NAVY
SBIR FY06.2 PROPOSAL SUBMISSION INSTRUCTIONS

The responsibility for the implementation, administration and management of the Navy SBIR program is with the Office of Naval Research (ONR). The Director of the Navy SBIR Program is Mr. John Williams, williajr@onr.navy.mil. For general inquiries or problems with electronic submission, contact the DoD Help Desk at 1-866-724-7457 (8AM to 5PM EST). For program and administrative questions, please contact the Program Managers listed in Table 1; **do not** contact them for technical questions. For technical questions about the topic, contact the Topic Authors listed under each topic on the website before **14 June 2006.** Beginning 14 June, the SITIS system (http://www.dodsbir.net/Sitis/Default.asp) listed in section 1.5c of the program solicitation must be used for any technical inquiry.

TABLE 1: NAVY ACTIVITY SBIR PROGRAM MANAGERS POINTS OF CONTACT

Topic Numbers	Point of Contact	Activity	Email
N06-100 thru N06-108	Mr. Paul Lambert	MARCOR	paul.a.lambert@usmc.mil
N06-109 thru N06-126	Mrs. Janet McGovern	NAVAIR	janet.mcgovern@navy.mil
N06-127 thru N06-142	Ms. Janet Jaensch	NAVSEA	janet.l.jaensch@navy.mil
N06-143 thru N06-165	Mrs. Cathy Nodgaard	ONR	nodgaac@onr.navy.mil

The Navy's SBIR program is a mission-oriented program that integrates the needs and requirements of the Navy's Fleet through R&D topics that have dual-use potential, but primarily address the needs of the Navy. Companies are encouraged to address the manufacturing needs of the Defense Sector in their proposals. Information on the Navy SBIR Program can be found on the Navy SBIR website at **http://www.onr.navy.mil/sbir**. Additional information pertaining to the Department of the Navy's mission can be obtained by viewing the website at **http://www.navy.mil**.

PHASE I GUIDELINES

Follow the instructions in the DoD Program Solicitation at **www.dodsbir.net/solicitation** for program requirements and proposal submission. It is recommended that cost estimates include travel to the sponsoring activity's facility at the end of the phase I. The Navy encourages proposers to include, within the 25 page limit, an option which furthers the effort and will bridge the funding gap between Phase I and the Phase II start. Phase I options are typically exercised upon the decision to fund the Phase II. For NAVAIR topics N06-109 thru N06-126 the base amount should not exceed $80,000 and 6 months; the option should not exceed $70,000 and 6 months. For all other Navy topics the base effort should not exceed $70,000 and 6 months; the option should not exceed $30,000 and 3 months. **PROPOSALS THAT HAVE A HIGHER DOLLAR AMOUNT THAN ALLOWED FOR THAT TOPIC WILL BE CONSIDERED NON-RESPONSIVE**.

The Navy will evaluate and select Phase I proposals using the evaluation criteria in section 4.2 of the DoD solicitation in descending order of importance with technical merit being most important, followed by the qualifications, and followed by commercialization potential. Due to limited funding, the Navy reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded.

One week after solicitation closing, email notifications that proposals have been received and processed for evaluation will be sent. Consequently, e-mail addresses on the proposal coversheets must be correct

The Navy typically awards a firm fixed price contract or a small purchase agreement for Phase I.

PHASE I SUMMARY REPORT

In addition to the final report required in the funding agreement, all awardees must electronically submit a non-proprietary summary of that report through the Navy SBIR website. Following the template provided on the site, submit the summary at: **http://www.onr.navy.mil/sbir**, click on "Submission", and then click on "Submit a Phase I or II Summary Report". This summary will be publicly accessible via the Navy's Search Database.

NAVY FAST TRACK DATES AND REQUIREMENTS

The Fast Track application must be received by the Navy 150 days from the Phase I award start date. Phase II Proposal must be submitted within 180 days of the Phase I award start date. Any Fast Track applications or proposals not meeting these dates may be declined. All Fast Track applications and required information must be sent to the Technical Point of Contact for the contract and to the appropriate Navy Activity SBIR Program Manager listed in Table 1 above. The information required by the Navy, is the same as the information required under the DoD Fast Track described in section 4.5 of this solicitation.

PHASE II GUIDELINES

Phase II proposal submission, other than Fast Track, is by invitation only. If you have been invited, follow the instructions in the invitation. **Each of the Navy Activities has different instructions for Phase II submission. Visit the website cited in the invitation to get specific guidance before submitting the Phase II proposal.**

The Navy will invite, evaluate and select Phase II proposals using the evaluation criteria in section 4.3 of the DoD solicitation in descending order of importance with technical merit being most important, followed by the qualifications, and followed by commercialization potential. Due to limited funding, the Navy reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded.

All awardees, during the second year of the Phase II, must attend a one-day Transition Assistance Program (TAP) meeting. This meeting is typically held in the summer in the Washington, D.C. area. Information can be obtained at http://www.dawnbreaker.com/navytap. Awardees will be contacted separately regarding this program. It is recommended that Phase II cost estimates include travel to Washington, D.C. for this event.

As with the Phase I award, Phase II award winners must electronically submit a Phase II summary through the Navy SBIR website at the end of their Phase II.

A Navy Activity will not issue a Navy SBIR Phase II award to a company when the elapsed time between the completion of the Phase I award and the actual Phase II award date is eight (8) months or greater; unless the process and the award have been formally reviewed and approved by the Navy SBIR Program Office. Also, any SBIR Phase I contract that has been extended by a no cost extension beyond one year will be ineligible for a Navy SBIR Phase II award using SBIR funds.

The Navy typically awards a cost plus fixed fee contract or an Other Transaction Agreement for Phase II.

PHASE II ENHANCEMENT

The Navy has adopted a Phase II Enhancement Plan to encourage transition of Navy SBIR funded technology to the Fleet. Since the Law (PL102-564) permits Phase III awards during Phase II work, the Navy may match on a one-to-four ratio, SBIR funds to funds that the company obtains from an acquisition program, usually up to $250,000. The SBIR enhancement funds may only be provided to the existing Phase II contract. If you have questions, please contact the Navy Activity SBIR Program Manager.

PHASE III

Public Law 106-554 provided for protection of SBIR data rights under SBIR Phase III awards. A Phase III SBIR award is any contract or grant where the technology is the same as, derived from, or evolved from a Phase I or a Phase II SBIR/STTR contract and awarded to the company which was awarded the Phase I/II SBIR. This covers any contract/grant issued as a follow-on Phase III SBIR award or any contract/grant award issued as a result of a competitive process where the awardee was an SBIR firm that developed the technology as a result of a Phase I or Phase II SBIR. The Navy **will** give SBIR Phase III status to any award that falls within the above-mentioned description. The government's prime contractors and/or their subcontractors shall follow the same guidelines as above and ensure that companies operating on behalf of the Navy protect rights of the SBIR company.

ADDITIONAL NOTES

The Small Business Administration (SBA) has determined that the Naval Academy, the Naval Post Graduate School and the other military academies may participate as subcontractors in the SBIR/STTR program, since they are institutions of higher learning.

Any contractor proposing research that requires human, animal and recombinant DNA use is advised to view requirements at website http://www.onr.navy.mil/sci_tech/ahd_usage.asp. This website provides guidance and notes approvals that may be required before contract/work may begin.

PHASE I PROPOSAL SUBMISSION CHECKLIST:

All of the following criteria must be met or your proposal will be REJECTED.

____1. Make sure you have added a header with company name, proposal number and topic number to each page of your technical proposal.

____2. Your technical proposal has been uploaded and the DoD Proposal Cover Sheet, the DoD Company Commercialization Report, and the Cost Proposal have been submitted electronically through the DoD submission site by 6:00 a.m. EST 14 July 2006.

____3. After uploading your file and it is saved on the DoD submission site, review it to ensure that it appears correctly.

____4. For NAVAIR topics N06-109 thru N06-126, the base effort does not exceed $80,000 and 6 months and the option does not exceed $70,000 and 6 months. For all other proposals, the Phase I proposed cost for the base effort does not exceed $70,000 and 6 months and for the option $30,000 and 3 months. The costs for the base and option are clearly separate, and identified on the Proposal Cover Sheet, in the cost proposal, and in the work plan section of the proposal.

Navy SBIR 06.2 Topic Index

N06-150	Streaming data capture box
N06-151	Advanced Fiber Optic Connectors for Condition Based Maintenance (CBM)
N06-152	Desulphurization of Logistic JP-5 Jet Fuel for Enhanced Fuel Cell Operations
N06-153	Semantical Machine Understanding
N06-154	Simulation, Mission Rehearsal, and Training Tools (SMRTTs) for Counter-Terrorism Operations
N06-155	High Sensitivity Midwave Infrared Laser Detection Using Sum Frequency Generation
N06-156	Time-Synchronized Underwater Ranging
N06-157	Holographic Polarimetric Laser Radar for Surveillance and Discrimination
N06-158	Rugged Low Heat Leak Cryogenic Seals and Electrical Quick Disconnects
N06-159	Next Generation Data Base Modeled on Human Neurological Processes
N06-160	Autonomous seafloor geotechnical property sensor
N06-161	Broadband Doppler-Sensitive Waveforms for Energy-Constrained Distributed Active Sonar Systems
N06-162	Dexterous Robotic Manipulator for Small Robotic Platforms
N06-163	Bi-Directional Power Converters
N06-164	Coherent Clocking in Digital Arrays
N06-165	Near-Wall Turbulence and Skin Friction Measurements

N06-100 TITLE: Advanced Equipment Maintenance Training Using Revolutionary Video Game Technology

TECHNOLOGY AREAS: Information Systems, Human Systems

ACQUISITION PROGRAM: Program Management Test, Measurement and Diagnostic Equipment (PMTMDE)

OBJECTIVE: Develop an advanced equipment maintenance training capability, based upon revolutionary video game technology, that is designed to give military personnel real-life equipment maintenance training in a virtual environment

DESCRIPTION: For many years, the U.S. military has been using computer-based training as a training tool for its troops. This type of training often takes the form of a web-based program in which a trainee must read through a long series of web pages full of text information and answer questions via common webpage controls such as edit boxes and radio buttons. Such training, although very effective, often tends to be boring, unchallenging, and somewhat mind numbing with questionable levels of memory retention.

In light of this, there is currently a need in the Marine Corps to provide its equipment maintainers with a cutting edge, graphic intensive, interactive, and highly intuitive video game-based equipment training capability designed to give them training in the use of the Marine Corps automatic test technology to troubleshoot and repair Marine Corps weapon systems. Such a training capability would literally pull the maintainer into learning how to use the Marine Corps' advanced automatic maintenance test technology and a variety of general purpose test equipment, by creating exciting and challenging real-life maintenance scenarios that he must resolve given a predefined set of maintenance resources.

As a maintainer attacks a given maintenance challenge, the immersive and ultra-realistic video game based training system may use state-of-the-art brain wave monitoring technology to measure his level of interaction with the system and intuitively adjust the difficulty and intensity level of the challenge according to its assessment of the trainee's ability to focus and concentrate on a given task. This will, in turn, enhance the trainee's ability to understand and retain new technical concepts that are presented to him during the game. This technology is currently being used to teach children with attention deficit disorder to focus and concentrate better on educational activities via a video game-based learning system, thus improving their learning and memory skills. Much research would need to be done to apply this technology to Marine Corps equipment maintenance.

Upon completing a given maintenance challenge, a maintainer is given a score based upon the amount of time and resources that he took to diagnose and solve the problem as well as upon the level of difficulty of the challenge. He may even choose to compete with one or more other maintainers to see who can diagnose and repair a given maintenance problem the fastest. Such an exercise would challenge maintainers to strive for better scores; hence, improving their troubleshooting skills in the process and continuing to enhance retention.

Video game industry research has shown that an average of one of every three American households has a video game system. In light of this, the use of video game technology for equipment maintenance training should be second nature to a large number of Marine maintainers. Many of them have already spent a great deal of time as teenagers playing with video games and becoming acquainted with a variety of video game controls. Also, by adding the excitement of a video game to equipment maintenance training exercises, Marines may even begin to be drawn to the thrill of the video games' maintenance challenges much in the same way that they would the challenges of a commercial video game.

This same video game technology would also benefit Navy, Army, and Air Force equipment maintainers. In the same way that a video game based training capability can be used to train Marine Corps maintainers in the use of advanced automatic test technology, it can also be used to train troops from the other services in the use of their respective test equipment.

PHASE I: Design a cutting-edge video game-based training system that challenges Marine Corps maintainers to overcome a variety of equipment maintenance challenges using the Marine Corps' advanced automatic maintenance test technology and a variety of general purpose test equipment. The training system must be designed to score maintainers performance based upon the amount of time and resources that they use to perform a given maintenance task and upon the level of difficulty of the task. The level of difficulty of the task is determined by the the system's ability to use state-of-the-art brainwave monitoring technology to measure the degree of interaction that the maintainer has with the system. The less time and resources that he uses to overcome a given maintenance challenge and the higher the difficulty level of the challenge, the better his score.

PHASE II: Develop a prototype video game that implements the video game design that is developed in Phase I.

PHASE III: Develop the video game prototype for field demonstration of equipment maintenance training for specific DoD platform applications. Transition the video game to the fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The proposed novel technology would have broad civilian impact for training equipment maintainers in diagnosing and repairing problems associated with a variety of electronic systems in numerous commercial applications.

REFERENCES:
1. Cpl. Shawn C. Rhodes, 2005. "Training Marines with Video Games", U.S. Military "About" website: http://usmilitary.about.com/od/marinetrng/a/videogame.htm

2. Associated Press, October 3, 2003. "Military Training Is Just a Game", Wired News website: http://www.wired.com/news/games/0,2101,60688,00.html.

3. Murdoc Online, April 8, 2005. "Playing Games With the Troops". Murdoc Online website: http://murdoconline.net/archives/002170.html.

4. BBC News, November 25, 2005. "US Army Cuts Teeth on Video Game". BBC News website: http://news.bbc.co.uk/hi/technology/4460082.stm.

5. Frank Vizard, 2005. "Couch to Combat", Popular Mechanics website: http://popularmechanics.com/science/defense/1674362.html.

6. "Play Attention" website: http://www.playattention.com/main.php

7. "S.M.A.R.T BrainGames" website: http://www.smartbraingames.com/

KEYWORDS: Video game, training, equipment maintenance, computer simulation.

N06-101 TITLE: Development of State-of Charge Technology for Zn/Air Battery Systems

TECHNOLOGY AREAS: Ground/Sea Vehicles, Electronics

ACQUISITION PROGRAM: Marine Corps PM Expeditionary Power Systems, Michael Gallagher

OBJECTIVE: Develop and demonstrate a state-of-charge technology for Zn/Air batteries.

DESCRIPTION: Many missions in remote locations are currently limited by the amount of power that can be carried on foot and/or left in place for unattended equipment operation. Currently non-rechargeable batteries offer better energy densities to rechargeable batteries but these energy densities are still too low leaving the Marine with a large battery burden. Advanced rechargeable batteries are anticipated to significantly reduce the overall number of batteries for Marine Corps Expeditionary units. However, the energy densities of these rechargeable batteries are not expected to see large increase over current state-of-the-art in the near future. In addition these rechargeable batteries must have a sustainable power source to recharge them in the field in order to see any weight savings.

To solve the Marine's battery weight burden advanced metal air batteries are being developed. These batteries are showing promising increase in energy densities, >350 Wh/kg, and can deliver significant power in hybrid configurations. One problem with the metal air chemistry is a lack of state of charge (SOC) indication technology. This technology is currently being pushed in all portable batteries and is very important to the acceptability and full use of metal air technology.

This innovative research is to develop a SOC technology for Zn/Air batteries. In order to develop this technology several environmental factors beyond the discharge profile must be factored into the SOC technology. Some of these environmental factors include temperature, humidity and O2 exposure times. These environmental factors will be influenced by the physical arrangement of the technology including whether it is a forced air system or open air system. Predictions as to the percent error, across a wide range of discharge states, environmental, and storage conditions, should be given for the SOC technology and supported by data. The SOC technology should be small and have a low cost impact on the overall Zn/Air battery. Power consumption for the SOC technology should be minimal over the life of the Zn/Air battery. The Navy will only fund proposals that are innovative and involve technical R&D risk.

PHASE I: Develop and demonstrate innovative Zn/Air SOC system design concepts that address the above requirements. Key acceptability factors mentioned above such as cost, size, and accuracy should be talked about in the final report. Current technology readiness levels (TRLs) should be used to discuss the components needed in the design of the SOC system. Feasibility of the proposed design and anticipated improvements during Phase II should be supported by available scientific test data. Make recommendations for a Phase II detailed design and document in a technical report.

PHASE II: Build and demonstrate one lot of prototype devices suitable for advanced laboratory and supervised field-testing. Develop and implement a test plan that will evaluate the accuracy off the SOC indicator with Zn/Air batteries at various states of charge and under various environmental and storage conditions. Deliver several prototype units for Marine Corps testing. Provide interaction as needed during Marine Corps advanced laboratory testing and limited field-testing of the packaged prototype units.

PHASE III: Prepare a manufacturing plan and marketing plan to sell this product to the government as well as the private sector. Make the necessary teaming arrangements with the manufacturers of the components used in this product.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Advanced metal-air technology is competing in electric vehicle and emergency power markets. SOC technology would be very beneficial for these commercial applications.

REFERENCES:
1. Advanced military batteries for the digital battlefield: A technology challenge by Dick Hooker

KEYWORDS: Zn/Air; Power Sources; State of Charge; Metal Air; Portable Power; Batteries

N06-102 TITLE: EFV Bilge Water Filtration System

TECHNOLOGY AREAS: Ground/Sea Vehicles, Human Systems

ACQUISITION PROGRAM: Direct Reporting Pgm Mgr – Advanced Amphibious Assault (DRPM-AAA) ACAT-1

OBJECTIVE: To provide each EFV Operating Force, Reserve Force and General Support Force Unit with an onsite Hazardous Waste Filtration System to filter EFV bilge water and reduce the Unit's, and ultimately the Marine Corps, hazardous waste disposal costs.

DESCRIPTION: Upon the completion of water operations EFVs have water in their bilges. This water mixes with contaminates that have settled in the hull (bilge) from drips, spills, other and is considered hazardous waste and must

be disposed of in accordance with Federal, State, Local and Base laws and regulations. The contaminates can consist of: diesel fuel (JP-8), hydraulic oil, engine oil, transmission oil, Ethylene Glycol and Propylene Glycol coolant, aluminum shavings, and plastic shreds/shards. Currently, EFV bilge waste water is suctioned from the bilge and stored in drums for disposal as hazardous waste. This contaminated bilge waste water is 95 – 98% water with the remainder some type of hazardous material. Up to 300 gallons of contaminated water can be generated from a single vehicle. The current cost for disposing of EFV bilge waste water at the Amphibian Vehicle Test Branch (AVTB) for a maximum of six vehicles is $20,000.00 per month. Extrapolating current costs to the cost to process the bilge waste water for the entire EFV fleet of 1,013 vehicles is cost prohibitive and will severely impact unit operating and maintenance funds. A cost effective way to separate the contaminates found in EFV bilge water from the water itself so that only contaminates are collected and disposed of with the remaining water being cleaned to where it meets Federal, State, Local and Base requirements that allow the water to be dumped onto the ground, into the ocean or into the Base waste water system. Currently available Hazardous Waste Filtration Systems are large and are permanently ground mounted and therefore are not transportable. Maintenance on these systems, often including filter media removal and replacement, has to be performed by a manufacturer representative. Current systems also use some type of filter media (i.e. carbon) that eventually becomes a hazardous waste, of significant size, that must also be disposed of. The desired complete Hazardous Waste Filtration System needs to have a small footprint, be operable by Marines with minimal training, and require minimal preventative and corrective maintenance. Any maintenance required needs to be able to be performed by Marines. The system needs to be modularized so that it can be transported into the field by the Medium Tactical Vehicle Replacement (MTVR) or Dragon Wagon and operated while carried on those vehicles. The system must have a capability/capacity to suction waste water from the bilges of a platoon of 14 EFVs in one half hour (assume 30 gallons of waste water per vehicle = 420 gallons per platoon) and then separate the waste from the water within a maximum of one half hour more. The filtration media needs to have a long life and be regenerable, if possible. The system needs to be able to filter and process the waste water from one battalion's worth of EFVs (207 vehicles) before the filtration media requires any type of replacement, if any is required. The filtration media needs to be such that it does not become hazardous material requiring disposal or if this is impossible, the now hazardous media needs to present a minimal footprint for storage and eventual disposal. Such a system will have application to other tactical vehicles within the Armed Services. Additionally, such a system would be applicable in the civilian sector by marinas for removing hazardous bilge water from pleasure craft.

