance braking performance, increased safety, reduce O&S Costs, increase durability and reliability in Light Tactical and non-tactical wheeled vehicles.

DESCRIPTION: The Army's wheeled vehicle fleet continues to incur high usage of brake components either from premature wearout or catastrophic failure during Army operations. Recent advances in high performance braking may offer potential significant opportunities for improvement in life and performance of Army vehicles. Some of these advances using new materials could improve resistance to conditions like climatic extremes and salt water. Companies such as BREMBO braking systems and Motor Sports have been researching "alternative materials" in their braking systems. Normal driving conditions as well as steep, mountain passes and famous racing circuits are being tested by BREMBO. By further researching creative brake technologies that are developing in the auto sports world or other
commercial applications, the efficiency of the braking systems could be improved as well as enhance the operational safety within the Army's tactical vehicle fleet.

PHASE I: Research new materials/compounds that could be used in the design of brake components and possibly construct in the laboratory a set of components that could be compared to those used in the existing Army inventory. The researcher would be required to offer a detailed comparison of predicted performance as well as potential durability in the military's operational environment. The research could include innovative approaches in the manufacturing processes that would enhance the performance and life of the brake components. Smart components that can identify to or alert the operator of impending failure or performance
degradation may be considered.

PHASE II: After comparisons are performed, investigations into why one design, process improvement, or one material (s) performs better than others would be required. A detailed outline including milestones would be required to show how the Army could implement any recommended new designs/changes into the light vehicle fleet. Implement the recommended plan for phase II with verification of enhancements being performed with a variety of tools, to include simulation and virtual testing. Operational testing would take place at either a government-testing site or at a military fort, camp or post.

PHASE III DUAL USE APPLICATIONS: Technologies developed during this SBIR project would allow a dual use opportunity for the automotive and trucking industries with the US Army and other services utilizing light tactical vehicles. The better performing and longer lasting brakes and components would be attractive to original equipment manufacturers and the Army could leverage their production quantities to reduce the acquisition costs for brake systems for the military vehicles HMMWV, COMBATT, and Severe Duty Pickups.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Operating and Support Cost Reduction would be a benefit beginning during the dual use application phase. Brakes and brake components are high demand items in the sustainment of all tactical vehicles within the army. The maintenance of the brakes is in most cases very difficult and most often require complex procedures. A minimally successful program would result in reduced acquisition costs as well as significant maintenance savings. Better performing brakes would also reduce the amount of down time for vehicles and personnel as a result of accidents.

REFERENCES:

http://www.brembo.com/development.htm#BREMBO

http://www.sccapro.com/wc/carfacts.html

KEYWORDS: brakes, brake pads, brake rotors, motor sports; racing; trucks; pickups, hybrid, electric, motors, aircraft, exotic, sensors, manufacturing processes

A00-178 TITLE: Integration of Hybrid Electric Vehicle Design Tool and Signature Tool for 21st Century Truck Total Thermal Management System

TECHNOLOGY AREAS: Ground/Sea Vehicles

OBJECTIVE: Develop a total thermal management system to analyze the complete thermal impact and thermal signature of advanced propulsion technology on combat vehicles and the next generation trucks.

DESCRIPTION: The Army's next generation weapon systems and tactical vehicles need to be smaller, lighter, and more efficient to accomplish Army 2010 and Beyond objectives. In order to meet these goals and still maintain high survivability, computer analysis tools must be utilized during the design phase to optimize the vehicle's performance before build and test. TARDEC's current signature modeling tool has proven commercially useful for automobile design in addition to combat vehicles (Demonstrated by it's use by FORD, GM and Chrysler engineers). In addition, a new Hybrid Electric Vehicle design tool is being developed to assist the Army in the improvement of advanced propulsions systems. The Army requires an innovative integration of the capabilities of simulations of these types to address it's rapid prototype needs, to analyze the impact of these new propulsions systems on survivability and creative ways to address problems (such as camouflage placement), and to create a total thermal management system for next generation weapons systems and the 21st Century Truck. This advanced simulation will give the Army the technical boost it needs to produce a lighter yet survivable force.

PHASE I: Design an innovative simulation capability of predicting the effect of advanced propulsion systems on ground vehicle and background signatures. This includes investigating approaches to perform threat based parametric studies for optimized camouflage solutions including pattern creation and selection and material properties selection and placement. Investigate approaches for shortening the time needed to build models using automatic meshers/re-meshers or meshless solutions. Identify and prioritize the unique modeling needs of designers of quick deployment light forces and the 21st Century Truck during this investigation.

PHASE II: Develop a prototype of the advanced capabilities investigated in Phase I. Demonstrate the capability of whole scene rendering including propulsion effects interacting with the vehicle and background.