PHASE I: Design a complete Hazardous Waste Filtration System, to include all requisite components, that will reduce existing unit hazardous waste disposal costs, can be used by Marines, with a minimum of training and unit required maintenance, that can remove, store, process, and filter EFV bilge water, to a safe level such that the water discharged from the filtration unit can be passed to Base Waste Water Treatment Systems, Base Storm Drains, into rivers, the Ocean, or onto the ground (less than 10 Parts Per Million and no heavy metals) and that the recovered contaminates are contained/stored for eventual disposal.

PHASE II: Develop and deliver a manufacturable prototype turnkey system and demonstrate that the system meets all requirements identified in Phase I.

PHASE III: Market the system to the Marine Corps so the USMC procures one Hazardous Waste Filtration System per Company of EFVs, or minimally one system per EFV Unit. The systems will be located across the Continental United States, Hawaii, and Japan/Okinawa.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Such a system will have application to other tactical vehicles within the Armed Services. Additionally, such a system would be applicable in the civilian sector by marinas for removing hazardous bilge water from pleasure craft. The Private Sector will benefit by being able to reduce its Hazardous Waste disposal costs and minimize the footprint of hazardous waste storage. This would particularly applicable in remote locations or environmentally sensative locations requiring waste water to be transported long distances for disposal.

KEYWORDS: Hazardous waste; waste water filtration system; carbon filters; weir tank; recycling; activated carbon systems.

N06-103 TITLE: Semi-Active Damped Seating Technology for the EFV

TECHNOLOGY AREAS: Ground/Sea Vehicles, Human Systems

ACQUISITION PROGRAM: DRPM Advanced Amphibious Assault ACAT-1

OBJECTIVE: Develop a suspended seating system which integrates semi-active shock and vibration mitigating technology into the existing EFV (Expeditionary Fighting Vehicle) seating positions. The system should be effective during both land and sea operations. The seat must fit within the current EFV structural constraints and not affect vehicle performance or interfere with crew duties.

DESCRIPTION: The Marine Corps EFV is a 78,000 lb. armored and tracked troop carrier designed to operate over harsh off-road terrain and in oceans and rivers. It is capable of much higher speeds on water than its predecessors. Increased speed has lead to high shock loads being transmitted to the occupants when the vehicle is operated in high sea states, particularly in the forward seating positions for the driver and troopcrew commander. In addition to sea operations, the seat system must be capable during land operations to provide shock mitigation when the vehicle is traversing rough terrain. While the EFV is equipped with a pneumatic suspension system, the seating system must provide additional shock isolation during high impact events as well as providing useful isolation from lower amplitude vibration that is transmitted through the suspension and hull. This operating environment has created a never addressed before situation. Current seating designs are very effective for land operations or for waterborne operations but not for both, especially with the amplitudes felt in the EFV. An original and innovative solution to the seat system design is required.

The seating system must be capable of compensating for variations in operator mass ranging from 5th to 95th percentile USMC personnel without user intervention or adjustment. The semi-active damper must be capable of providing sufficient dynamic range to prevent harsh contact with the end of travel stops during operations in extreme sea states or over rough terrain as well as providing good vibration isolation when operating over smooth roads or calm seas. ISO 2631 Part 5 “Mechanical vibration and shock-Evaluation of human exposure to whole-body vibration” will be used as the metric to determine effectiveness of the suspension system. This standard defines a shock “dose” which is transmitted into the seat occupant, a lower dose number indicating more effective shock mitigation.

The seating system must be capable of responding in real time to changing sea states or road conditions without user intervention. The vehicle operator must be focused on the task of controlling the vehicle and cannot be expected to change or adjust suspension settings when the sea state changes. In addition the possibility of an unexpected or “rogue” wave must be detected and handled in real time by the suspension system. The damper must also provide a useable default mode in the case of system failure. Ideally an intermediate setting would be provided which allows the damper to continue to function as a passive damper. Power draw must be kept to a minimum and use only the available on board 24VDC power bus. Any hydraulic or pneumatic systems must be self-contained within the seat assembly and powered from the DC bus. The Seating system must also be affordable, easily maintainable, and operate reliably over extreme temperature ranges (-40 to +145 degrees F). The seating system must also be capable of withstanding long-term exposure to sea water, mud, dust, sand, and debris without significant degradation.

PHASE I: Investigate current EFV seating design and performance; to include feasibility of incorporation of semi-active damping controlled seats. Develop overall system design to include specification of technological approach. Computer modeling and simulation should be used to predict performance benefits using shock input data from the EFV hull as the forcing function. Based on the information developed by the end of Phase 1, propose one or more semi-active seating design concepts. Include estimated prototype and production costs, space claim estimates, estimated performance improvements, estimated weight and power requirements.

PHASE II: Down-select to one or two seat design concepts. Develop and demonstrate a prototype system in a realistic environment. Conduct testing to prove feasibility over extended operating conditions. Refine and re-test the seat or seats in order to further mature the technology and quantify the benefits.

PHASE III: Support incorporation of the semi-active seating technology into prototype SDD and/or LRIP vehicles and support further maturation of the design. Transition the design to a full production capable version.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This system could be used in a broad range of military and civilian applications including seating for commercial boats, heavy equipment, trucking or any vehicle with either an extremely stiff or no suspension system. The system would mitigate injurious or debilitating effects caused by chronic exposure to severe and repeated mechanical shock.

REFERENCES:
1. Engineering Design Handbook, Automotive Series Automotive Suspensions, 14 April, 1967, published by United States Army Material Command
2. ISO 2631 Part 5 “Mechanical vibration and shock-Evaluation of human exposure to whole-body vibration”
3. Fundamentals of Vehicle Dynamics, Gillespie, T. D., Copyright 1992, published by Society of Automotive Engineers

KEYWORDS: Semi-active, seat, ride quality, shock, vibration

N06-104 TITLE: Individual Field Service Drinking Water Cooler

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: Mr. Alex Papadopoulos, PM - Infantry Combat Equipment. ACAT IV

OBJECTIVE: To develop and demonstrate a small, lightweight, innovative device to cool drinking water contained in the 100-ounce On The Move Hydration System. The device will occupy less than 5 cubic inches (less than 2 cubic inches desired) and weigh less than 1 lb (less than 1/2 pound desired). It will be carried in combination with the On The Move Hydration System in the warrior’s modular lightweight load-bearing equipment pack (MOLLE) and require no outside power sources. The device will reduce heat and dehydration related injuries to individual warriors in the desert environment.

DESCRIPTION: Marines carry their personal water supplies on their backs in small, 100-ounce capacity, bladder-type reservoirs commonly referred to as the “On The Move Hydration System”. The bladders are equipped with drinking tubes and bite-actuated valves to provide the user with hands-free, on the move access to their personal water supply. Water provides cooling to humans through two basic processes, evaporation (perspiration evaporates thus cooling the skin) and sensible heat exchange (drinking cool liquids reduces body temperature). In the field, personal drinking water temperature approximates that of the ambient environment. In desert environments, personal drinking water temperature often exceeds normal body temperature. There are several problems associated with drinking liquids that are warmer than the body in hot (desert) environments. Sensible heating raises body temperature, which increases the potential for heat-related injuries. This is tantamount to giving hot coffee to a person exhibiting signs of heat stroke. Increased perspiration is then required to achieve the same ultimate cooling effect. Drinking water consumption must then be further increased to combat dehydration. In addition, warm drinking water does not taste as good as cool water and can lead to insufficient hydration. Recent desert operations have reinforced the need to maintain adequate hydration levels in the field. A lightweight, innovative means of cooling the individual warrior’s drinking water to temperatures below body temperature while on the move is therefore needed. The device could also be useful for small-scale field cooling needs through direct contact such as fighting heatstroke and other field medical purposes.

PHASE I: Conceptualize, design, develop and demonstrate a prototype for the Individual Field Service Drinking Water Cooler. The device will have minimum complexity and require no maintenance. It will contain no hazardous chemicals or require special handling or disposal. A disposable product is desired, but not required. Phase I will include a trade study to balance design factors such as cost, efficiency, reliability, component life and weight for at least 2 alternatives. Phase I will conclude with down selection of a recommended technology for transition to Phase II and demonstration of a prototype. Each Phase I proposal shall include a transition plan into Phase II.

PHASE II: Using the knowledge gained in Phase I, develop, test, demonstrate and deliver a field-ready version of the Individual Field Service Drinking Water Cooler. The field-ready version of the device will occupy less than 5 cubic inches (less than 2 cubic inches desired) and weigh less than 1 lb (less than 1/2 pound desired). It will

designed and constructed to be carried in combination with the On The Move Hydration System hydration unit in the warrior's MOLLE backpack, operate hands-free while on the move, and require no outside power sources. It will be easily operated (simple "ON-OFF" or "Activate" switch or pull string desired) and require no maintenance other than field replacement of consumables such as compressed gas cartridges, batteries, etc. if utilized. It will be virtually silent during operation. It will have a storage life of 30 months (5 years desired). During Phase II the field-ready version will be demonstrated to be appropriate for the field environment, and to have no detrimental effects on drinking water or user mobility. Phase II will include a detailed plan for transition to Phase III.

PHASE III: Incorporate knowledge gained during Phases I and II into final product design and preparation for production. Military products should include packaging for direct use with the backpack-carried On The Move Hydration System personal water reservoirs in military service. The military product will be virtually identical (other than color or other non-function related features) to the product offered to the wider use commercial market. Phase III packaging and production should also include configurations suitable for direct contact with the body to provide immediate surface cooling where needed. These will be used during emergency response situations and for other medical needs such as combating heat stroke and reducing fever in both the commercial and military sectors. Commercial products will be produced that are readily in the military environment as commercial, off the shelf (COTS) items. During Phase III the technology will be transitioned from a demonstrated field-ready unit to cool drinking water, to production products suitable for both military and commercial use wherever immediate, small scale cooling is needed. Phase III will include a detailed commercialization plan.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This device would be useful in recreational applications such as backpacking, hiking, biking, off-road exploration, etc. With direct application to the body, it would be useful as first aid to combat heatstroke and other heat-related illness in emergency medical and civil defense sectors. The technology could be useful in the treatment of burn victims through the immediate application of a sterile, cool surface to burn areas. The device could be used to provide sub-dew point cooling to condense emergency drinking water in remote locations for military, civil defense and commercial applications.

REFERENCES:
1. Body Water Homeostasis and Human Performance in High Heat Environments: Fluid Hydration Recommendations for Operation Desert Storm. Naval Health Research Center, San Diego, CA November 1991. 2. Countermeasure: Army Ground Risk Management Information, Volume 24, Number 3. Army Safety Center, Fort Rucker, AL. 3 March 2003.

KEYWORDS: water cooler; heatstroke; drinking water; On The Move Hydration System; hydration; dehydration;

N06-105 TITLE: Marine Portable Power Unit

TECHNOLOGY AREAS: Ground/Sea Vehicles, Electronics

ACQUISITION PROGRAM: Marine Corps PM Expeditionary Power Systems, Michael Gallagher

OBJECTIVE: Develop and demonstrate an innovative Man Portable Power Unit that can utilize in-service military batteries as back-up power and battery charger.

DESCRIPTION: Many Marine Corps missions require operations where AC grid power is not available. Within these types of operations many applications utilize small portable batteries to meet power requirements for the individual Marine and utilize portable generator power to operate more stationary facilities. Maintaining uninterrupted power at these stationary facilities can be critical. Portable generators used to supply power to these facilities, though reliable, can be taken off-line for various reasons unexpectedly and for random periods of time. Therefore, an Uninterrupted Power Supply (UPS) is needed that will not add significant weight or logistical burden. Current off-the-self UPS's use non-military batteries as their energy storage device, making the system inflexible for other non-UPS applications. These systems also do not have the flexible input and output options desired by the Marine Corps. In addition, most commercial systems using lead acid batteries would be extremely heavy if required to provide over 1kW for a significant length of time, over 3 hour.

This innovative research is to develop a Marine Portable Power Unit that can both act as a UPS system and a battery charging system while utilizing several of the currently deployed military batteries as their energy storage device. This Marine Portable Power Unit (MPPU) should be man portable, under 50lbs and easily transportable. The current deployed batteries suitable for this application include the BB-2590/U. The MPPU must be able to safely handle batteries in multiple series/parallel configurations. When rechargeable batteries are used the system will be able to act as both a UPS and a battery recharging station with batteries easily able to hot swap in-and-out. The input and out-put of the MPPU will have a 12VDC, 24VDC and 120VAC-1 phase 60 Hz capability. The Marine Corps will only fund proposals that are innovative and involve technical R&D risk.

PHASE I: Develop and demonstrate innovative MPPU design and packaging concepts that address the above requirements. Reasonable weights and volumes for system components based on current technology readiness levels (TRLs) should be used. Feasibility of the proposed design and anticipated improvements during Phase II should be supported by available scientific test data. Make recommendations for a Phase II detailed design and document in a technical report.

PHASE II: Build and demonstrate a packaged prototype device suitable for advanced laboratory and supervised field testing. Develop and implement a test plan that addresses the requirements needed for fieldable electrochemical power systems. Document and provide a Safety Assessment Report of the systems. Deliver several packaged prototype units for Marine Corps testing.

PHASE III: Prepare a manufacturing plan and marketing plan to sell this product to the government as well as the private sector. Make the necessary teaming arrangements with the manufacturers of the components used in this product.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The commercial market would not utilize military batteries for a UPS system but this system could be modified to utilize commercially available batteries. Developing a UPS system that can work off numerous types of batteries could be useful in the electronics and telecommunications industry.

REFERENCES:
1. A Novel Online UPS with Universal Filtering Capability, by Farrukh Kamran and Thomas G. Habetler, Georgia Institute of Technology, Atlanta, GA.

KEYWORDS: Power Sources; Generators; BB-2590/U; Portable Power; Batteries, UPS; Battery charger

N06-106 TITLE: On The Move (OTM) Ku/Ka SATCOM Capability for the EFV

TECHNOLOGY AREAS: Ground/Sea Vehicles, Electronics

ACQUISITION PROGRAM: DRPM Advanced Amphibious Assault ACAT-1

OBJECTIVE: Coupled with existing and future Ku/Ka band antenna technology, develop a light weight low volume Ku/Ka satellite communications (SATCOM) high data rate on the move (OTM) communications antenna and transceiver capability for the Expeditionary Fighting Vehicle (EFV) and other Department of Defense (DOD) combat ground vehicles as applicable.

DESCRIPTION: The Marine Corps EFV is a 76,000 pound armored and tracked troop and command vehicle designed to operate over harsh terrain, on the seas, and on rivers. It currently hosts a Ultra High Frequency (UHF) SATCOM transceiver and a non-steerable conformal antenna that is capable of on the move data communications at rates of 16 Kilo Bits Per Second (Kbps) and below.

Evolving user requirements necessitate the development of a capability to allow OTM high data rate (64 Kbps and greater) communications. This capability must include operation in a variety of scenarios including high speed water operations (25 knots) in Sea State 3 where significant salt spray and water vapor will be present and land movement at speeds of up to 45 miles per hour (MPH), across rough terrain where extensive and frequent irregular

vehicle movement will occur. The proposed solution will be subjected to significant shock and vibration, and extremes of temperature and humidity. The proposed solution must not generate a significant radar cross section, nor can it present a significant physical profile. Due to the limited vehicle volume for installation, the physical footprint of the solution must be minimized to the maximum extent possible. There are no large contiguous open areas available in the current vehicle design to support the installation of a conventional antenna, consequently the implementation must be adaptable to a design that would permit taking advantage of multiple smaller open areas on the topside vehicle layout and use them all simultaneously. This will probably require planar or phased array implementations. The proposed solution will operate in close proximity to Very High Frequency (VHF), High Frequency (HF) and Ultra High Frequency (UHF) transmitters operating at power levels up to 100 watts. The capability should take advantage of current or imminent military or commercial SATCOM capabilities to provide a capability that is available world wide (Polar/Antarctic regions excepted.), which may include the use of Low Earth Orbiting or Geosynchronous Satellites.

PHASE I: The contractor will utilize existing vehicle drawings and link budget analysis to determine an antenna configuration and associated RF system that can support the necessary data rates, provide coverage across all azimuths of the vehicle (minimal to no blocked zones) and still fit within existing open areas. Using this information he will then design a family of solution sets that individually optimize against each of the following parameters: Cost, throughput, Radar Cross Section, and Physical Size/Weight. He will also provide a recommended best fit solution that trades off against each of the parameter areas to provide a best value solution.

PHASE II: The contractor will built one or more prototype systems for concept development, proof of viability and field testing aboard the EFV.

PHASE III: The contractor will build one or more complete units under contract to the EFV Prime Contractor suitable for operational testing and deployment.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: A low profile, OTM capability that utilizes military and commercial SATCOM services would find widespread interest among all Federal, Military, and commercial organizations that need to pass and process large amounts of data while stationary and on the move.

REFERENCES:
1. EFV Capabilities Production Document (CPD) draft
2. DRPM AAA Website: WWW.EFV.USMC.MIL
3. EFV C Variant Topside Antenna location drawing

KEYWORDS: OTM, Amphibious, Communications, SATCOM

N06-107 TITLE: Development of a Extremely Compact and Lightweight Sleeping Bag

TECHNOLOGY AREAS: Materials/Processes, Human Systems

OBJECTIVE: Current sleeping bags carried by US servicemembers are too bulky and heavy for extended operations. Recent developments in materials for superior insulation at lighter weights and reduced loft have not made the transition to the commercial state of the market in end products (e.g. sleeping bags). The objective is to combine the advances in construction with the advances in chemistry and production of insulating materials to reduce the weight and stowed cubic size of the current sleeping bag system by a minimum of 30%. The product needs to provide a acceptable level of comfort, heat retention, and internal humidity to the user in an operating range of 80F to –40F with a minimal amount of re-configuration or user adjustment. Must not require an internal or external power supply or rely on chemical reactions that must be replaced or reset prior the next sleep cycle. The sleeping bag must be water resistant and be suitable for use on moist ground or shallow (up to ¼ in.) standing water. Must be capable of being cleaned by standard laundry methods fifty times over its life.

DESCRIPTION: The need exists to reduce the weight and volume of equipment carried by a serviceman. Phase I is the evaluation of the current and emerging materials as well as evaluating design configuration to produce a sleeping

bag that when stored is less than 104 cubic inches in size and weighs less than 7.22 Lbs. Phase II is the modeling and construction of conceptual and ergonomic test bags for evaluation and feedback. This culminates with testing, verification, and corrections to the design. Phase III is the transfer of design information to and new materials to commercial manufacturers for production of prototypes for further testing, or full rate production.

PHASE I: Evaluation of current and emerging insulation materials,fabrics and concepts to determine to optimal combination for this application. This is followed by the evaluation of possible configurations,designs and construction strategies using the information developed during the evaluation of materials to support this application.

PHASE II: Modeling of heat retention and humidity flow by computer simulation, ergonomic and operator acceptance evaluation of design features by using mockup bags followed by copper mannequin testing to validate insulation and stability for use throughout the entire temperature range. During this phase, we anticpate initial production of prototype bags. Limited user evaluation in test chambers for comfort throughout temperature range, and iterative feedback incorporated in design until requirement parameters are met.

PHASE III: Provide technical expertise and aid in the transfer of design and materials evaluation to a commercial producer for limited production supporting a field user evaluation for the military.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Technology and designs would have direct crossover to the commercial camping equipment sector and the winter clothing market. Current state of the market does not support this requirement.

REFERENCES:
1. Current Sleeping Bag Specifications (MARCORSYSCOM-CID-93-A-A50603)

2. Standard Test Method for Measuring Thermal Insulation of Sleeping Bags Using a Heated Manikin (F1720-96(2004))

3. Standard Test Method for Measuring Sleeping Bag Packing Volume (F1853-03)

4. Standard Test Method for Flammability of Sleeping Bags F1955-99(2005)

5. Standard Test Method for Dimensional Changes in Commercial Laundering of Woven and Knitted Fabrics Except Wool AATCC Test Method (96-2004)

6. Anthropometry of US Military Personnel (DOD-HDBK-743A)

7. Environmental Engineering Considerations and Laboratory Tests (Mil-Std-810f)

KEYWORDS: Sleeping bag; Insulation; Fabrics; Cold; Modeling; Simulation

N06-108 TITLE: Cognitive Technology for Advanced Maintenance

TECHNOLOGY AREAS: Information Systems, Materials/Processes, Human Systems

ACQUISITION PROGRAM: Program Management Test, Measurement and Diagnostic Equipment (PMTMDE).

OBJECTIVE: Develop and leverage existing and emerging efforts to dramatically advance the state of the art in cognition based agent technologies for maintenance across DoD.

DESCRIPTION: Due to the large number of existent and emerging weapons systems platforms (to include all systems that move, shoot, communicate, detect), the challenge to the maintainer base continues to grow. The need to more accurately and rapidly diagnose and prognostically detect, current and incipient systems failure or degradation continues as expeditionary warfare tempo increases and costs rise.

The ability to accurately and rapidly troubleshoot complex systems requires sophisticated analytical ability and experience on the part of the maintainer.
Retaining and maintaining this capability across the Joint Services requires continual effort. With refocusing of manning requirements and a shift to considering methods of increasing efficiencies and operational responsiveness of the maintainer base, there is a need to investigate supplemental/advanced technologies. Multiple efforts have been undertaken over the years within the maintenance community to aid the maintainer community. These efforts have ranged from built in test (BIT), built in test equipment (BITE), to sophisticated test equipment and electronic interactive technical manuals. These also included troubleshooting trees and other early efforts at artificial expert systems to allow the maintainer more structured methods of diagnosis.

Government, industry, and academia have undertaken extensive work over the last three decades in these areas. We seek to leverage these efforts and advance them greatly to provide a superior, truly innovative and novel capability to the field maintainer during the troubleshooting process. An effort to put together an intelligent agent form of technology that accurately simulates and realistically augments human troubleshooting of weapons systems under significantly different scenarios does not yet exist.

The goal is to provide an extraordinary, intelligent troubleshooting agent/technology that appears to the user as a systems expert. The system must be capable of rapid learning and designed to closely interface with the maintainer unlike any previous systems. Enormous strides have been taken within the credit industry, insurance analysis, network security, homeland security, nuclear, and others to set up pseudo-intelligent systems to successfully aid in human oversight of vast amounts of data and activities. Many industries are looking at ways to reduce cost and improve readiness by having systems in place that anticipate and even predict incipient systems failure to their respective maintenance infrastructures. Leveraging this kind of technology to the DoD maintenance infrastructure and driving it to the next level could provide a revolutionary jump to the newly emerging test hardware and complex weapons systems that would thus benefit. Additionally, a system of this type of intelligence-based software maintenance technology should be adaptable to any system within the DoD.

PHASE I: Using a current weapons platform as a test bed, demonstrate the ability to rapidly and accurately troubleshoot operational failure and degradation scenarios under a variety of conditions with maintainers from a low experience skill-set. This innovative system must be capable of understanding it's environment and rapidly changing conditions. The system must be able to closely, accurately, and directly interact with the user on a level approximately similar to a junior maintainer and a system expert under real world situations. Contrast and compare the differences and capability of this form of highly advanced intelligent agent troubleshooting with all previous methods and constraints with each.

PHASE II: Demonstrate the ability of the system to rapidly assess complex electronic, mechanical, and diverging electromechanical troubleshooting capabilities under random conditions with a variety of scenarios and widely varying maintainer skill sets. Demonstrate the ability to accurately resolve false diagnosis, unknowns, and to predict failure based on observed system behavior, data, and human verbal interaction. Demonstrate active learning within the system and the ability to assess novel (unpredicted) conditions.

PHASE III: Demonstrate the capabilities shown in Phases I and II with the ability to be rapidly incorporated across multiple platforms. Demonstrate additional enhancements that provide a seamless and fluid interface between the system and the maintainer.

Demonstrate how the intelligent system technologies can respond/react to chaotic scenarios and incomplete data while still providing benefit to the maintainer.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The proposed intelligent system technology could have broad impact across the commercial maintenance community.

REFERENCES:
1. An Ecological Framework for Cancer Communication: Implications for Research
Kevin Patrick1, MD, MS; Stephen S Intille2, PhD; Marion F Zabinski1, PhD, MPH
1Department of Family and Preventive Medicine, University of California, San Diego, La Jolla, California, USA

2House_n, Massachusetts Institute of Technology, Cambridge, Massachusetts, USA
Corresponding Author:
Kevin Patrick, MD, MS
Department of Family and Preventive Medicine
University of California, San Diego
9500 Gilman Drive MC 0811
La Jolla, California 92093-0811
USA
Phone: +1 858 457 7296
Fax: +1 858 622 1463
Email: kpatrick [at] ucsd.edu

2. Technical Design of Condition Based Maintenance System
-A Case Study using Sound Analysis and Case-Based Reasoning
Marcus Bengtsson1, Erik Olsson2, Peter Funk2, Mats Jackson1
1Department of Innovation, Design and Product Development
2Department of Computer Science and Engineering
Mälardalen University
Box 325, SE-631 05 Eskilstuna, Sweden
marcus.bengtsson; erik.olsson; peter.funk; mats.jackson@mdh.se
1phone +46 16 153 486, fax +46 16 153 610

KEYWORDS: Intelligent agents;artificial intelligence;expert systems; direct visualization

N06-109 TITLE: Data Fusion Handoff

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PMA-299, PMA-265

OBJECTIVE: Develop innovative data fusion tracking techniques to combine data from disparate sensor sources with nearby but only partially overlapping coverage areas.

DESCRIPTION: Data fusion is critical to many Navy missions and platforms. In particular, many missions and platforms rely on target tracking systems. These tracking systems typically focus on fusing data from multiple heterogeneous sensors with overlapping coverage areas. For these systems, the intent is to develop higher quality and higher precision tracks using the data from all the sensors collectively. For emerging Naval missions, such as supporting National Maritime Domain Awareness (MDA), the sensors are sufficiently far enough from each other that the coverage areas are nearby but mostly non-overlapping. Also, the data from one region may not be available in a timely manner to provide to the nearby regions, adding data latency to the problem of tracking across these regions. The goal is to persistently track surface vessels as they move from one coverage area to another, including moving in and out of the same coverage area using data from disparate sources. The track information that the sensor has will then be shared with the next sensor. An important attribute of a track is its track number. The track should retain its number as it moves from region to region. In the case of maritime objects, knowledge of the landmasses could be used to restrict the areas where the object could go. This information along with knowledge of adjoining sensors will be used to alert the appropriate sensors.

PHASE I: Investigate the feasibility of new algorithms to persistently track vessels in non-overlapping coverage areas using data from disparate sensor sources with various levels of latency. Demonstrate a scheme for issuing track numbers to keep them unique and persistent as the object moves from one coverage area to another. Develop the initial concept design and model.

PHASE II: Construct and demonstrate the scheme and the tracking methodology using government data in accordance with the criteria developed in Phase I. Include simulated data created during the effort.

PHASE III: Work with Navy customers and their primes to identify and mitigate any software transition issues, i.e. real-time performance, etc. Develop a prototype to be flown on the MH-60 aircraft. Transition technology into a Navy system, e.g., DCGS.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology developed under this program will have application to any commercial activity that shares data generated from multiple sources over a large distributed environment. Commercial shipping and distribution of goods would benefit from this technology.

REFERENCES:
1. Waltz, E.; Llinas, J.; Multi Sensor Data Fusion, Artech House, Boston, 1990.
2. A. Pawlowski and P. Gerken, "Simulator, Workstation, and Data Fusion Components for Onboard/Offboard Multi-Target Multi-Sensor Fusion", Presented at 17th IEEE/AIAA Digital Avionics Systems Conference, Seattle, WA, November 1998.
3. Bar-Shalom, Yaakov; L, X. Rong; Kirubarajan, Thiagalingam; Estimation with Applications to Tracking and Navigation.

KEYWORDS: Data Fusion; Tracking; Tracking Algorithms; Data Hand-off; Multi-Sensor Tracking; Wide-Region Tracking

N06-110 TITLE: Advanced Antenna Array Beamformers

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMA-231, E-2D Advanced Hawkeye

OBJECTIVE: Utilizing advanced component technology, innovative optimization algorithms and design concepts, develop high-efficiency, multi-octave antenna array beamformer systems capable of adaptively compensating for significant dissimilarities in the on-aircraft array embedded element patterns.

DESCRIPTION: Antenna array beamformer designs typically assume that the array elements are isotropic radiators operating in free space in the absence of mutual coupling. The desired monopulse gain and sidelobe performance of an array over specified scan angles can be achieved with a predetermined fixed amplitude taper and stepped phase adjustments. Once the array is on the aircraft, its radiation pattern may change because of interactions with the radome structure, the airframe, and other nearby antennas. This has a detrimental effect on array radiation pattern. It is, therefore, necessary to account for the environment in which the antenna array is placed.

Providing complete amplitude and phase control at each element would appear to be the obvious solution. However, power loss in conventional amplitude and phase control beamformers make this solution impractical. To be practical, advanced low loss power dividers and phase shifters as well as wideband pattern optimization algorithms are needed. In some instances, the wideband pattern optimization algorithms will make it possible to meet performance objectives with phase only control along with fixed, but atypical, power division architecture.

PHASE I: Develop detailed conceptual designs for high-efficiency two-octave (UHF through L-band) array beamformers. The preferred solution set will be determined after developing optimization algorithms for fixed-amplitude variable-phase solutions and variable-amplitude variable-phase solutions. A set of embedded element patterns and desired array radiation pattern sets will be provided. Key in the selection is the resistive loss introduced into the beamformer by amplitude and phase control components. Reducing the sidelobe level at the expense of antenna gain is one of the beamformer tradeoffs in the selection process.

PHASE II: Utilizing phase I results design, assemble and demonstrate a prototype array beamformer capable of controlling a 36-element array in monopulse operation. Investigate and define the packaging and I/O requirements to ensure suitability for transition of the design into the E-2D Advanced Hawkeye aircraft.

PHASE III: Working with sensor system OEMs, fabricate an advanced array beamformer satisfying E-2D sensor system requirements. Transition the beamforming system to the operational fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: High performance array beamformers are needed on a wide range of civilian and military sensor systems.

REFERENCES:
1. Van Trees, H.L., Optimum Array Processing, Part IV of Detection, Estimation, and Modulation Theory, John Wiley & Sons, New York, 2002
2. Wirth, W.-D., Radar Techniques Using Array Antennas (Radar, Sonar, Navigation and Avionics Series; No. 10), The Institution of Electrical Engineers, London, 2001
3. Fourikis, N., Advanced Array Systems, Applications and RF Technologies, Academic Press, London, 2000

KEYWORDS: Array Processing; Beamforming; Antenna Array Systems; Array Amplitude Control; Array Phase Control; Broadband Array; Array Pattern Synthesis

N06-111 TITLE: High-Turbine Operational Sensor Assembly

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: PMA-231, E-2C and PMA-261, H-53

OBJECTIVE: Develop innovative hot-section sensors (or an assembly of sensors) that would be positioned closer to the combustor outlet to better assess the high-pressure, and low-pressure turbine component environments and transients. Rotor-speed variable and time-varied turbine gas-stream and/or component pressures, temperatures and airfoil dynamic responses are needed.

DESCRIPTION: The assembly should enable the determination, monitoring and tracking of failure modes of interest (through near real-time data processing methods not included herein, but in coordination with the other SBIR and/or engine OEMs schemes). Examples of the types of safety related parameters and life limiting failure modes are: the airfoil structural response normality-state tracking (for sudden deviations and with aging), cooling blockages or leakages from cracks or abnormal holes, oxidation, corrosion, thermal-mechanical failure (TMF), creep, life-cycle fatigue (LCF) and high-cycle fatigue (HCF). Abnormal- or damaged-state sensing is needed, especially if coupled with an upstream issue such as a hot-start or an EDO/FOD event.

PHASE I: Define the sensing and interface requirements, to include the expected data transmission approach. Initiate the design to the conceptual-level for one or several engine systems, like the JSF P&W F135 or GE/RR F136, the SH60 GE T700, F/A18E/F GE F414, E-2C RR T56-427 or a similar future naval air systems platform. A prototype sensor assembly may be demonstrated in bench tests if feasible.

PHASE II: Produce detail design(s) and prototype the assembly. This effort should be performed in strong coordination with selected-engine OEM and/or multiple designated 2nd-party partners (especially relating to signal data bus transmission scheme, data acquisition and processing approach, and the specific assembly-interface to the engine case).

PHASE III: Finalize hot section sensor assembly integration with major DOD end users and engine manufacturers and conduct necessary qualification testing.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This integrated sensing capability, sensing in closer proximity to the combustor would provide better information for control and avoidance of exceedances that damage expensive turbine components. The technology is directly transferable to commercial gas turbine engine applications.

REFERENCES:

1. Von Flotow, "NSMS in a High-Pressure Turbine with Eddy Current and Fiber Optic Sensors," 2005 HCF Conference, New Orleans, LA

2. O. J. Gregory and T. You, "Ceramic temperature sensors for gas turbine engine applications," Proceedings of the 50th International Instrumentation Symposium, San Antonio, TX, 2004

3. A.D. Kurtz, A. Ned, J. Declama, S. Goodman, R.W. Ainsworth and A.H. Epstein, "Advanced sensors for turbine applications, " Proceedings of the 50th International Instrumentation Symposium, San Antonio, TX, 2004.

4. J. Kleppe, "Acoustic Tomography for Jet Engines/Turbines: Proof of Concept," Final Report, NASA Cooperative Agreement NCC3-750 with the U of Nevada at Reno, Sept 2005.

5. D. Ng and G. Fralick, "Use of a multi-wavelength pyrometer in several elevated temperature aerospace applications," Review of Scientific Instruments, Vol. 72, No. 2, p.1522-1530, Feb. 2001

6. Non-contact Blade Vibration Measurement System for Aero Engine Application.
http://www.mtu.de/channel/files/pdf/noncontact_blade_vibration.pdf

7. Sporian Microsystems: http://www.sporian.com/press/pr-20040901.html, "…monitor temperature and pressure under extremely harsh conditions up to 1400°C (2500°F)."

8. Siemens Westinghouse Power Corporation program, "On-Line Thermal Barrier Coating Monitoring for Real-Time Failure Protection and Life Maximization"
http://www.osti.gov/bridge/servlets/purl/823021IAfMbe/native/823021.pdf
http://www.netl.doe.gov/publications/proceedings/02/turbines/Wiant.pdf

9. J. Xu, G. Pickrell, B. Yu, M. Han, Y. Zhu, X. Wang, K.L. Cooper and A. Wang, "Epoxy-free high temperature fiber optic pressure sensors for gas turbine engine applications," Proceedings of SPIE - The International Society for Optical Engineering Sensors for Harsh Environments v 5590, 2004.

KEYWORDS: Turbine Engine; High-Temperature Sensors; Operational, High-Pressure; Hot-Section; Diagnostics; Prognostics

N06-112 TITLE: Advanced Multi-Source Digital Signal Processing And Analysis For Characterization Of Vibrations In Turbo-Machinery Blades

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: Joint Strike Fighter

OBJECTIVE: Develop advanced multi-source digital signal processing techniques that utilize data from multiple acquisition sources and analytical models for use in characterization of complex vibratory behavior in turbine engine blade during test.

DESCRIPTION: Characterization of turbomachinery response dynamics is growing increasingly difficult with the introduction of advanced designs like integrally bladed rotors (IBR). These rotors can contain modes of vibration that are coupled among blades. Standard techniques for acquisition and processing of dynamic signals from these rotors are often inadequate to fully characterize these responses. Turbine engine testing has benefited from improvements in measurement technology over the last several years with particular advances being made in laboratory test techniques, the application and use of non-interference stress measurement systems (NSMS) and improvements in digital dynamic data acquisition systems and signal processing with optimally placed strain gages. Combining these techniques (and others) through advanced signal processing and judicious placement of sensor locations can improve the characterization of complex vibratory behavior. This effort will develop, demonstrate and apply innovative advanced processing techniques to specific rotor types in laboratory and component/engine testing environments.

PHASE I: Develop laboratory test apparatus to induce known rotor vibration characteristics. Demonstrate feasibility of integration of multiple dynamic data sources for characterization of test-rotor responses.

PHASE II: Extend the Phase I effort to include optimum placement of sensors for component response characterization. Apply advanced algorithms to test-rotor to demonstrate vibration characteristics. Assess the performance of the advanced algorithms against current state-of-the-art techniques. Demonstrate technology in a production or demonstration rotor.

PHASE III: Develop, validate, and deliver algorithms for application to be used on turbine blades of several aircraft engine systems. Apply this technology to new aircraft development program like the Joint Strike Fighter (JSF).

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The development of this technology to military aircraft engines can be easily translated into application for commercial engines and land-based turbine systems and other power plant parts. Results and understanding gained from applying this technology to particular turbine blades would significantly help decrease life cycle cost through reduced inspections and design improvements.

REFERENCES:
1. Holistic T&E and the Role of Model Validation, Seventh National HCF Conference, Monterey CA., April, 2003.

2. Development of the Structural Dynamics Response Analysis Capability, Proceedings of the Third National HCF Conference, San Antonio, Texas, February, 1998.

3. A Model Modification Method Using Perturbed Finite Elements, Proceedings of the 37th AIAA/ASME/AHS/ASC Structures, Structural Dynamics, and Materials Conference, Salt Lake City, Utah, April 1996.

KEYWORDS: Response Dynamics; Multi-Source Digital Signal Processing; Vibration testing; Response characterization; Turbine engine testing; Integrally Bladed Rotor

N06-113 TITLE: Broadband Solid-State LINC Power Amplifier

TECHNOLOGY AREAS: Air Platform, Sensors, Electronics

ACQUISITION PROGRAM: PMA 265 F/A-18 Hornet, ACAT I

OBJECTIVE: Develop a GaN power amplifier for the quadrature Linear Amplification Using Non-Linear Component (LINC) architecture in the UHF through L-Band frequency range to support navy aircraft communication systems.

DESCRIPTION: Military aircraft communication systems require high linearity and high efficiency amplifiers to handle non-constant complex waveforms. To meet the growing demands of airborne networking, higher performing power amplifiers are needed to meet the Navy's communication requirements. Recent advances in linear power amplifier architectural design, using LINC, have shown improvements in both linearity and efficiency (size, weight and power)[1]. The quadrature (QUAD) LINC architecture utilizes (Laterally-diffused metal oxide semiconductor) LDMOS transistors. LDMOS transistors, when compared to ideal switches, exhibit a noise floor on the quadrature modulators of -150 dBc/Hz. However a broadband noise floor of -170 dBc/Hz is required to meet the noise requirement of the power amplifier system. Despite the success of LINC, the linearity and efficiency of these devices could further be improved.

Gallium Nitride (GaN) transistors are more advantageous as switching devices for the Class D power amplifiers due to their higher power density, higher efficiency, and improved linearity. GaN device technology today provides up to 100 W devices with 60 V breakdown voltage and ft of several GHz, thereby supporting the mobile high efficiency waveforms in the L-band.