PHASE III DUAL USE APPLICATIONS: The capabilities demonstrated in Phase II would be of great use to the government and it's contractors who design weapon systems. If successful, TARDEC would financially support the commercialization of this effort. (A real life example of this is the thermal model now used by the Army which is a proven dual use commodity and has moved into Phase III.) The faster model building capabilities described here are needed for commercial rapid prototyping as well as computer animation markets. Optimized propulsion systems can be tailored for Hybrid Electric Vehicles creating more environmentally friendly commercial and military designs. The video game industry is employing physicists to add realism to video games and the vehicle/background interaction capability could be valuable to a very competitive market

OPERATING AND SUPPORT COST (OSCR) REDUCTION: More efficient and economical propulsions systems will naturally reduce operating costs over the life of the vehicle

REFERENCES: PITAC - Report to the President Information Technology: Transforming our Society, Chapter 1.7 Transforming How We Design and Build Things: "High-end computing technologies are needed for concept design, simulation, analysis with interactive control and computation steering, the mining of archived data, and the rendering of data for display and analysis."

KEYWORDS: Modeling and Simulation, Signature Management, Thermal Management, Exhaust, HEV, Ground Vehicles

U.S. Army Topographic Engineering Center (TEC)

A00-179 TITLE: Abstraction and Removal of Feature Data to Generate Bare Earth Models from LIght Detection and Ranging (LIDAR) Technologies

TECHNOLOGY AREAS: Battlespace

OBJECTIVE: To develop improved methodologies and techniques to identify, classify, and remove urban structures, transportation networks, power and communication towers, and vegetation features from high resolution DEMs generated from LIght Detection And Ranging (LIDAR) technologies.

DESCRIPTION: LIDAR-topographic-mapping systems have considerable promise for producing high-resolution digital elevation models. The integration of satellite-communications and GPS-navigation systems are critical parts of LIDAR-mapping systems. Many of the available LIDAR sensors can collect ground points at sub-meter spacing which can be processed into a high resolution DEM with a vertical accuracy of 15 cm or less. Many cultural and vegetation features are included at these resolutions and accuracies.

There is considerable interest within the Army regarding the utility of high-resolution digital elevation data. The availability of such data has the potential for significant enhancements to the responsiveness, flexibility, and performance of numerous systems and operations

PHASE I: The contractor shall evaluate the various component technologies that need to be combined to accurately identify delineate, and separate for removal or export both cultural and vegetation features from high resolution DEMs produced from LIDAR sensors. The various technologies that need to be considered include: 1) establishing terrain editing tools to effectively combine varying resolution DEMs, 2) develop processing filters and utilities to effectively compare and contrast both cultural and vegetation features within the terrain models, 3) and explore the use of airborne imagery to assist in the removal of cultural and vegetation features in developing a bare earth terrain model. The researchers evaluations should preferably include hands-on valuations from multiple LIDAR data sets during the phase I development.

PHASE II: Will accumulate the processing capabilities that are defined in Phase I into a prototype system. The prototype system will further develop and apply these emerging processing capabilities to support a broad range of civil engineering and military applications. The utilization of the LIDAR data for these applications will result in the production of end products suitable for execution of civil engineering tasks to providing timely information for military operations.

PHASE III: This SBIR would result in a technology with broad applications in the civil community, where LIDAR based mapping is advancing rapidly. This SBIR addresses the research issues associated with the next generation of LIDAR based mapping. It would be of particular interest to local and state governments, as well as the emergency management/disaster relief and environmental communities.

REFERENCES: K. Mclintosh, A. Krupnik and T. Schenk, "Registration of airborne laser data to surfaces generated by photogrammetric means", Workshop on "Mapping surface structure and topography by airborne and spaceborne lasers", La Jolla, CA, November 9-11, 1999.

D-C. Lee, B. Csatho, and S. Filin, "Analysis of accuracy of airborne laser scanning over urban areas", Workshop on "Mapping surface structure and topography by airborne and spaceborne lasers", La Jolla, CA, November 9-11, 1999.

P. Gamba and B. Houshmand, "Integration of high resolution imagery with LIDAR and IFSAR data for urban analysis application", Workshop on "Mapping surface structure and topography by airborne and spaceborne lasers", La Jolla, CA, November 9-11, 1999.

C. Toth and D. Grejner-Brzezinska, "Integrating LIDAR with direct digital imagery", Workshop on "Mapping surface structure and topography by airborne and spaceborne lasers", La Jolla, CA, November 9-11, 1999.

Eckmullner et al. "Vegetation types, buildings and roads from laser scanner data within a forest enterprise", Workshop on "Mapping surface structure and topography by airborne and spaceborne lasers", La Jolla, CA, November 9-11, 1999.