The integration of the GaN (e.g. custom MMICS or comparable devices) will provide improved performance of the QUAD LINC architecture. Key parameters of interest are: linearity, efficiency, duty cycle, weight, dimensions, two-tone intermodulation distortion (IMD), fifth order IMD, broadband noise, spurious emissions, noise power ratio, harmonics, instantaneous bandwidth, stability, and automatic power recovery.

PHASE I: Define the technical requirements for the UHF to L-Band power amplifier. Demonstrate the capability of the power amplifier by using computer simulation, analysis, or experimental results.

PHASE II: Demonstrate the push pull QUAD LINC power amplifier architecture in a laboratory environment. Demonstrate that the architecture will meet the performance objectives.

PHASE III: Develop test plans and procedures to evaluate the Quad LINC power amplifier architecture. Demonstrate the operation of the Quad LINC power amplifier architecture in an Unmanned Aerial Vehicle (UAV) and/or F-18 aircraft operating on an active network.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: New highly efficient linear amplifiers will support all spectrums of communications, from radios to cell phones to wireless networks.

REFERENCES:
1. Hegazi, Gamal M., Chu , Thanh T., and Groshong, Richard A., “Improved LINC Power Transmission Using a Quadrature Outphasing Technique”, IEEE IMS 2005.

2. Sundstrom, L., "Spectral sensitivity of LINC transmitters to quadrature modulator misalignments:, Vehicular Technology, IEEE Transactions on Volume 49, Issue 4, July 2000 Page(s):1474 - 1487.

KEYWORDS: Power Amplifier; Communications; Linearity; Efficiency; Solid State; Airborne

N06-114 TITLE: High Speed Continuous Blade Health Monitoring for Turbine Engines

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: Joint Strike Fighter

OBJECTIVE: Develop and demonstrate high-speed continuous blade health monitoring technology for turbine engines that deterministically calculates blade vibration modes from continuous time-series data, rather than the currently employed undersampled approach.

DESCRIPTION: Current non-contacting stress measurement systems (NSMS) utilize sensors optimized for determining the exact time of arrival of each blade, and process the collected data in an undersampled manner to infer blade vibration modes. Assumptions are made and pre-defined specific circumferential transducer positions are required based on vibration modes of interest. As a result the capability and flexibility of using current systems on turbine engines is severely limited. Innovative turbine engine blade vibration sensors and associated algorithms are sought, with the ability to sense blade vibration in a continuous manner suitable for collecting time series data that will support Fourier Analysis techniques to deterministically calculate blade vibration modes. The spacing and number of the sensors will need to be optimized for determining various blade modes. The desire is to overcome these constraints and limitations via sensors that will sense blade location in a continuous manner over a given arc, and the associated algorithms to process this data and extract blade vibration modes in a deterministic, non-aliased manner.

PHASE I: Demonstrate feasibility of proposed sensors to make continuous measurements of blade position for each blade through a predefined arc of travel. Develop and demonstrate proof of concept sensors and associated algorithms that are capable of making the required measurements

PHASE II: Develop a prototype continuous blade health monitoring system. Refine the sensor design to ensure robust, reliable operation in the required operational environments. Design a robust means of attaching the through-the-case sensor, with provision for sensor removal as required. Design a flexible sensor installation and removal procedure. Refine the algorithms to robustly and deterministically calculate blade vibration modes.

PHASE III: Finalize sensor integration with major DoD end users, airframe, and engine manufacturers; and conduct necessary qualification testing.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This advanced sensing capability would significantly enhance the state of the art for commercial aviation engine tests and inspections requiring NSMS instrumentation. The technology is directly transferable to commercial gas turbine engine applications.

REFERENCES:
1. Michael Zielinski, Gerhard Ziller; "Noncontact Blade Vibration Measurement System for Aero Engine Application"; International Symposium of Air Breathing Engines, ISABE-2005-1220
http://www.mtu.de/channel/files/pdf/noncontact_blade_vibration.pdf

2. NSMS Data Acquisition Using an Alternative Multi-Point Approach;
http://www.hcf.utcdayton.com/HCF05_pdfs/11_0430_Hill_paper.pdf

KEYWORDS: Turbine Engine; Blade Vibration; NSMS; Vibration Modes; Sensors; Propulsion

N06-115 TITLE: Aircraft Survivability Re-routing

TECHNOLOGY AREAS: Air Platform, Information Systems, Sensors, Battlespace, Human Systems

ACQUISITION PROGRAM: PEO-A (PMA-299 MH-60R/S); Software/Explanatory Development

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop a near real-time novel algorithm to compute the maximum altitude (Above Ground Level – AGL) throughout an entire flight corridor in which an air vehicle is out-of-sight from all dynamic threats and provide for safe air vehicle rerouting in order to avoid applicable threats within the operational Area of Interest (AOI).

DESCRIPTION: Our military's air superiority, especially in Combat Search and Rescue (CSAR) operations, are threatened from various ground threats including Surface to Air Missiles (SAMs). Current state-of-the-art methods used to compute maximum safe altitudes for military aircraft are based on computationally intensive 3D terrain-masking calculations or intervisibility calculations and are run on large ground-based mission planning computer systems in non-real-time and on static intelligence data of the threat. Due to the computational demands of these algorithms, these methods are not capable of providing maximum safe altitude solutions in near real time to an aircraft in flight, especially using aircraft computer processing capability. If the threat changes during the operation, the aircraft is then exposed to the emerging threat with no way of re-computing a safe fly altitude or direction of flight in sufficient time to react to the threat. The development of a novel algorithm or methodology is sought that can compute safe fly altitudes in near real-time. This safe fly altitude solution can then be fed to a real-time aircraft re-routing tool to provide a safe corridor and haven away from the pop-up threat. This will greatly enhance the survivability and successful completion of CSAR operations. This ability needs to account for the radar and infrared signature of the air vehicle platform and be capable of running on current on board mission computers systems.

PHASE I: Design, develop and demonstrate a prototype for providing near real time safe fly altitude calculations for an Order of Battle (OOB) in response to a new or changed threat. The prototype will take into account air

vehicle radar and IR signatures and provide in near real time no-fly areas and recommended safe fly areas based on specific SAM emitters encountered. The capability will be compatible with the Nation Geospatial Intelligence Agency's (NGA's) Digital Terrain Elevation Data (DTED), NGA's cultural / feature and vertical obstruction data, and the OOB.

PHASE II: The feasibility prototype will be incorporated in a laboratory version of the MH-60 R/S mission computer and ran against simulated threats. It must demonstrate the above-mentioned objectives and performance criterion. The prototype should demonstrate a change in the AOI data set when the OOB changes and provide a calculated new data set to represent near real-time mission re-routing / re-planning and situational awareness.

PHASE III: Transition to the MH-60 R/S for mission planning and in-flight re-routing/re-planning.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This type of technology can be used to enhance the mission planning and surveillance systems of the U.S. Customs and Border patrol.

REFERENCES:
1. Gossett, J and Corman, Dr. D., (October 2001). WSOA – Weapon Systems Open Architecture – An Innovative Technology Framework for Time Critical Target Operations Retrieved from http://www.dodccrp.org/events/2001/6th_ICCRTS/Cd/Tracks/Papers/Track5/052_tr5.pdf

2. Cohen, H., Cook-Anderson, G., Buis, A. (August 2004). Refined Topographic Data Now Available for Large Areas of the World Retrieved from http://www.fas.org/sgp/news/2004/08/nga082704.pdf

3. Moitra, A., Mattheyses, R., DiDomizio, V., Hoebel, L., Szczerba, R., Yamron, B. (July 2003). Multi-vehicle Reconnaissance Route and Sensor Planning. IEEE Transactions on Aerospace and Electronics Systems Vol. 39, No. 3 http://ieeexplore.ieee.org/iel5/7/27785/01238737.pdf

KEYWORDS: Situational Awareness; Mission Planning; Safe Air Vehicle Rerouting; Reconnaissance; DTED; Navigation Systems

N06-116 TITLE: Broadband Solid-State Power Amplifier Predistortion Linearization Scheme

TECHNOLOGY AREAS: Air Platform, Sensors, Electronics

ACQUISITION PROGRAM: PMA 265 F/A-18 Hornet, ACAT I

OBJECTIVE: Develop a predistortion linearization scheme for the quadrature Linear Amplification Using Non-Linear Component (LINC) architecture that will support both Laterally Diffused Metal Oxide Semiconductor (LDMOS) and gallium nitride (GaN) power amplifiers in the UHF through L-Band frequency range for airborne platforms.

DESCRIPTION: Recent advances in linear power amplifier architectural design, using LINC has shown improvements in both linearity and efficiency (size, weight and power)[1]. A LINC transmitter system often suffers from branch complex gain imbalance that, being a distortion source, has a direct effect on linearity displayed in adjacent channel power ratio and dynamic range[2]. Digital predistortion can improve linearity when considering the imbalanced LINC transmitter as a memoryless, nonlinear system but suffers from a limited dynamic range restitution at the output of the LINC transmitter. Cross talk between the branch amplifiers in a LINC transmitter becomes unavoidable when using isolationless combiners that are necessary to keep the transmitter's efficiency high. This cross talk causes imbalance in the branch complex gain that in turn has a negative impact on linearity. The use of the digital predistortion linearization restores linearity of the LINC transmitter system while maintaining high efficiency.

A mixed digital signal processing/field programmable gate array (DSP/FPGA) implementation for the linearization architecture is proposed that is suitable for an accurate impairment detection and compensation for the LINC transmitter system linearity. The predistortion architecture must provide the capability to operate with LDMOS or

GaN power amplifiers while optimizing the following parameters: adjacent channel leakage ratio (ACLR), error vector magnitude (EVM), power added efficiency (PAE), linearity, efficiency, duty cycle, weight, dimensions, two-tone intermodulation distortion (IMD), fifth order IMD, broadband noise, spurious emissions, noise power ratio, harmonics, instantaneous bandwidth, stability, automatic and power recovery.

PHASE I: Develop a design concept by utilizing computer simulations, analytical or experimental approaches. Provide trade-offs which summarize the design approaches for the predistortion scheme.

PHASE II: Develop and demonstrate the capability of the predistortion linearization circuit in a laboratory environment. Provide design concepts to address packaging the quadurature LINC power amplifier architecture.

PHASE III: Demonstrate the operation of the quadurature LINC power amplifier architecture in an Unmanned Aerial Vehicle (UAV) and/or F-18 aircraft operating on an active network.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: New highly efficient linear amplifiers will support all spectrums of communications, from radios to cell phones to wireless networks. The RF power amplifier has the largest impact on the cost, size, weight and power of wireless communication systems. There is a continuing demand to transmit multimedia information while minimizing signal distortion.

REFERENCES:
1. Gamal M. Hegazi, Thanh T. Chu, and Richard A. Groshong, “Improved LINC Power Transmission Using a Quadrature Outphasing Technique”, IMS 2005.

2. Garcia, P.; Ortega, A.; de Mingo, J.; Valdovinos, A.; "Nonlinear Distortion Cancellation in OFDM Systems Using an Adaptive LINC Structure", Personal, Indoor and Mobile Radio Communications, 2004. PIMRC 2004. 15th IEEE International Symposium on, Volume 2, 5-8 Sept. 2004 Page(s):1506 - 1510 Vol.2.

KEYWORDS: Linearization; Efficiency; Predistortion; Power Amplifier; Communication Systems; Aircraft

N06-117 TITLE: Low Cost Conformal Transmit/Receive SATCOM Antenna for Military Patrol Aircraft

TECHNOLOGY AREAS: Air Platform, Sensors, Electronics

ACQUISITION PROGRAM: PMA 290 Multimission Maritime Aircraft (MMA) ACAT I

OBJECTIVE: Develop a low cost conformal Sattelite Communication (SATCOM) transmit/receive antenna system that can operate at X, Ku and/or Ka band for military patrol aircraft to enable over-the-horizon high speed communications.

DESCRIPTION: Current Navy patrol aircraft such as the P-3 or P-8A Multimission Maritime Aircraft (MMA) do not have wideband over-the-horizon communications capabilities. The military is relying on SATCOM for this capability. SATCOM capabilities currently span from the UHF to the Ka frequency band and are made up of military and commercial systems. The higher frequency band systems provide higher data rates. The technology challenge will be to develop a small, low cost conformal antenna system for military patrol aircraft such as the MMA. Innovative designs based on a sub-array approach that utilizes a fixed number of phase shifters to lower manufacturing costs are desired. In addition the antenna needs to support both transmit and receive as well as both linear (vertical and horizontal) and circular polarization (both right and left circular polarization) with sufficient antenna gain to communicate with military satellites at X, Ku and Ka band. The antenna should also have a low radar cross section.

PHASE I: Develop and demonstrate antenna or sub-array design using either computer modeling and/or a fabrication of a lab model sub-array system with limited measured data.

PHASE II: Develop and fabricate prototype antenna and demonstrate design goals. If lab model was developed during phase I further maturity of design is expected to be demonstrated.

PHASE III: Transition this antenna technology for airborne integration, operation evaluation, and production, on naval aviation platform such as MMA, P-3, or other aircraft programs.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This antenna system would be useful for the commercial aviation community also for use with X, Ka, and Ku-Band SATCOMs.

REFERENCES:
1. Butz, J.; Spinnler, M.; Christ, J.; Mahr, U., "Highly Integrated RF-modules for Ka-Band Multiple-beam Active Phased Array Antennas", Microwave Symposium Digest, 2002 IEEE MTT-S International, Volume 1, 2-7 June 2002 Page(s):61 - 64.

2. Miura, A.; Yamamoto, S.; Obara, N.; Saito, H.; Takahashi, T.; Wakana, H.; Tanaka, M.; "Development of a Ka-band Active Phased Array Antenna for Mobile SATCOM Stations", Vehicular Technology Conference, 1999. VTC 1999 - Fall. IEEE VTS 50th, Volume 2, 19-22 Sept. 1999 Page(s):814 - 818 vol.2

KEYWORDS: Airborne; Over-The-Horizon Communications; Antenna; SATCOM; Conformal; Satellite

N06-118 TITLE: Advanced Blade-Damping Coatings

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: Joint Strike Fighter

OBJECTIVE: Develop a thin, lightweight, durable damping coating for turbine engine airfoils (Titanium or Nickel alloys) with dual-use capabilities (e.g. erosion and damping, thermal barrier and damping, or corrosion and damping).

DESCRIPTION: Modern high performance turbine engines have an inherently higher risk of high cycle fatigue (HCF) failures due to their increased work per airfoil and higher flows. Higher rotational speeds have caused new designs to use shorter necks in turbine airfoils or integrally bladed rotors (IBRs) in compressor airfoils, which result in reduced friction damping for the airfoil. Since new designs have inherently less friction damping, airfoil coatings are being investigated to provide damping and reduce HCF failures. Current turbine engine airfoils often have coatings for durability to increase time-on-wing. Coatings are also used on production engines to improve erosion resistance due to sand ingestion in the compressor (or fan), as a thermal barrier (TBC) in the turbine to reduce base metal temperatures, and to provide oxidation/corrosion resistance in the turbine. While the ability to avoid HCF failure would be highly beneficial, damping coatings have not been incorporated into current coating designs. The turbine engine industry is seeking a damping coating (or coating system) that will also improve overall blade life by providing the added effects of either thermal barrier or erosion coatings. A ‘dual-use’ coating would provide a much greater cost benefit to the user while improving aircraft safety and reliability. Proposed techniques should be thin, lightweight, durable, should not significantly impact material fatigue, and will need to meet requirements for long-term turbine engine use. Total coating thickness should be 10 mils or less.

PHASE I: Demonstrate coating feasibility with appropriate (Titanium or Nickel alloy) specimens. For example, if the coating proposed is a TBC/damping coating for turbine use, testing should be performed on Nickel alloy specimens at elevated temperatures, or if the coating proposed is an erosion/damping coating for fan use, testing should be on Titanium specimens with erosion testing. Use specimen test to evaluate other pertinent properties (erosion resistance, HCF strength, etc.). Test results should quantify damping and material properties.

PHASE II: Develop a prototype coating and apply to an appropriate set of engine airfoils to demonstrate long term durability of the coating system. Demonstrate durability in appropriate combined load bench test or HCF spin test. Demonstrate manufacturing application method feasibility for typical engine components. Develop and validate design methodology for the new system including required engineering properties.

PHASE III: Apply coating to a set of engine-quality airfoils and submit hardware for engine demonstration in a government or industry-supplied asset. Finalize coating integration with and OEM on a current or development engine.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: An effective dual-use damping coating would increase airfoil lives and engine time-on-wing, while also increasing engine safety and reliability. The technology would be applicable to both commercial and military aircraft turbine engines.

REFERENCES:
1. B.A. Movchan, A.I. Ustinov, International Center for Electron Beam Technologies of E.O. Paton EWI of NAS, Ukraine, 'Highly Damping Coatings for Protection o Titanium Blades' presented at NATO RTO AVT-121 Symposium.

2. Dr. Herman Shen, 'Free Layer Blade Damper by Magneto-mechanical Coating' 10th National Turbine Engine High Cycle Fatigue (HCF) Conference, March 2005

3. Dr. John P. Henderson, Mr. Donald W. Zabierek, Mr. John A. Justice, and Mr Robert M. Wilson; 'Preliminary Investigations of Modified Plasma Sprayed Damping Coatings for Titanium Airfoils' March 2005.

KEYWORDS: turbine engine; damping coating; airfoils; fatigue; erosion coating; thermal barrier coating

N06-119 TITLE: Broadband GaN-based Power Amplifier for Airborne Tactical Communication Systems

TECHNOLOGY AREAS: Air Platform, Information Systems, Sensors, Electronics

ACQUISITION PROGRAM: PMA-265 F/A-18 Hornet ACAT I

OBJECTIVE: Develop new innovative broadband gallium nitride (GaN)-based radio frequency (RF) power discrete or microwave monolithic integrated circuit (MMIC) solutions capable of 35-40 watts output power over 225 – 3200 MHz to significantly enhance airborne and weapon tactical communication systems capabilities.

DESCRIPTION: Airborne and weapon data links require more range in order to meet the Navy's demand to operate data links a greater distances. Most of the current airborne and weapon data link systems consists of multiple narrow frequency banded RF power amplifiers that greatly reduce mission planning flexibility. Additionally, a large operational logistics support base is needed to maintain the inventory. A small volume, lightweight power amplifier with greater output power is need to reduce the size of tactical and missile data links. Recent advances in III-V RF power technologies, particularly gallium nitride (GaN) may provide technically feasible and low cost solutions for low-to-high RF power generation approaches using relatively straightforward applications of prior art RF combiner technologies or other innovative RF power amplifier architectural concepts. Solutions should include novel small form factor packaging concepts that shall not exceed 250mm total in the x-y axis and 12 mm in the z-axis (~2 cubic inches) and be able to demonstrate high efficiency (>35%), low cost, good thermal management (Tj-c < 1°C/W), and proven reliability.

PHASE I: Determine the feasibility of developing broadband GaN-based RF power discrete or microwave monolithic integrated circuit (MMIC) and demonstrate proofs-of-concept utilizing computer simulations and/or experimental results.

PHASE II: Develop and demonstrate the capability of the power amplifier architecture in a laboratory environment.

PHASE III: Demonstrate the power amplifier in an aircraft, weapon, or Unmanned Aerial Vehicle (UAV) data link platform.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Successful design and implementation of broadband GaN-based RF power technology provides a potential for a new generation of low-to-high RF power amplifiers with smaller form factor, lower weight, and higher reliability.