J. Jaafar, G. Priestnall and P. M. Mather, "The effect of grid resolution of Lidar DSMs on the categorizing of residential and industrial areas", Workshop on "Mapping surface structure and topography by airborne and spaceborne lasers", La Jolla, CA, November 9-11, 1999.

Z. Wang, and T. Schenk, "Building extraction and reconstruction from Lidar data", Workshop on "Mapping surface structure and topography by airborne and spaceborne lasers", La Jolla, CA, November 9-11, 1999.

Carter, Bill. University of Florida, "Airborne Laser Swath Mapping: Digital Terrain Modeling of Marsh Areas", Fifth International Conference on Remeote Sensing for Marine and Coastal Environments, October 1998.

Duffy, Mark. National Park Service, "Processing , Integration , and Application of LIDAR Survey Elevation Data in a Local GIS", Coastal GeoTools 1999.

Gutierrez, Oskar. University of Texas at Austin, "Airborne Laser Swath Mapping of Galveston Island and Bolivar Peninsula", Fifth International Conference on Remeote Sensing for Marine and Coastal Environments, October 1998.

Jansen, Mark. NOAA Coastal Services Center, "Using Airborne Laser Topographic Data to Examine North and South Carloiina Beach Dynamics", Coastal GeoTools, 1999.

Wright, Wayne. NASA Wallops Island, "High Resolution Airborne Topographic Mapping LIDAR - Description and Preliminary Results"

KEYWORDS: High Resolution and Bare Earth DEM, LIDAR, Feature Removal

A00-180 TITLE: Fusing Terrain and Sensor Data During Spectral Feature Extraction

TECHNOLOGY AREAS: Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS PROGRAM: Program Manager, Combat Terrain Information Systems

OBJECTIVE: Improve spectral feature extraction by directly fusing terrain and sensor data to increase the depth of the imagery stack. Reduce supervision efforts that train, stratify, label, and adjust spectral feature extraction. Improve rapid mapping, modeling and simulation systems or programs by reducing the cost and time requirements from spectral feature extraction supervision efforts.

DESCRIPTION: Spectral feature extraction mathematically sorts separated spatial distributions of brightness values within many stacked imagery bands. Current supervision efforts require inordinate involvement by terrain and spectral analysts to train, stratify, label, and adjust spectral feature extraction. Directly fusing appropriate terrain representations along with data from separate sensors to form a deeper imagery stack should reduce the other already developed but more costly spectral feature extraction supervision efforts.

PHASE I: Explore the technical feasibility of directly fusing separate data sources during spectral feature extraction. Find innovative and creative methods of directly fusing terrain representations and data from separate sensors. Develop terrain and sensor data representations, find methods to directly fuse these separate data sources, and apply spectral feature extraction methods and systems to this fused data for rapidly generating or updating the terrestrial environment data of military mobility and concealment models or weapon systems.

PHASE II: Use the phase one concepts and technology to directly fuse terrain representations and data from separate sensors during spectral feature extraction for rapid mapping of terrestrial environments. Reduce supervision efforts to train, stratify, label, and adjust spectral feature extraction from directly fusing terrain and sensor data. Show improvements to military mapping, modeling and simulation systems or programs.

PHASE III: Add these discovered methods and technology into commercial or government modeling and information systems like the Army Combat Terrain Information Systems that use terrestrial environment data from spectral feature extraction. Extend these methods towards generating terrestrial environment feature data for construction or environmental (pollution, flooding, hurricanes, earthquakes, others) civilian applications.

REFERENCES:

Roger Brown, Photogrammetric GIS Technology: Feature Mapping on Digital Stereo Imagery, GIS/LIS'91 Proceedings, November 1991.

Roger Brown, Combined Terrain and Spectral Reasoning Methods, 1998 ESRI User Conference Proceedings CDROM, (http://www.esri.com/library/userconf/proc98/PROCEED/TO400/PAP387/P387.HTM , http://www.tec.army.mil/news/p387.htm , http://www.browns-place.net/stomp/p387.htm), July 1998.

Charles F. Hutchinson, Techniques for Combining LandSat and Ancillary Data for Digital Classification Improvement, Photogrammetric Engineering and Remote Sensing, January 1982.

Bobby Junkins, A Geobased Information System Providing Applications based on LandSat MSS Data, Digital Topographic Terrain Data, and Selected Collateral Data, March 1983, NASA Earth Resources Laboratory Report #219.

Thomas M. Lillesand, Ralph W. Kiefer, Remote Sensing and Image Interpretation, 1979, John Wiley & Sons Incorporated.

KEYWORDS: Terrain Sensor Imagery Spectral Feature Extraction