REFERENCES:
1. Palmour, J.W.; Sheppard, S.T.; Smith, R.P.; Allen, S.T.; Pribble, W.L.; Smith, T.J.; Ring, Z.; Sumakeris, J.J.; Saxler, A.W.; Milligan, J.W.;"Wide bandgap semiconductor devices and MMICs for RF power applications"; Electron Devices Meeting, 2001. IEDM Technical Digest. International, 2-5 Dec. 2001, Page(s):17.4.1 - 17.4.4
2. Vellas, N.; Gaquiere, C.; Guhel, Y.; Werquin, M.; Bue, F.; Aubry, R.; Delage, S.; Semond, F.; De Jaeger, J.C.;"High linearity performances of GaN HEMT devices on silicon substrate at 4 GHz", Electron Device Letters, IEEE Volume 23, Issue 8, Aug. 2002, Page(s):461 - 463

KEYWORDS: Microwave Monolithic Integrated Circuit (MMIC); Amplifier; Thermal Management; Data Link; Radio Frequency; Tactical Communication Systems

N06-120 TITLE: UHF to L-Band Linear Amplifier 3-D Dielectric Material Enhancements

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Sensors, Electronics

ACQUISITION PROGRAM: PMA 265 F/A-18 Hornet

OBJECTIVE: Develop dielectric materials and three-dimensional RF packaging technology for the quadrature Linear Amplification Using Non-Linear Components (LINC) architecture in the UHF through L-Band frequency range for airborne platforms.

DESCRIPTION: Targets of opportunity for improving linear amplification include: 1) architectural changes, 2) advancements in devices and 3) materials & packaging improvements. Recent advances in linear power amplifier architectural design, using LINC, has shown improvements in both linearity and efficiency (size, weight and power) [1]. This iniative focuses on the advances that could be made to improve the linearity and efficiency of this technology by advances in 3-D packaging and materials. Significant improvements in performance could be obtained that will facilitate highly efficient linear operations in a small compact enclosure necessary to support other platforms such as hand held radios, space constrained platforms, and UAVs. The parameters include, but are not limited to: 1) tightly controlled dielectric substrates, 2) low loss tangent dielectrics (tan d), 3) controlled 3-D geometrics and, 4) proper grounding. The improved packaging and material development should not degrade the QUAD LINC power 30 amplifier performance.

PHASE I: Develop models to emulate realistic parasitics for the 3-D board design using computer simulations, analytic or experimental results for the Quad LINC architecture.

PHASE II: Develop and demonstrate a prototype of the new optimized 3-D materials and packaging design for a push pull power amplifier Quad LINC architecture. Demonstrate the improved operational performance.

PHASE III: Demonstrate the operation of the Quad LINC power amplifier architecture in a Unmanned Aerial Vehicle (UAV) and/or F-18 aircraft operating on an active network. Transition technology to applicable naval aviation platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: New highly efficient linear amplifiers will support all spectrums of communications, from radios to cell phones to wireless networks. The technology has unlimited applications.

REFERENCES:
1. Gamal M. Hegazi, Thanh T. Chu, and Richard A. Groshong, Improved LINC Power Transmission Using a Quadrature Outphasing Technique, 2005

2. Lahteenmaki, J.; Miettinen, J.; Heino, P.; "The design of miniature 3D RF module"; Electronic Components and Technology, 2005. ECTC '05. Proceedings
31 May-3 June 2005 Page(s):814 - 817 Vol. 1.

KEYWORDS: Linear Amplification Using Non-Linear Components; Dielectric Substrates; Three Dimensional (3-D) RF Packaging; L-Band; Amplifier; Communications

N06-121 TITLE: Multi-component Aircraft Engine Monitoring

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: Joint Strike Fighter

OBJECTIVE: Develop an advanced sensor suite/signal acquisition system for aircraft engine health management.

DESCRIPTION: The life cycle cost, weight, complexity and qualification effort severely constrains the introduction of advanced sensors for engine health management. While we need to be selective it is almost impossible to anticipate exactly which components will require monitoring due to in-service deficiencies. Many of these sensors require high bandwidth communication channels and carry heavy signal acquisition and processing burdens. Even the "real estate" required to connect multiple sensor leads is at a premium. Leading examples are the various means proposed to monitor blade tip clearance, flutter and deterioration, requiring individual sensors at each blade row each with dedicated signal acquisition interfaces. Similar challenges are found in other areas of the engine. Furthermore, these sensor-signal acquisition interfaces and interconnecting communication media must be compatible with the extreme engine environment. The signal acquisition (analog/digital) interfaces must be robust at 90+ degrees Celsius in a high vibration environment. The harness and sensors must be extremely dependable (25,000 hr. service life, minimal intermittency and false indications) mounted directly to the engine in a thermal environment exceeding 200 degrees Celsius, and preferably 600-700 degrees Celsius.

We are seeking subsystems consisting of sensors (preferably families of sensors for multiple uses), communication media and interfaces, signal acquisition/digitizing interfaces and algorithms that enable sensor systems to perform one or more of the following:

Interface multiple sensors to a common signal acquisition interface, either multiplexed, field interchangeable or both.

Detect failures in multiple components with a single sensor (Note: This item excludes the established technology of high frequency vibration analysis.)

Enable sensing of multiple classes of parameter with a common generic signal acquisition interface. Open system interfaces are particularly desirable to allow multiple sensor vendors to offer diverse but compatible sensors.

PHASE I: Conceptualize and design a suitable sensor suite/signal acquisition system and demonstrate its feasibility in a laboratory environment. This phase must include consultation with appropriate potential industrial users to ensure adequate requirements definition and technology suitability.

PHASE II: Design and prototype a mutually agreed subset of the sensor suite, integrated with a suitable communication media/electronic interface, and demonstrate system functionality in a representative environment. This phase must include participation by potential aerospace industry users to ensure application suitability and appropriate functionality.

PHASE III: Mature the design and develop it for application on future airborne weapon systems. Achievement of TRL 6 through engine test bed and/or flight test demonstration is expected.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The system solicited should find other application in military and commercial aircraft control and monitoring. Marine, industrial and power systems expected to have application for this technology, for both control and monitoring. Scientific and aircraft & gas turbine developmental instrumentation is another likely market, and the approach may also be useful for space systems. Automotive applications are possible.

REFERENCES:
1. "A Survey of Intelligent Control and Health Management Technologies for Aircraft Propulsion Systems"; Jonathan S. Litt; Donald L. Simon; Sanjay Garg; Ten-Heui Guo; Carolyn Mercer; Richard Millar; Alireza Behbahani; Anupa Bajwa; Daniel T. Jensen; Journal of Aerospace Computing, Information, and Communication 2004, 1542-9423 vol.1 no.12 (543-563)

2. "Optical Technologies for Sensing Voltage and Current", pp. 26-28, SENSORS, December 2005, http://www.sensorsmag.com/articles/1205/26/

KEYWORDS: sensor; multiplexed; propulsion; high Mach; air vehicle; control

N06-122 TITLE: Automated Ship and Small Craft Classification Tools for ISAR Imagery

TECHNOLOGY AREAS: Information Systems, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMA-290 Multi-Mission Aircraft, ACAT I, PMA-299 Multi-Mission Helicopter

OBJECTIVE: Develop innovative and robust automated ship and small craft inverse synthetic aperture radar (ISAR) imagery target classification algorithms and tool sets.

DESCRIPTION: The DoD has made major investments in the development of automatic target recognition (ATR) algorithms for both synthetic aperture radar (SAR) and high-resolution radar (HRR) modes. A number of capable ATR packages have been developed including the DARPA/AFRL Moving and Stationary Target Acquisition and Recognition (MSTAR) system, the AGRI Critical Experiment (ACE) HRR ATR, the Sandia National Laboratory real-time SAR ATR, as well as others from MIT-Lincoln Laboratory and SAIC. In comparison, relatively little has been invested into ISAR ATR tools. However, supporting work has been accomplished by the Naval Research Laboratory including their polar reformatting for improved image focusing, time-frequency and micro-Doppler exploitations, image while scan mode development and ISAR classification by parts methods.

A number of SAR adaptive classification engines have been investigated including principal and independent component analysis, support vector machines and neural networks. Such methods may form the basis for an ISAR classification engine however ISAR imagery is fundamentally different than SAR imagery. The operational performance of various candidate methods as a function of training data, confusion matrices, orientation variant and invariant features, articulating components and variability within a specific target type is not known. The goal of this project is explore innovative techniques that will provide a robust adaptive ISAR classification tool to assist the radar operators rapidly and accurately classifying ships and small boats in the littoral. The classification methods should provide a high probability of correct target classification for both ships and small craft including variation within a specific class. The methods should be robust in the presence of limited signature contamination in littoral operating conditions. Ultimately the classification tool must be capable of distinguishing between targets in a large number of classes. Consideration should also be given to classification tool performance with and without application various image enhancement techniques, performance against targets types that the system has not been trained on, and the value of collateral information.

PHASE I: Assess and conduct a trade-off analysis of potential ISAR classification techniques. Demonstrate the feasibility and technical merit of the proposed technique and generate a detailed system architecture description. Develop an RDT&E plan addressing performance metrics, training requirements, classification attributes, target class mix, number of classes, effects of variations within a class, image aspect, image defects, image focus, image resolution and human-system interface.

PHASE II: Develop prototype technology and demonstrate that it can accomplish the goal of accurately classifying ships and small craft operating in their operational environment based on their ISAR images. Whenever possible evaluate the performance using available or sponsor provided data sets.

PHASE III: Working with radar system OEMs transition the technology improvements to the Fleet.

PRIVATE SECTOR USE OF TECHNOLOGY: The general methods developed could be ap-plicable to a wide range of feature classification needs ranging from those of homeland security to the medical field.

REFERENCES:
1. V.C. Chen and R. Lipps, ISAR Imaging of Small Craft With Roll, Pitch and Yaw Analysis, Proceeding of the IEEE International Radar Conference 2000, pp. 493-498

2. J. LI, R. WU and V.C. CHEN, Robust Autofocus Algorithm for ISAR Imaging of Moving Targets, IEEE Transactions On Aerospace And Electronic Systems Vol. 37, No. 3 July 2001, pp.1056-1069

3. R. Lipps and D. Kerr, Polar Reformatting For ISAR Imaging, IEEE 1998 National Radar Confer-ence, Dallas, Tx, 12-13 May 1998, pp. 275-280

4. M. Bottoms, R. Lipps and V.C. Chen, ISAR Techniques for Target Identification, 2002 Combat Identi-fication System Conference, vol. 1, 3-7, June, 2002.

5. K. Kawakami, H. Tanaka and K. Yamamoto, 3D Object Recognition using ISAR Image, SICE Annual Conference in Sapporo, August 4-6,2004, pp. 204-207

6. R. Wu, Z.-S. Liu and J. Li, Time-Varying Complex Spectral Estimation with Applications to ISAR Imag-ing, Conference Record of the Thirty-Second Asilomar Conference, 1-4 Nov. 1998 pp. 14 - 18 Vol.1

KEYWORDS: Inverse Synthetic Aperture Radar; Automatic Target Recognition; Ship and Small Craft Classification; Image Classification; Image While Scan; High-Resolution Radar

N06-123 TITLE: AESA-based RADAR Performance in Complex Sensor Environments

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMA-265 F/A-18 Hornet; Joint Strike Fighter, ACAT I

OBJECTIVE: Develop innovative highly-adaptive radar resource scheduling algorithms to support optimal multifunction operation of Naval airborne active electronically scanned array (AESA) based radar systems in a variety of operational situations/scenarios. A key component of these algorithms is to adequately capture radar timeline, energy and computational constraints while optimizing system performance against representative target sets and mission tasking in the operational environment.

DESCRIPTION: Modern AESA-based radar systems are theoretically able to near-instantaneously and adaptively position and control their array beam to support concurrent multiple target tracking in air-to-air and air-to-ground modes as well as interleave other modes such as SAR and GMTI. Optimally adapting the system operating parameters according to present tasking and how they perceive the operational environment is needed. The scheduling of these tasks has traditionally employed a combination of conservative heuristics, table lookups, and/or operator intuition. A variety of more advanced approaches have been investigated including use of neural networks, artificial intelligence, operations research theory, fuzzy logic and particle swarm algorithms. In general these investigations have focused on the optimization of resources in surveillance and multiple maneuvering target tracking modes. A comprehensive treatment is needed that addresses the complete set of radar modes including ways to optimally nest multiple interleaving modes. The desire is to develop algorithms that provide responsive scheduling of prioritized tasks within the system time and energy budget constraints so as to maximize the probability of detection and minimizing time, energy usage and probability of false alarms even in adverse propagation, clutter or jamming conditions.

PHASE I: Develop a detailed description of the proposed resource scheduling algorithm set as applied to a Naval tactical airborne AESA based radar system. The description must address the functional capability of candidate radar systems as installed on tactical aircraft, resource scheduling logic and optimization methods to be employed by the radar. An initial performance assessment should be made using a set of operational scenarios of interest to the

Naval TACAIR community. The operational scenarios should capture host platform characteristics and mission objectives, target types and their kinematics, target density, clutter return, jamming environment and the presence of discrete unintentional interfering sources.

PHASE II: Develop and refine the resource scheduling system as applied to a specific radar system of interest. Whenever possible evaluate the prototype scheduling system's performance by comparing to existing models to sponsor provided test data.

PHASE III: Working with radar system OEMs transition the AESA resource management tools to the Fleet.

PRIVATE SECTOR USE OF TECHNOLOGY: Integrated resource management and scheduling with multiple constraints finds application in a wide range of civilian communication systems. The general models developed under this SBIR could be modified to support these civilian applications.

REFERENCES:
1. Miranda, S.L.C., C.J. Baker, K. Woodbridge and H.D. Griffiths, Phased Array Radar Resource Management: A Comparison of Scheduling Algorithms, Radar Conference, 2004. Proceedings of the IEEE, 26-29 April 2004, pp.79 - 84

2. Hansen, J.P., S. Ghosh, R. Rajkumar and J. Lehoczky, Resource Management of Highly Config-urable Tasks, Proceedings of the 18th International Parallel and Distributed Processing Symposium 26-30 April 2004, pp.116

3. Watson, R. Radar Resource Management Modeling, RADAR 2002, 15-17 Oct. 2002, pp.562 - 566

4. Lee, C.-G., A Novel Framework for Quality-Aware Resource Management in Phased Array Ra-dar Systems, Proceedings of the 11th IEEE Real Time and Embedded Technology and Applications Symposium, 7-10 March 2005, pp.322 - 331

KEYWORDS: Phased Array Radar; Resource Management; Modeling and Simulation; Operational Scenarios; Multifunction Radar; Radar Timeline

N06-124 TITLE: Development of Advanced Thin-Film Microwave Filters

TECHNOLOGY AREAS: Materials/Processes, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Joint Strike Fighter, ACAT I

OBJECTIVE: Utilizing advanced thin-film component technology, develop high-efficiency low cost and reduced size microwave RF and IF filters suitable for use in X-band active electronically steered antenna (AESA) array based radar systems.

DESCRIPTION: Thin-film filter technology has provided the wireless consumer telecommunications market with increased device functionality, improved channel selectivity, reduced component size, lower weight and higher device reliability. Steady improvements have been made in thin-film technology including reduced filter parasitic crosstalk; improved integration onto active device substrates; wider bandwidth operation; very rapid tunability; and the utilization of advanced materials for reduced device size and lower loss. Our desire is to leverage these advances where possible and focus new research on critical issues associated with the use of thin-film tunable filters for multifunction wideband active electronically steered antenna array based radar systems.

Improvements in both materials and circuit performance are of interest. Considerations should be given to critical performance parameters for this application including the input and output impedance, selectivity, phase response, transient response, insertion loss, terminal crosstalk, tuning speed, signal power handling capability, power consumption, size and ease of integration.

PHASE I: Leveraging the state-of-the-art knowledge base in thin-film microwave filter technology and the projected performance limits of these devices, develop a broad based research and development plan that provides a prioritized investment strategy for thin-film filter technology applicable to X-band AESA-based radar systems. In consultation with the sponsor, develop a detailed research and development plan focusing on a limited set of the most promising concepts of interest to the sponsor.

PHASE II: Using the most promising concepts from Phase I, develop and demonstrate the capability of providing meaningful performance, producability and/or cost improvements to thin-film microwave filters.

PHASE III: Working with RADAR system OEMs and device manufacturers transition the technology improvements to the Fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: High performance thin-film filters are essential to a wide range of civilian and military sensor and communication systems.

REFERENCES:
1. K.M. Lakin,, Thin Film Resonator Technology, IEEE Transactions On Ultrasonics, Ferroelectrics, And Frequency Control, vol. 52, no. 5, May 2005, pp. 707-716
2. H.R. Yi, S.K. Remillard and A. Abdelmonem, A Novel Ultra-Compact Resonator for Superconducting Thin-Film Filters, IEEE Transactions On Microwave Theory And Techniques, vol. 51, no. 12, December 2003, pp. 2290-2296
3. K. Lakin, and J. Belsick, Integration of Thin Film Resonator Devices Onto SiGe Substrates, Silicon Monolithic Integrated Circuits in RF Systems, 2001. 12-14 Sept. 2001 pp.37 – 41
4. H.R. Yi, S.K. Remillard, and A. Abdelmonem, A Superconducting Thin Film Filter Of Very High Wide-Band Rejection, Microwave Symposium Digest, 2003 IEEE MTT-S International Volume 3, 8-13 June 2003 pp. 1893 - 1896
5. J. Nath, D. Ghosh, J.-P. Maria, A.I. Kingon, W. Fathelbab, P.D. Franzon, and M.B. Steer, An Electronically Tunable Microstrip Bandpass Filter Using Thin-Film Barium–Strontium–Titanate (BST) Varactors, IEEE Transactions On Microwave Theory And Techniques, vol. 53, no. 9, September 2005, pp. 2707-2712

KEYWORDS: Microwave filters; RF filters; Thin Film Devices; Phased Array; T/R Modules; AESA radar

N06-125 TITLE: L-Band Solid-State High Power Amplifier for Airborne Platforms

TECHNOLOGY AREAS: Air Platform, Sensors, Electronics

ACQUISITION PROGRAM: PMA 231 E2D Advanced Hawkeye ACAT I

OBJECTIVE: Develop a lightweight and small volume L-band solid-state power amplifier for aircraft platforms.

DESCRIPTION: Navy aircraft must be equipped with communication networking systems to meet the growing demand of exchanging large volumes of information between multiple users. However, space is limited on aircraft, consequently there is a need to reduce the volume and weight of current communication equipment on-board aircraft.

The E2C/D communication system currently utilizes a JTIDS vacuum tube based high power amplifier that occupies a significant volume, footprint, and weight in the aircraft. Current dimensions of the high power amplifier are 7.68" h x 15.52" w x 21.00"l for a volume of 1.45 cu. ft. The high power amplifier weighs 83.7 lbs. [3] There is a strong desire to develop innovative solid-state high power amplifier architecture based on LDMOS, SiC, or GaN that is capable of outputting power of 1000 watts continuous-wave (cw) in the L-band [1,2]. The amplifier architecture should demonstrate a significantly smaller volume, smaller footprint, and lower weight than the E2C/D JTIDS high power amplifier while meeting the JTIDS electrical and mechanical requirements. Thermal management and packaging issues should be addressed. The power amplifier architecture is expected to consist of a pre-driver stage and a high power stage.

PHASE I: Develop a computer model, analytic model or breadboard to validate the design for the high power amplifier architecture to achieve the performance requirements.

PHASE II: Demonstrate the capability of the power amplifier architecture to meet the operational requirements in a laboratory environment. Develop the design concepts for packaging the power amplifier architecture in a reduced volume, reduced footprint, and lower weight.

PHASE III: Demonstrate the power amplifier architecture in a reduced volume, reduced footprint, and lower weight. Demonstrate the amplifier in an E2D electrical and mechanical environment. Transitions power amplifier technology to naval aircraft platform.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: New highly efficient linear amplifiers will support all spectrums of communications, from radios to cell phones to wireless networks. The RF power amplifier has the largest impact on the cost, size, weight and power for communication systems. A small volume low weight high power amplifier will be benificial for wired and wireless communication systems in the cell phone and networking industries.

REFERENCES:
1. Palmour, J.W.; Sheppard, S.T.; Smith, R.P.; Allen, S.T.; Pribble, W.L.; Smith, T.J.; Ring, Z.; Sumakeris, J.J.; Saxler, A.W.; Milligan, J.W.; "Wide Bandgap Semiconductor Devices and MMICs for RF power Applications", Electron Devices Meeting, 2001. IEDM Technical Digest. International, 2-5 Dec. 2001 Page(s):17.4.1 - 17.4.4.

2. Chen, P.; Chang, H.R.; Li, X.; Luo, B.; "Design and Fabrication of SiC MESFET Transistor and Broadband Power Amplifier for RF Applications", Power Semiconductor Devices and ICs, 2004. Proceedings. ISPSD '04. The 16th International Symposium on, 24-27 May 2004 Page(s):317 - 318.

3. Interface Control Document High Power Amplifier for JTIDS Class 2H Terminal Configuration Y207A115; will be posted on SITIS

KEYWORDS: Power Amplifier; Solid State; Communication System; Thermal Management; Airborne; Efficiency

N06-126 TITLE: Fretting Fatigue Modeling and Life Prediction

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: Joint Strike Fighter

OBJECTIVE: Develop and demonstrate advanced modeling techniques and programs that can be used to accurately characterize aircraft engine systems component (and/or sub-component) to determine fretting fatigue and life prediction.

DESCRIPTION: In order to ensure the flight safety of engine components, the ability to model fretting fatigue and to determine the safe life prediction of the components (and/or sub-components) is imperative. This effort should leverage existing analysis tools, methods and information where possible from existing programs (High Cycle Fatigue ((HCF), SBIR, etc.) and expand the current capabilities to include fretting fatigue crack initiation, multiple fretting crack coalescence, and both crack growth trajectory and rate in a 3D environment for a complex engine mission cycle. The failure progression rates are to be characterized from the earliest incipient fault stages, incrementally through the final component (and/or sub-component) failure stages. The development and demonstration of the methodology should be acquired through a controlled environment and/or through actual fleet failures with the later the preferred demonstration method. The goal is to develop a program or programs capable of providing an understanding of component fretting fatigue analytically through the use of advanced models. This effort will develop, demonstrate, and apply these advanced models in support of the predictive part of fretting fatigue and life prediction.

PHASE I: Develop initial concept design and define key elements of an advanced modeling program to characterize aircraft system failure progression rates from fretting crack initiation to final component failure. Develop an initial prototype-modeling program and demonstrate the feasibility of its use on an aircraft system component failure progression time history.

PHASE II: Develop a prototype modeling program or programs with the capability to characterize the described failure progression rates for several aircraft mechanical-systems components. Demonstrate how the fault failure progression rates provided by these models can be used to accurately predict a component failure event and determine the useful remaining component life at any point in time. Assess the application boundaries and limitations for these modeling techniques.

PHASE III: Develop and deliver a complete set of application modeling programs to be use on several aircraft engine systems. Integrate the failure progression rate results of these modeling programs with a comprehensive useful life determination method. Apply these modeling programs a new aircraft engine development program like the JSF.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: These advanced models would be applicable to any mechanical machine application that has fretting fatigue crack initiation and crack propagation potential to determine useful life. This is particularly true any rotating machines used in aviation, power plants, etc. The results gained from applying these failure progression rate models to particular systems would provide a significant cross over benefit to other similar applications, commercial or military.

REFERENCES:
1. Barlow, K.W., Chandra, R., “Fatigue crack propagation simulation in an aircraft engine fan blade attachment,” International Journal of Fatigue, 27, 2005, pp. 1661-1668.

KEYWORDS: fretting fatigue; crack initiation; crack coalescence; crack propagation; modeling; simulation

N06-127 TITLE: Service-Oriented Architecture for Naval Strike Force Interoperability Readiness

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: The objective of this project is to develop web service based architecture to revolutionize the Navy’s approach to planning, assessing, scheduling, and maintaining configuration control under the guidance of the C5I modernization process for Strike Force deployment baselines. System architecture is to be developed for the implementation of this model; hardware, network, and COTS product components are to be evaluated and selected to create an integrated working System of Systems representing the selected architecture. This is to include a methodology for ensuring information assurance in a multi-level secured environment.

Proof of concept is to be provided to demonstrate the model’s usefulness in integrating the science of service-oriented technology for application-to-application communication as well as the assembled system’s interoperability, portability flexibility, scalability and reliability, and conformance with the secured data transmission and processing requirements. The initial version of the working system is to be developed that can function with the legacy source databases following the completion of proof of concept demonstrations and evaluation of user feedback. Simultaneously, a transition process is to be put in place to incorporate new and emerging source databases, models, and architectures, and new application programs that interact with the Afloat Master Planning System module and the Navy Development Environment (NDE) to generate near real time information that can be used by the decision makers.

DESCRIPTION: The architecture will enable a system-of-system communication approach that employs capabilities for: (a) simple and ubiquitous interfaces to all participating software agents; (b) descriptive messages constrained by an extensible schema delivered through the interfaces; (c) stateless service; (d) stateful service; (e) high assurance multi-level servers. This architecture must be capable of safeguarding the integrity of data and transactions, minimize performance degradation and gridlocks, and perform in a minimum of three security level environment.

PHASE I: The objective of work during Phase I is to develop a system concept to demonstrate that web and knowledge services can expedite data flow from one module of the NDE to another meeting the required application-to-application communication concept then perform the necessary knowledge management associated with decision performance, acknowledgement and capture. This system concept will articulate the transition of data between an unclassified and secured environment. This will be accomplished with a minimum of two security level environment with a transition plan of performing Phase II in a minimum of a three security level environment.

PHASE II: The objective of Phase II is to develop an executable architecture that can be used to exercise the broader community of users and other affiliated modules of AMPS and the NDE, obtain feedback, and enhance the architecture to function in a multi-level secured environment. This may have the potential to be a fast-track phase.

PHASE III: The objective of Phase III is to transition the architecture to apply the application-to-application communication concept implemented in the NDE to the joint force C5I data environment for planning, scheduling, assessing, and maintaining configuration control for enhanced battle management.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The problem of determining the readiness and interoperability extends from naval task forces to multi-service and multi-country forces engaged in joint and combined operations. The architecture that is developed under this project is expected to be of interest to the US Joint Chiefs of Staff and NATO.

REFERENCES:
1. URL https://www.nde.navy.mil/
2. Enterprise SOA Service-Oriented Architecture Best Practices by Dirk Krafzig, Karl Banke, Dirk Slama (C) 2005Pearson Education, Inc.

KEYWORDS: Strike Force Readiness; C5IMP; Combat Systems Interoperability; Service-Oriented Architecture; Knowledge Based Services; Web Based Services; Information Assurance; Information Security; Multi-level Security

N06-128 TITLE: SBIR Phase 1: Riverine Assault Support System

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes, Weapons

ACQUISITION PROGRAM: NAVSEA 05

OBJECTIVE: Expand upon current capabilities for riverine operations and logistics support by proposing applications of new technologies aimed at extending the present operational state of the art for riverine craft operations.

DESCRIPTION: Current inventory of riverine-capable craft is limited in its ability to operate in anticipated threat environments with an appropriate mix of speed, payload, and crew/vessel survivability. In addition, lessons learned from operational experience illuminate a potential capability gap, centered on the need for riverine-capable craft with enhanced survivability / armament suites to counter anticipated threats, modular C4ISR capabilities (including transport, operation, recovery, and maintenance of Unmanned Vehicles), and unit-level Logistics support functions.

Proposals are sought for the application of technologies aimed at addressing these identified capability gaps, either by incorporation of new technologies within a suitable riverine combatant-craft concept, or by definition of the new technologies as modular “add-on” capability packages, with system interfaces defined sufficiently to enable consideration as modifications to existing or planned riverine craft design concepts.

PHASE I:
1. Proposer shall conceptualize technology alternatives that advance the present operational state of the art for riverine operations, including but not limited to:

a. Expanding operational envelope (reduction of required operational draft, damping of vessel motions during maneuvering, improved seakeeping, etc.)
b. Increasing survivability (modular and optimized ballistic protection arrangements, material selections, vessel machinery layouts)
c. Augmeting organic unit-level fire support (modular, stabilized, lightweight, sensor integrated, high-lethality weapon systems)
d. Improving C4ISR (integration of all-source intel feeds, blue force tasking and tracking, support of organic UV assets)
e. Providing affordable and sustainable unit-level Logistics (transport/deployment of supplies and small ground vehicles e.g. motorcycles and fast attack vehicles)
2. Proposer shall incorporate technology alternatives into existing or newly-proposed riverine craft concepts to illustrate potential benefits and provide suitable definition for assessment of technology impact on the basis of cost, military effectiveness, ability to operate in varied environments (tropics to desert).
3. Proposer shall define appropriate testing and validation methodology for model-to-full scale evaluation of the proposed concepts in a Phase II effort.

PHASE II: The Proposer will provide programmatic risk reduction by instantiating proposed technologies and conducting model-to-full scale testing, if selected as a result of Phase 1 efforts.

PHASE III: The Proposer will transition technologies deemed beneficial, affordable, and sustainable (as a result of testing in Phase II) into design and acquisition efforts anticipated as forthcoming in the next 2-5 years. This effort might include provision of services and analysis to the government directly in preparing a requirements documents and evaluating industry proposals. The government will support the contractor in preparing detail design guidance for use by the vehicle builder.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Riverine support technologies can enhance the logistics support/relief network to aid civilian flood and storm victims in the U.S. and around the world.

REFERENCES:
1. Friedman, N., "U.S. Amphibious Ships and Craft", 2002, Naval Institute Press, Annapolis, MD.
2. McAbee, R. L., "Brown Water Navy: U.S. Naval Riverine Operations Vietnam", 2001, Honoribus Press
3. Mintz, J., "Game Warden, Mobile Riverine Force and Revolutionary Development Operations In the Delta", 1968, The Center
4. Lindberg, M. and Todd, D., “Brown-, Green-, and Blue-Water Fleets”, 2002, Praeger

KEYWORDS: Riverine, Logistics, Assault, Vietnam, Craft, Amphibious

N06-129 TITLE: High Power 95 GHz Source with Permanent or Conventional Solenoid Magnets for Active Denial Technology

TECHNOLOGY AREAS: Ground/Sea Vehicles, Electronics, Weapons

OBJECTIVE: The objective of this proposal is to develop a high-power 95 GHz millimeter wave RF vacuum source employing permanent or conventional solenoid magnets. The goal is to reduce weight and cost, improve reliability and, most importantly, eliminate the cool-down time of the current Active Denial System without imposing or increasing additional constraints (e.g. prime power) on the system. A source with output power exceeding 30 kW average (100 kW goal) utilizing permanent magnets is desired. The development of such a source would be a major step forward for the deployment of this technology and the resultant capabilities. Furthermore, this technology would have other significant military (e.g. mm-wave radar) as well as scientific and commercial (e.g. sources for materials processing, plasma heating and diagnostics, etc.) application.

DESCRIPTION: The frequency band near 95 GHz is of interest for a number of applications, one of which is Active Denial [1]. This is due to a natural atmospheric transmission window at this band [2]. Another major military application at this frequency is mm-wave radar for detection of small, elusive targets and remote sensing such as

cloud mapping [3-5]. In addition, the gyrotron presently used in the Active Denial System is fundamentally similar to other gyrotrons (at various mm-wave frequencies), almost all of which are used in scientific (e.g. plasma heating, confinement and diagnostics) and industrial (e.g. materials processing) applications [6,7]. Applications in these fields would also benefit, as the technology should readily scale to other frequencies.

Presently, high-power gyro-sources above 30 GHz almost exclusively employ superconducting magnets [8]. This is fundamental as the frequency of operation is directly determined by the magnetic field [6, pp. 8-11]. Superconducting magnets are expensive and difficult to transport, operate and maintain in the field. In scientific and industrial applications they account for significant expense as cryogenic magnets are typically used, requiring considerable amounts of liquid Helium. The elimination of the superconducting magnet would be a major advancement in the development of systems designed to exploit the 94-96 GHz frequency band in particular and the upper mm-wave band in general.

Harmonic operation, the technique to eliminate the superconducting magnet in gyro-devices, is (theoretically) well known [9-11]. That is, the frequency of operation, f, is directly proportional to the magnetic field, B. However, the frequency of operation can be generated as a harmonic, n, of the fundamental frequency, fo, of the device (that is, f=nfo is proportional to B). Therefore, the magnetic field can be reduced by the harmonic number (i.e. f~B/n). Although the physics are relatively straight forward, the technological developments required for viable harmonic operation are challenging. Since the vast majority of gyrotrons produced to date have been for the scientific and industrial communities (which have the benefits of controlled environment and schedule), the impetus for research and development in this area has not been seen as outweighing the technical risks. This is not so for military applications.

Presently, efficient generation of 94-96 GHz mm-wave power requires a magnetic field of approximately 38-40 kG. The best published result for permanent magnets (in a gyro-device) is around 10 kG [12]. Therefore, operation at a harmonic of n=4 or more is anticipated. However, present gyro-device technology exhibits a prohibitive decline in efficiency above the n=2 harmonic (see [13] for the present state-of-the-art of gyro-devices operating in both fundamental and harmonic modes). Techniques for efficient, high-harmonic operation have been proposed [9-11], including operation in slotted cavities and/or with axis-encircling electron beams (and typically with depressed collectors), but not yet effectively realized. It is this challenge (realization of efficient, high-power, high-harmonic operation) that represents a major advancement of the art. To that end, demonstration of an efficient (>35%), high power (>30 kW) 95 GHz source with permanent magnets presents an opportunity for innovative research.

PHASE I: The Phase I technical objective is to design an experimental vacuum device operating at (approximately) 95 GHz, utilizing permanent or conventional solenoid magnets and capable of producing 30 kW at 35% efficiency. The design need not be intended to produce 30 kW average power (it may be a device with 30 kW or more peak power operated at a lower duty cycle. However, this is only intended to mitigate the Phase I cost (and risk) and the technology may not have a fundamental physical limitation which would prohibit its application to the 30 kW average power goal.

PHASE II: The Phase II technical objective is to (1) build a prototype device designed in Phase I, (2) demonstrate the performance of the device, and (3) modify the design to achieve the goal of 30 KW average power output, prepare and provide the design for Phase III implementation.

PHASE III: Build and evaluate an Engineering Development Model (EDM) 30+ kW device for system application.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Success of this project would allow development of a family of high power, compact, mobile, mm-wave sources since the technology should translate easily to other frequencies. Furthermore, harmonic generation applies to amplifiers as well as oscillators. Therefore, another immediate Phase III application would be high-resolution mm-wave radar for detection of, for example, space debris, small fast moving targets, and targets hidden in clutter. Furthermore, the advantages of such a radar for remote sensing (e.g. storm cloud mapping) have been demonstrated [14]. Mobile, high data rate (high bandwidth), communication systems would be another probable application.

Successful demonstration of this device will lead to wide interest in commercialization of the technology. Spin-offs would include cheaper sources for advanced materials processing (e.g. mm-wave sintering of ceramics and metals), plasma heating and spectroscopy.

REFERENCES:
1. Active Denial Web site – http://www.de.afrl.af.mil/fact sheets/Active denial.html
2. E. S. Rosenblum, "Atmospheric absorption of 10-400 KMCPS radiation, summary and bibliography to 1961," Microwave Journal, vol. 4, pp. 91-96, March 1961.
3. V. L. Granatstein and A. V. Gaponov-Grekhov, "High-power microwave electronics: a survey of achievements and opportunities," in Applications of High Power Microwaves, A. V. Gaponov-Grekhov and V. L. Granatstein, Ed. Norwood MA: Artech House, 1994, pp. 18-19.
4. A. W. Fliflet, et. al., "Cloud imaging using the NRL WARLOC radar," Conference Record of the RF 2003 Workshop, pp329-338, 2003.
5. J. B. Mead, et. al., "Millimeter-wave radars for remotely sensing clouds and precipitation," Proc. IEEE, vol. 82, pp. 1891-1906, Dec. 1994.
6. M. V. Kartikeyan, E. Borie, and M. K. A. Thumm, Gyrotrons, High Power Microwave and Millimeter Wave Technology. Berlin: Springer-Verlag, 2004, pp. 185-192.
7. Communication and Power Industries, "Products: Gyrotron", Online: http://www.cpii.com/mpp/products/gyrotron.shtml.
8. K. L. Felch, B. G. Danly, H. R. Jory, K. E. Kreischer, W. Lawson, B. Levush, and R. J. Temkin, "Characteristics and applications of fast-wave gyrodevices," Proc. IEEE, vol. 87, pp. 752-781, May 1999.
9. K. R. Chu, "The electron cyclotron maser," Rev. Modern Physics, vol. 76, pp. 489-540, April 2004.
10. R. C. Stutzman, D. B. McDermott, Y. Hirata, D.A. Gallagher, T.A. Spencer and N. C. Luhmann, Jr., "94 GHz sixth-harmonic slotted gyrotron," in IEEE Conf. Record - Abstracts, The 27th IEEE Int. Conf. on Plasma Sci., 2000, p171.
11. D. B. McDermott, A. J. Balckum, and N. C. Luhmann, Jr., "35-GHz 25-kW CW low-voltage third-harmonic gyrotron," IEEE Trans. Plasma Sci., vol. 24, pp. 613-619, June 1996.
12. T. Idehara, et. al., "A high harmonic gyrotron with an axis-encircling electron beam and a permanent magnet," IEEE Trans Plasma Sci., vol. 32, pp. 903-909, June 2004.
13. M. K. Thumm, "State-of-the-art of high power gyro-devices and free electron masers, update 2004," Forschungszentrum Karlsruhe, Karlsruhe, Germany, Tech. Rep. FZKA 7097, February, 2005.
14. W. M. Manheimer, et. al., "Initial cloud images with the NRL high power 94 GHz WARLOC radar," Fourth IEEE Int. Vacuum Electronics Conf. (IVEC 2003) - Conf. Record, p. 378, May 28-30, 2003.

KEYWORDS: Gyrotron; Gyro-device; Millimeter-wave; Harmonic; Oscillator; Super conducting

N06-130 TITLE: LIDAR Sensor for Underwater and Airborne Mine Detection

TECHNOLOGY AREAS: Sensors, Electronics

ACQUISITION PROGRAM: PMS 495 Mine Warfare Program Office, AN/AQS-20A and ALMDS, ACAT II

OBJECTIVE: Develop a novel hardware and software solution for integrating a readout integrated circuits (ROIC)-based laser imaging detection and ranging (LIDAR) camera into the AN/AQS20 electro-optic identification (EOID) and Airborne Laser Mine Detection System (ALMDS) sensors.

DESCRIPTION: The Streak Tube Imaging LIDAR for Electro-optic Identification (STIL-EOID) sensor has been successfully integrated into underwater and airborne sensors by the Navy for mine detection. However, new technologies are desired to reduce size, complexity and cost to support the transition from manned to unmanned system operation. Recent developments in fast readout integrated circuits (ROIC) have proven the technology for use in small 3-D flash LIDAR cameras and show promise for use in a lidar for underwater and airborne mine detection. However, technical innovations must be made in order to yield a larger 3-D flash LIDAR camera that is capable of meeting all of the requirements for these two mine detection systems. These innovations include novel approaches to reduce sensor noise, increasing the readout times of the camera, and increasing the fill factor. The new lidar receiver must fit inside the current EOID and ALMDS envelopes, cost less, and have comparable

performance. The sensor must be rugged for operation attached directly to a helicopter or towed behind. Data will provide co-ordinates of mine-like objects detected and data collection will be at 400 Hz. Ultimately, this sensor would be transitioned to unmanned underwater and airborne mine countermeasures systems requiring even smaller packaging.

PHASE I: Select sensor technology and determine specifications and requirements for the LIDAR camera. Create preliminary system designs for AQS20 and ALMDS, including approximate cost and estimated performance.

PHASE II: Construct and test a working prototype LIDAR camera for technology proof of concept. Develop system receiver design for integrating sensor into the AQS20 EOID hull and the ALMDS pod.

PHASE III: Final sensor will be produced and integrated into the AQS20 EOID and ALMDS POD for validation testing. Testing would also include environmental qualification testing to ensure that sensor meets military specification requirements.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Any electro-optic sensor using streak tube imaging technology (or any other low-light amplification technique) could potentially use this technology.

REFERENCES:
1. Swartz, B. A., J. D. Cummings, “Laser range gated underwater imaging including polarization discrimination”, Underwater Imaging: Photography and Visibility, SPIE V. 1537, 1991

2. Ulich, B. L., P. Lacovara, S. E. Moran, M. J. DeWeert, “Recent results in imaging lidar”, Advances in Laser Remote Sensing for Terrestial and Hydrographic Applications, SPIE V. 3059, April 1997

3. Strand, M. P., “Underwater Electro-Optic System for Mine Identification”, Naval Research Reviews, 1997

4. McLean, J. W., J. D. Freeman, R. E. Walker, “Beam Spread Function with Time Dispersion”, Applied Optics V37, No 21, 20 July 1998.

5. Walker, R. E. and McLean, J. W., “Lidar equations for turbid media with pulse stretching”, Applied Optics V38, No. 12, 20 April 1999

6. McLean, J. W. and R. E. Walker, “Lidar equations for turbid media with pulse stretching”, Airborne and in-Water Underwater Imaging, SPIE V 3761, July 1999.

7. McLean, J. W. "High Resolution 3-D Underwater Imaging"

KEYWORDS: sensor; LIDAR; camera; imaging; mine countermeasures; STIL

N06-131 TITLE: Low Cost Navigation Radar Detector for Unmanned Maritime Vehicle Surface Contact Avoidance

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors, Electronics

ACQUISITION PROGRAM: PMS 403

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop a miniature low cost receive antenna and low power processing for passive detection and direction finding of sources of radar and communication frequencies for use on unmanned undersea, surface, and air vehicles to assist with navigation and surface contact avoidance.

DESCRIPTION: Unmanned systems are envisioned to operate in the littoral environments. Safe operation will depend on the need to passively identify white traffic including freight, shipping, and pleasure traffic. Use of passive detection will complement the active navigation radar and/or visual detection systems when fused in the vehicle, especially at times of low visibility. Most of the littoral traffic will use both navigation radar and some type of communications. The desired system shall be capable of receiving and decoding Automated Identification System (AIS) signals, which are required for ships over 300 gross tonnage. The system should also have the ability to detect radar and communication transmissions and localize on a bearing to assist with tracking of ships less than 300 gross tonnage (not AIS equipped). The system shall include software to localize and track the targets (including position uncertainty) using the inputs from the receiver antenna and electronics. This system can be installed on Unmanned Underwater Vehicles (UUVs) for fully passive detection or coordinated with radar on an Unmanned Surface Vehicle (USV) to determine location and type of vessel for navigation purposes. The system should be designed for the more challenging case of UUVs. UUVs are power and space limited; their masts do not extend far above the water surface and are subject to wind and wave motion effects. The system is not expected to detect traffic over the horizon. Current state of the art in applicable technology is deployed on the Virginia class submarine as part of the AN/BLQ-10 ESM system and described in references 3, 4, and 5. Part of the purpose of this system is to assist the submarine with navigation in high traffic areas. A similar capability is needed for UUVs & USVs. For the UUV and USV application, it is necessary to reduce the size of the equipment to fit the processing in a desktop sized box (which may include multiple processors) and use less than 500W of power. The system should be fully automated providing signal type, direction, range (if determined), and the AIS information (if vessel is equipped) of the detected signal to the unmanned vehicle control system. The system should fit into an 8” diameter x 6” long waterproof package for mounting on a UUV or USV mast and cover the radar and communication frequencies from 3 MHz (coastal radars) to 12 GHz (satellite communications). The receive antenna will be mounted only 18” above the waterline which may decrease reception due to washover and reflections as compared to current system. New technology development is needed to overcome the reduction in size and power, reduced distance from waterline, and reduced antenna size, and fully automate the system (without manned assistance or supervision) to provide a similar capability to unmanned vehicles as the AN/BLQ-10 provides to the submarine for navigation in the littoral regions.

PHASE I: Design new technologies to miniaturize antennas for receiving and direction finding of electronic signals of both radar and communication frequencies. Design low power electronics and advanced processing to allow surface contact tracking. Proof of concept demonstrations are desired and may include lab simulations, breadboards, or smaller scale prototypes.

PHASE II: Develop, build, and test a prototype version of the antenna, low power electronics, and software capable of receiving and localizing electronic signals of both radar and communication frequencies. Demonstration of receiving and decoding of AIS signals. Development of standard interfaces of this system with the unmanned vehicle control system.

PHASE III: Support for integration of the prototype system onto a Navy UUV or USV and support of testing. Navy test assets will be provided that match the interfaces defined in Phase II., including the test platform obstacle avoidance system.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: An automated surface contact avoidance system will reduce manning aboard both military and commercial shipping.

REFERENCES:
1. Navy UUV Master Plan. April 20, 2000 http://www.auvsi.org/resources/UUVMPPubRelease.pdf
2. The Navy UUV Master Plan. November 9, 2004. http://www.chinfo.navy.mil/navpalib/technology/uuvmp.pdf
3. BLQ-10 Sub ESM Suite www.navalsupport.com/pdfs/astecs.pdf
4.) BLQ-10 Sub EMS Suite http://www.fas.org/man/dod-101/sys/ship/weaps/an-blq-10.htm
5.) NSSN Photonics Mast http://www.eo.kollmorgen.com/product_spec3.html

KEYWORDS: UUV; USV; navigation; radar; communications; AIS ; unmanned vehicles

N06-132 TITLE: Improved Approaches to Nondestructively Test Marine Aluminum Structures

TECHNOLOGY AREAS: Materials/Processes, Sensors

ACQUISITION PROGRAM: DD(X)

OBJECTIVE: The objective of the project is to develop and implement new, innovative approaches and techniques for the nondestructive inspection of thin, welded, marine aluminum structures.

DESCRIPTION: The Navy's Program Executive Office for Ships is leveraging the National Shipbuilding Research Program (NSRP) to effect change across the non-nuclear surface shipbuilding, modernization and repair enterprise by coordinating with U. S. shipbuilders to adapt and implement "World Class" commercial best manufacturing practices. The U.S. shipbuilding industry lags behind the global shipbuilding market significantly in adapting new technologies to long-standing inefficient manufacturing processes and improvement is this area is key to closing this gap.

This topic seeks innovative scientific and engineering solutions to inefficiencies in the long-standing nondestructive inspection methods for marine aluminum structures. The Navy has for many years limited the use of aluminum alloys in topside structures because of the potential for catastrophic damage due to fire and the frequency of fatigue cracks forming in these structures. Recently there has been a resurgence in the planned use of aluminum in Navy surface ships. As a result , shipbuilding and repair facilities will require improved methods of inspecting structures made from aluminum alloys. Portability, adaptability, precision and automation will be important attributes to consider in developing solutions.

Efforts cited within each research area are illustrative only and proposals dealing with other efforts within the described area of interest are also solicited. The research areas include aluminum nondestructive inspection technology that can:
- Provide rapid, non-traditional surface nondestructive testing of butt, corner and tee weldments for the presence of fatigue cracks
- Provide rapid non-traditional surface and subsurface inspection independent of the presence of surface coatings, various weld sizes, weld profiles and weld surface roughness
- Locate and map areas within a 5XXX aluminum alloy plate that has become sensitized due to extended high ambient temperatures and may be susceptible to accelerated corrosion attack
- Conduct rapid, non-contact, field inspection and provide documentation

Of particular interest are initiatives with a clear business case. Proposal should specifically describe the technology that will be applied to solve the problem, how it will be developed, what the specific benefit will be and how it might be transitioned into the shipbuilding industry. While NSRP members are available to provide guidance and assistance in the preparation of proposals and in the execution of efforts awarded from this solicitation, teaming or consulting with the shipbuilder and repair industry (both public and private yards) is not required and will not be a factor in proposal selection.

PHASE I: Demonstrate feasibility for improvements being developed and also identify impact upon shipbuilding affordability. Include a first order Return-On-Investment (ROI) analysis for industry implementation and estimate potential Total Ownership Cost (TOC) reduction. Establish Phase II performance goals and key developmental milestones.

PHASE II: Finalize the design, as appropriate, and demonstrate a working prototype of the proposed system. Perform laboratory tests to validate the performance characteristics established in Phase I. Develop a detailed plan and method of implementation into a full-scale application.

PHASE III: Implement the Phase III plan developed in Phase II in coordination with the shipbuilding and repair industry.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology developed under this topic shall be directly applicable to current military and commercial shipbuilding operation and repair practices. The products developed should find wide use in most heavy industrial plant/processing facilities such as the power industry and will be marketable to the shipbuilding and repair industry.

REFERENCES:
1. NSRP ASE Strategic Investment Plan, available on line at http://www.nsrp.org
2. Repair Industry Contacts are available at http://www.usashipbuilding.com
3. US Naval Shipyard information is available at http://www.shipyards.navy.mil

KEYWORDS: shipbuilding; topside structures; affordability; aluminum alloys, nondestructive testing

N06-133 TITLE: Advanced Environmental Monitoring Technology

TECHNOLOGY AREAS: Information Systems, Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: DD(X)

OBJECTIVE: The objective of the project is to develop and implement innovations that will allow the shipyard to monitor and take measures to control critical by-products of its operation. By developing a system of reliable and cost-effective, detection and monitoring technology, the shipyard will be able to act quickly to reduce unacceptable emissions and to have proof that it complies with local environmental standards.

DESCRIPTION: The Navy's Program Executive Office for Ships is leveraging the National Research Program (NSRP) to effect change across the non-nuclear surface shipbuilding, modernization and repair enterprise by coordinating with U. S. shipbuilders to adapt and implement "World Class" commercial best manufacturing practices. The U.S. shipbuilding industry lags behind the global shipbuilding market significantly in adapting new technologies to long-standing inefficient manufacturing processes and improvement is this area is key to closing this gap.

This topic seeks innovative scientific and engineering solutions to detect, evaluate and control known pollutants from industrial wastewater discharges and pollutants that may enter the stormwater run-off and result in concentrations that exceed local environmental discharge limits. Shipyards conduct numerous industrial operations that result in surface contamination. Technologies that could be combined into a system that is economical, could autonomously monitor the presence of these contaminants and provide an early warning alert of the condition, is the goal of this topic.

Efforts cited within each research area are illustrative only and proposals dealing with other efforts within the describe area of interest are also solicited. The industrial and stormwater research areas include:
- Sensors and sampling equipment that can detect, characterize and quantify industrial wastewater and stormwater contaminants
- Software solutions that can alert facility managers, in real time, of water quality conditions approaching or exceeding NPDES permit limits
- Rapidly deployable water treatment methods that can mitigate water quality conditions that violate regional standards
- Monitoring systems that can collect pertinent water quality data and maintain a record to assist facility managers in addressing current and future regulatory requirements

Of particular interest are initiatives with a clear business case. Proposal should specifically describe the technology that will be applied to solve the problem, how it will be developed, what the specific benefit will be and how it might be transitioned into the shipbuilding industry. While NSRP members are available to provide guidance and assistance in the preparation of proposals and in the execution of efforts awarded from this solicitation, teaming or consulting with the shipbuilder and repair industry (both public and private yards) is not required and will not be a factor in proposal selection.

PHASE I: Demonstrate feasibility for improvements being developed and also identify impact upon shipbuilding affordability. Include a first order Return-On-Investment (ROI) analysis for industry implementation and estimate potential Total Ownership Cost (TOC) reduction. Establish Phase II performance goals and key developmental milestones.

PHASE II: Finalize the design, as appropriate, and demonstrate a working prototype of the proposed system. Perform laboratory tests to validate the performance characteristics established in Phase I. Develop a detailed plan and method of implementation into a full-scale application.

PHASE III: Implement the Phase III plan developed in Phase II in coordination with the shipbuilding and repair industry.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology developed under this topic shall be directly applicable to current military and commercial shipbuilding operation and repair practices. The products developed should find wide use in most heavy industrial plant/processing facilities such as the power industry and will be marketable to the shipbuilding and repair industry.

REFERENCES:
1. NSRP ASE Strategic Investment Plan, available on line at http://www.nsrp.org
2. Shipbuilding and Repair Industry Contacts are available at http://www.usashipbuilding.com
3. US Naval Shipyard information is available at http://www.shipyards.navy.mil
4. Federal Clean Water Act 40 CFR Part 122.
5. OPNAVINST 5090.1B, Chapter 7, Paragraph 4.2 (d) and 7-5.1 (b) and (c).

KEYWORDS: environmental quality; stormwater; pollution abatement; water treatment

N06-134 TITLE: Application of Fault Current Detection and Limiting Technology on Electrical Distribution Systems for Naval Ships

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes, Electronics

ACQUISITION PROGRAM: PEO Ships, PMS 500 IPS, Mike Collins

OBJECTIVE: Explore the development and application of power dense, efficient and cost effective fault current detection and limiting technology for use in future surface combatant power electronic based distribution systems and Integrated Power Systems (IPS).

DESCRIPTION: Fault current limiters are installed in electrical systems to prevent fault currents from exceeding fault clearance capacity of circuit breakers and/ or to enable system wide benefits. The potential benefits provided by fault current limiters are of increasing importance, due to the steadily increasing power requirements of future surface combatants. The increased power is accompanied by increased short circuit power at various nodes across the system, which is expected to exceed the rated value of available current limiting and current protection technologies.

This topic seeks to explore the application of advanced fault-current detection and limiting technology as means of controlling fault-current levels on power dense electronic based distribution systems. Fault-current limiter based systems will allow for architectural flexibility in placement within the system design without adding impedance to the circuit(s) during normal operation.

Primary distribution systems are planned to support 80-100MW with asymmetrical fault current peaks of 100kA or more. Greatest interest is in higher current, 1000A or higher steady-state current, and higher voltage, 1-15 KV AC or DC, applications. There are numerous potential application opportunities for this SBIR topic in future Navy and commercial distribution systems from 120 to 15,000V AC or DC.

PHASE I: Demonstrate the feasibility of innovative fault current detection and current limiting technology for use in Navy electrical power systems. Establish performance goals and metrics to analyze the feasibility of the proposed solution. Develop a test and evaluation plan that contains discrete milestones for product development for verifying performance and suitability.

PHASE II: Develop and demonstrate prototype(s) as identified in Phase I. In a laboratory environment, demonstrate that the prototype meets the performance goals established in Phase I. Develop a cost benefit analysis and a Phase III testing and validation plan.

PHASE III: Working with the Navy and industry, as applicable, transition the technology to commercial and military power distribution applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The resulting fault current limiting technology improvements will be directly applicable to commercial and military electrical distribution networks. Commercial shipping and cruise lines employ electric drive systems comparable to Navy IPS. Integrated Power Systems employ voltage and current levels comparable to commercial utility and industrial systems. As commercial power levels and power quality/continuity improvements are required, the developed fault current limiting technologies should provide an attractive solution over expensive system upgrades and redundancy improvements.

REFERENCES:
1. "Full scale land based testing of the US Navy's Integrated Power System (IPS)"; LCDR T. J. McCoy, US Navy, Naval Sea Systems Command, USA, M. Stauffer and E. Harvey, Naval Surface Warfare Center, USA; Marine Engineering Challenges for the 21st Century, Fifth International Naval Engineering Conference and Exhibition, INEC 2000
2. "Shipboard Electric Power Distribution: AC Versus DC Is Not the Issue, Rather, How Much of Each Is the Issue"; LCDR John V. Amy Jr. PhD, Mr. David H. Clayton and Mr. Rolf O. Kotacka; All Electric Ship 98 Conference.2nd ed., vol. 3, J. Peters, Ed. New York: McGraw-Hill, 1964, pp. 15-64.
3. Henry Hegner, Bipin Desai: "Integrated Fight Through Power", IEEE Power Engineering Society, Chicago, USA, July 2002. http://ieeexplore.ieee.org/Xplore/guesthome.jsp
4. Fault current limiters, http://www.wtec.org/loyola/scpa/04_03.htm

KEYWORDS: Integrated Power System; Fault Current; Current Limiter; Power Conversion; Electrical Distribution; Zonal Distribution;

N06-135 TITLE: Potable Water Production Module

TECHNOLOGY AREAS: Ground/Sea Vehicles, Human Systems

ACQUISITION PROGRAM: PEO SHIPS – Littoral Combat Ship (PMS501) - ACAT 1D

OBJECTIVE: Develop and demonstrate a modularized potable water production system suitable for shipboard use.

DESCRIPTION: The next generation of Navy combatants will utilize commercial modularization standards to allow great flexibility in the payloads and systems they can employ. This flexibility means that the types and capacities of ship service systems are no longer imbedded in the basic ship design and unchangeable, but can be adjusted for a particular role or over the life of the ship with the installation of particular modular services. The objective of this topic is the development of technologies to enable a standard commercial ten foot container that can generate and manage freshwater supply for shipboard applications.

A conventional shipboard freshwater plant can have a weight of 11,000 lbs to produce 12,000 gallons per day. These plants are directly integrated into ship power and piping, and require continuous watchstander operation and monitoring. While remaining in compliance with weight and volume limits of reference (1), the objective system should generate 12,000 gallons per day of potable water from ship supplied seawater supply and transfer resulting freshwater to ship tanks, effectively doubling the water making capacity of a small Navy combatant. The system

must also be capable of rapid startup and shutdown, variable water production rates, and must provide automated monitoring and treatment of output water to ensure safety and compliance with applicable standards. Because the host ships may operate in near shore littoral waters with corresponding high risk of seawater contaminants, the system must demonstrate exceptional capability for continued operation and production of potable water under these conditions. The operations and conditions of conventional desalination approaches may be unacceptably restricted by the need to operate in a modular mission bay with only limited interface connections, strict weight limits, and power and thermal exhaust limits. Therefore completely new desalination processes or modifications to conventional approaches are desired.

In addition to innovative core technologies for water purification, successful modularization in compliance with ISO standard 1161 layers on additional challenges. In order to comply with this global commercial standard for transport containers, the system will have to meet strict size, weight, and ruggedness specifications. Beyond transportability requirements, the systems will then have to operate within the challenges of a shipboard operating environment, including shock and damage control requirements. Unlike a traditional system that is highly integrated into the ship's engineering plant, the modular system will have minimal interfaces with ship systems and must operate safely and effectively as a stand alone module with minimal manning and monitoring. Because the target system goes beyond current interface connections for seawater and freshwater flows, innovative methods to interconnect the container with ship systems with minimal manpower and impact on ship operations will be highly valued.

Together, these performance requirements, the challenges of compliance with the commercial containerization standards, and the need to operate effectively in the shipboard environment, make conventional approaches to potable water generation inefficient and ineffective. Innovative core technologies for water production will be required to provide the physical and operational characteristics necessary to perform in these circumstances.

PHASE I: Develop and demonstrate the feasibility of a detailed concept for a potable water production module that will provide the above features. Provide a prototype design including a concept of operation and projected capabilities, system descriptions, drawings, weight and cost projections. Consideration should also be given to, and summaries developed for, operating sequences, emergency procedures, logistics support concept, shock and fire safety compliance.

PHASE II: Finalize the design, fabricate and demonstrate a prototype of the system developed in Phase I. Through land-based testing, demonstrate the functionality of the module in each of its required functions, including generating capacity, efficiency, water quality, and ease of integration and operation. Develop detailed concept of operation and projected capabilities, prototype descriptions, production drawings, operating sequences, emergency procedures, logistics support plan, weight breakdown, system cost estimates (both acquisition and lifecycle), and manning/Human Systems Interface (H.S.I.) requirements.

PHASE III: Working with the Navy and Industry, as applicable, develop transition plans and demonstrate the commercial and shipboard uses of the potable water production module.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: All commercial ships are limited in their freshwater production capacity by the installed plant. For ships in roles with intensive freshwater needs, such as washdown of remote vehicles, certain drilling operations, or support of expanded numbers of crew or passengers, the ability to easily and affordably expand that capacity through the addition of self contained potable water modules would be highly valuable. These modules would also provide increased capability for drinking water supply for disaster relief or homeland security applications.

REFERENCES:
Available at http://www.navysbir.com/ via the SBIR/STTR Interactive Topic Information System (SITIS) web link
1. "Interface Control Document (ICD) for Littoral Combat Ship (LCS) Flight Zero Reconfigurable Mission Systems," Baseline 1.0, 18 February 2005.
2. "Ship Impacts & Capabilities Analyses: Providing Modular Habitability Support in LCS Mission Zones," January 2005.

KEYWORDS: Potable; Water; Module; Container; Shipboard; LCS

N06-136 TITLE: Automated EO/IR Detection Techniques For Floating Objects

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: ACAT I, PMS 500 DD(X) Integrated Undersea Warfare (IUSW)

OBJECTIVE: Develop innovative Electro-Optical/InfraRed (EO/IR) algorithms to aid in automated detection and classification of floating objects for bow mounted High Frequency (HF) surface ship mine avoidance sonar.

DESCRIPTION: Ship motion, ship speed, surface acoustic interactions, bubble fields, organic matter, and other phenomena in the near-field ocean environment impact the performance of HF sonar systems. These effects, significantly impact the ability of operators to detect and classify floating objects in order to assess their threat to the ship and neutralize or take evasive action if required. HF sonar utilizing acoustics is one of the primary systems being installed on future surface combatants to satisfy the requirement to detect and classify floating objects. Of particular interest is the application of EO/IR as a means of augmenting the acoustic performance of HF sonar. While the use of EO/IR to detect and classify floating objects for avoidance is technically feasible, the tools to automatically perform the detection and classification are relatively immature. All proposed solutions must provide confidence of low False Alert Rates (FAR), should use a modular software philosophy, and should incorporate associated software into a suitable open architecture system.

PHASE I: Demonstrate the feasibility of developing improved detection and classification capability for floating objects. Provide a Phase II development approach and schedule that contains discrete milestones for product development.

PHASE II: Finalize the prototype design based on the design concept(s) proposed in Phase I. Fabricate the critical components of the prototype system and conduct laboratory characterization experiments. Provide a detailed test plan and conduct a scaled capabilities demonstration as a means of prototype validation.

PHASE III: Utilizing the concept developed during Phase I and II, Work with the Navy and Industry to adapt the automated EO/IR detection and classification of floating objects to current surface combatants and to the future ship combat systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Techniques developed under this topical area are expected to support automation avoidance of floating objects for surface vessels. This technology would be valuable for use in naval and commercial ship systems to help avoid collision with floating objects.

REFERENCES:
1. The International Society for Optical Engineering (SPIE), SPIE Proceedings Vol. 2496, “Detection Technologies for Mines and Minelike Targets,” http://www.spie.org/web/abstracts/2400/2496.html

2. “DD(X) CLASS MULTIMISSION DESTROYER, USA,” http://www.naval-technology.com/projects/dd21/

KEYWORDS: EO/IR; Object Avoidance; detection;, classification; automation; floating objects

N06-137 TITLE: Dynamic Compensation System for Towed Bodies

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors

ACQUISITION PROGRAM: PMS 501 - Littoral Combat Ship - ACAT 1D

OBJECTIVE: Develop and demonstrate a dynamic, motion compensation system to enable the steady towing of sensors from small surface craft.

DESCRIPTION: The next generation of Navy will employ unmanned surface vehicles to operate sensors in the performance of mine countermeasure, anti-submarine and anti-surface warfare operations. However, these small surface craft lack the control authority to counter random and chaotic surface movements as they move through the water. These movements can occur in multiple, simultaneous axes and mixed time scales depending on unpredictable wave and wind influences. Tow bodies such as sensors, can be highly sensitive to even minor surface craft movement as the tow cable transmits and sometimes amplifies these motions resulting in unacceptable performance degradation. This currently necessitates the use of semi-submersible platforms that are largely decoupled from surface effects to provide a stable towing platform. The ability to sense the full-range of these motions in real-time, anticipate likely effects on a towed sensor through a wide variety of speed and depth conditions, and apply corrective force or action quickly and accurately exceeds the capabilities of any current system.

In order to facilitate the use of a common unmanned surface craft for the widest possible range of missions, a system is required to precisely monitor and counter small craft motions to eliminate the need for an additional semi-submersible platform, eliminate tow-line heave and maintain near constant altitudes (above the ocean bottom) for up to and including a sea state 4 conditions at various headings over extended durations. The proposed system will be required to provide the capability to safely launch, tow, and recover representative tow bodies from manned or unmanned surface vehicles up to 11 meters in length.

PHASE I: Develop and demonstrate the feasibility of a detailed concept for a dynamic motion compensation system that will provide the above capabilities. Approaches should address the concept of operations and projected capabilities, system descriptions, concept drawings, and applicable interface requirements.

PHASE II: Finalize the design, fabricate and demonstrate a prototype of the system developed in Phase I. Through land-based testing, demonstrate the functionality of the prototype in: integration into representative surface craft; integration of representative towed body; and towed body stability over all headings through sea state 4. Develop detailed concept of operation and projected capabilities, prototype descriptions, production drawings, interface specifications, operating sequences, emergency procedures, logistics support plan, weight breakdown, system cost estimates (both acquisition and lifecycle), and manning/Human Systems Interface (H.S.I.) requirements.

PHASE III: Working with the Navy, develop transition plans and demonstrate the commercial and Naval uses of the dynamic motion compensation system.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Private sector applications of towed sensors face the same challenges, prohibiting their use or requiring similarly complex semi-submersible tow platforms. Successful completion of this project to allow relatively simple and inexpensive surface vessels to accurately deploy sensitive towed bodies will have significant commercial value.

REFERENCES:
Available at http://www.navysbir.com/ via the SBIR/STTR Interactive Topic Information System (SITIS) web link
1. “Interface Control Document (ICD) for Littoral Combat Ship (LCS) Flight Zero Reconfigurable Mission Systems,” Baseline 1.0, 18 February 2005.
2. AN/WLD-1(V)1 Remote Minehunting System Specification Amendment 0005 Dated 26 February 2003.

KEYWORDS: small boat; water craft;towed body; heave; motion compensation; sensors

N06-138 TITLE: Techniques for Automatically Exploiting Passive Acoustic Sonar Data

TECHNOLOGY AREAS: Information Systems, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: ACAT I, PMS500 DD(X) Integrated Undersea Warfare (IUSW)

OBJECTIVE: Develop and demonstrate automated techniques and processing algorithms for improved passive acoustic data exploitation.

DESCRIPTION: Passive ASW capability is required both as an adjunct to active sonar operation and as a primary mode under restricted active emission conditions. Passive ASW has historically required a high level of operator workload and associated manning. In order to reduce manning associated with passive ASW operation, a high level of Detection, Classification and Localization (D/C/L) processing must be automated. Automated, passive ASW operation would provides both true and false alerts to the operator for validation. The operator would then validate true alerts and dismiss false alerts in a timely and accurate manner. Fast validation times contribute to an earlier ASW reaction, allowing for successful engagement action and self defense. Accurate operator validation reduces the probability of false reactions and the unnecessary expenditure of ASW resources.

This topic seeks to develop techniques that will reduce involvement by the operator in searching through Passive Broadband (PBB) and Passive Narrowband (PNB) waterfall displays for potential targets to track. Candidate techniques might also include those that provide for the effective assembling of target cues for faster operator validation and template match confidence. All proposed solutions must provide confidence of low False Alert Rates (FAR) while reducing the operator workload, should use a modular software philosophy, and should incorporate associated software into a suitable open architecture system.

PHASE I: Demonstrate the feasibility of the proposed concept(s) that will enable automated techniques for exploiting passive acoustic data. Provide a Phase II development approach and schedule that contains discrete milestones for product development.

PHASE II: Finalize the techniques and develop a prototype based on the design concept(s) proposed in Phase I. In a laboratory environment, demonstrate the viability of automated techniques for exploiting passive acoustic data and the ability to reduce the Passive ASW False Alert Rate. Conduct limited laboratory testing as a means of demonstrating the viability of the prototypes capabilities. Provide a detailed test plan and test report.

PHASE III: Utilizing the concept developed during Phase I and II, Work with the Navy and Industry to adapt the automated techniques for exploiting passive acoustic data and passive ASW false alert rate reduction to current surface combatants and to the future ship combat systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Techniques developed under this topical area are expected to support automation of monitoring systems that use acoustic sensors. This technology has direct application to numerous commercial sonar systems. This technology could be valuable for use in commercial port security systems deployed on docks, on the sea-floor, and/or aboard commercial vessels.

REFERENCES:
1. "AN/BQR-20 Series," http://www.globalsecurity.org/military/systems/ship/systems/an-bqr-20.htm
2. "DD(X) CLASS MULTIMISSION DESTROYER, USA," http://www.naval-technology.com/projects/dd21/
3. Richard O. Nielsen, Sonar Signal Processing, Artech House, Massachusetts, 1991, pp. 231-257.
4. William S. Burdic, Underwater Acousitc System Analysis, Prentice-Hall, New Jersey, 1984, pp. 361-366.
5. Steven M. Kay, Fundamentals of Statistical Signal Processing Volume II Detection Theory, Prentice-Hall, New Jersey, 1998, pp. 515-520.
6. Yaakov Bar-Shalom and Xiao-Rong Li, Estimation and Tracking : Principles, Techniques, and Software, Artech House, Massachusetts, 1993.

KEYWORDS: ASW; passive; bellringers; FAR, classification; automation

N06-139 TITLE: Pier-Side, Bow Sonar Calibration Methodology for Wave Piercing Hull Forms

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: ACAT I, PMS500 DD(X) Integrated Undersea Warfare (IUSW)

OBJECTIVE: Develop a methodology and the associated processing techniques to provide the capability to perform pier-side, near-field calibrations of Mid Frequency (MF) and High Frequency (HF) Sonars on wave piercing hull forms.

DESCRIPTION: Current methods of calibrating MF and HF sonars are not applicable to the wave piercing hull forms on future surface combatants. Currently, calibration is accomplished by the use of hydrophones mounted on a boom located on the center axis of the hull. These hydrophones measure the near-field at a fixed distance from the array thereby allowing in-water calibration to be accomplished pier-side. Future combatant ships with wave piercing hull forms and a non-cylindrical MF and/or HF arrays require new and innovative methods for pier-side calibration. The calibration system developed should avoid the need to be mounted directly on the deck of future ships due to Radar Cross Section (RCS) considerations. The system shall be portable and able to be configured with minimal manpower and time to execute. Solutions are not constrained by shipboard storage limitations, as calibration will most likely be conducted when a ship is at a suitable port facility.

PHASE I: Demonstrate the feasibiliy of a methodology to conduct pier-side calibration of MF and HF sonars on wave piercing hull forms. Provide a Phase II development approach and schedule that contains discrete milestones for product development.

PHASE II: Develop and demonstrate a prototype based on the design concept(s) proposed in Phase I. Fabricate the critical components of the prototype system and and conduct laboratory characterization experiments. Provide a detailed test plan and conduct a scaled capabilities demonstration of the prototype.

PHASE III: The small business shall work with the Navy and Industry in the implementation of the developed sonar calibration for wave pirecing hull system for DD(X) and other naval platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The nearfield calibration techniques developed under this topical area support acoustic far-field measurements within a laboratory and research institution for tanks of finite size and in-place (installed) sonar systems onboard ocean survey, mapping and marine reasearch vessels that utilize sonar systems to aid in the conduct of their respective missions. Also, the nearfied technology can be directly applied to home audiofile systems aiding in improvements in design and sound delivery.

REFERENCES:
1. "DD(X) CLASS MULTIMISSION DESTROYER, USA," http://www.naval-technology.com/projects/dd21/
2. Sheridan, C., "A calibration system for large-aperture sonar arrays," OCEANS, Volume: 5 Sep 1973, Page(s): 470- 474. http://ieeexplore.ieee.org/iel6/8271/26021/01161291.pdf?arnumber=1161291
3. Robert J. Bobber, Underwater Electroacoustic Measurements, Peninsula Publishing, Los Altos, CA, 1988, pp 199-224
4. Robert J. Urick, Principles of Underwater Sound for Engineers, McGraw-Hill, New York, 1967, pp. 44-53.
5. "Near-field measurement techniques using cylindrical surface geometry," http://www.npl.co.uk/acoustics/publications/acnews/15/#near_field
6. "Near field underwater acoustical measurements, " http://www.npl.co.uk/acoustics/publications/acnews/11/

KEYWORDS: SONAR; acoustic calibration; near-field; wave piercing; HF; MF

N06-140 TITLE: Power Generation and Management Module

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PEO SHIPS Littoral Combat Ship (LCS) (PMS-501) - ACAT 1D

OBJECTIVE: Develop and demonstrate a modular power generation and management system to supplement Littoral Combat Ship (LCS) mission system power services.

DESCRIPTION: The next generation of Navy combatants will utilize modular mission packages to provide focused mission capability and facilitate technology refresh. The LCS seaframe's ship service electrical plant is designed to handle power generation and management requirements for known mission systems in their respective module stations. While this ensures that LCS will be able to effectively support current mission modules, future systems that demand more power cannot be accommodated without significant ship system redesign, and module placement may be limited to specific stations. A modular power generation and management module can leverage the flexibility of the LCS modular mission bay to augment ship service power for increased mission module loads and placement flexibility without impacting current ship design and performance requirements.

A power generation and management module is required to produce, condition, and route both module generated and ship service power to multiple module loads in flexible locations and configurations. The module should maximize power generating capacity, as well as: a) comply with LCS Interface Control Document (reference 1) to facilitate module loading, handling, and stowage in Support Type module zones, b) internally generate power as required to supply loads, c) condition, synchronize, and distribute ship service and self generated power to multiple loads, d) quickly reroute power supply to mission modules in various locations, e) satisfy Navy operational, safety, fire fighting, and damage control requirements.

PHASE I: Develop and demonstrate the feasibility of a detailed concept for a power generation and management module that will provide the above features. Provide a prototype design, including a concept of operation and projected capabilities, system descriptions, drawings, weight and cost projections and any projected manning/Human Systems Interface (HSI) requirements, and interface requirements. Consideration should also be given to, and summaries developed for, operating sequences, emergency procedures, logistics support, shock and fire safety, qualification plans, and test plans.

PHASE II: Finalize the design, fabricate and demonstrate a prototype of the system developed in Phase I. Through land-based testing, demonstrate the functionality of the module in each of its required functions, including generating capacity, efficiency, power quality, and load reconfiguration and management. Develop detailed concept of operation and projected capabilities, prototype descriptions, production drawings, operating sequences, emergency procedures, logistics support plan, weight breakdown, system cost estimates (both acquisition and lifecycle), and manning/Human Systems Interface (H.S.I.) requirements.

PHASE III: Working with the Navy, develop transition plans and demonstrate the commercial and shipboard uses of the power generation and management module. Build and deliver to the Navy a LRIP module and conduct shipboard feasibility testing with Navy guidance to evaluate performance in the operational environment. Develop plans for and support shipboard certification and full acquisition and lifecycle cost estimates. Develop the production unit detailed concept of operation and projected capabilities, drawings and specifications, operating sequences, emergency procedures, logistics support plan, weight breakdown, system cost estimates (both acquisition and lifecycle), and manning/Human Systems Interface (H.S.I.) requirements.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: There are a wide variety of naval, maritime, and land based applications for a modularized system capable of generating and managing power to a variety of loads. Specific applications might include container ship refrigerated module supply, module power supply while in storage ashore, and land based power supply for military, emergency response, homeland security, and construction operations.

REFERENCES:
Available at http://www.navysbir.com/ via the SBIR/STTR Interactive Topic Information System (SITIS) web link

1. "Interface Control Document (ICD) for Littoral Combat Ship (LCS) Flight Zero Reconfigurable Mission Systems," Baseline 1.0, 18 February 2005.

KEYWORDS: Power; Distribution; Generation; Module; Shipboard; LCS

N06-141 TITLE: Light-weight, Low-Cost Fire Barrier

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: PEO SHIPS – Littoral Combat Ship (PMS501) - ACAT 1D

OBJECTIVE: Develop and demonstrate a lightweight and cost effective fire insulation system to limit the spread of fire in steel or aluminum ships.

DESCRIPTION: Navy ships are currently built with steel, aluminum, or combined steel and aluminum construction. One of the many design considerations for steel or aluminum is fire performance. The US Navy fire safety goals for surface ships include limiting fire spread (fire resistance), preventing flashover (fire growth), and maintaining tenability (smoke and fire gas toxicity). Recent and past work performed by the US Navy indicates that current US Navy steel or aluminum designs do not meet the fire safety criteria without passive fire protection systems. Passive fire protection is used aboard US Navy ships to contain fire and prevent fire spread to adjacent or overhead compartments. For fire resistance, the performance criteria is 30 minute or more rating with backside peak temperature rise less than 325°F and average temperature rise less than 250°F (UL-1709 fire curve). The test procedures are in accordance with MIL-PRF-32161 (reference 1).

The Navy currently uses high temperature alkaline earth silicate fiber batt, which is installed with steel pins and caps to meet shock requirements prior to fire resistance tests. It weights approximately 7-8 lbs/ft3. For a N-30 rating (30 minute rating using UL 1709 fire curve during a fire resistance test) where insulation is attached on both sides, the fiber batt system weighs approximately 1.68 lbs/ft2. Due to a combination of factors such as weight, attachment system complexity, material and labor costs, there is a need for a more cost-effective lightweight fire insulation system.

Technical issues to be addressed include application and attachment of insulation products to the substrate and the effectiveness of insulation products in meeting fire resistance tests. The insulation products should be cost effective and possess general and physical properties compatible with shipboard environment such as weight, adhesion, salt spray, impact, shock, etc. All passive fire protection materials shall meet the requirements of MIL-PRF-32161, Type 1.

PHASE I: Demonstrate the feasibility of a low-cost, light-weight passive fire protection solution. Evaluate solutions in the form of materials, passive fire protection concepts, and production/installation methods to exceed performance of current Navy methods as measured by weight, cost, and performance (fire growth, tenability, fire resistance, fire endurance). Establish performance metrics to analyze the feasibility of the proposed solution. Develop a test and evaluation plan that contains discrete milestone for product development for verifying performance and suitability.

PHASE II: Develop and demonstrate prototype materials/methods based on Phase I results. In a laboratory environment, demonstrate that the prototype(s) meet the performance goals established in Phase I. Demonstrate installation, maintenance and removal methodologies. Provide detailed production/installation plans and estimates, production drawings, logistic support plans, weight breakdown, and system cost estimates (both acquisition and lifecycle).

PHASE III: Working with the Navy, develop transition plans and demonstrate the commercial and shipboard uses of the lightweight low-cost fire barrier. Coordinate with the Navy to develop and execute plans for shipboard installation in a suitable application in conjunction with a Navy ship acquisition program.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Steel and aluminum construction are used in the commercial marine shipbuilding, offshore platforms, and aircraft industries where improved fire safety is of high interest. Development of a fire barrier with superior cost, weight, and performance characteristics will directly benefit the US Coast Guard and civilian shipbuilding industry.

REFERENCES:

1. "Performance Specification Insulation, High Temperature Fire Protection, Thermal and Acoustic," MIL-PRF-32161. http://assist.daps.dla.mil/quicksearch/
Available at http://www.navysbir.com/ via the SBIR/STTR Interactive Topic Information System (SITIS) web link
2. ABS Naval Vessel Rules, Section 1-2-1, Structural Fire Protection.
3. Evaluation of Intumescent Coatings for Shipboard Fire Protection; U. Sorathia, T. Gracik, J. Ness, A. Durkin, F. Williams, M. Hunstad, F. Berry (submitted for publication in Journal of Fire Science).

KEYWORDS: Insulation; Lightweight; Fire Resistance; Fire Protection;

N06-142 TITLE: Motor Insulation Material Development for Improved Power Density

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: ACAT 1, DDX Program, PMS 500IPS - Mike Collins

OBJECTIVE: Development of motor insulation materials/methods to allow for the application of pulse-width-modulated (PWM) adjustable speed power controllers for ship propulsion scale motor applications.

DESCRIPTION: In the past, large motors (20 MW and higher) have employed a fixed speed motor controller operating with a constant 60 HZ power waveform. More and more motor manufacturers have begun to use pulse-width-modulated (PWM) adjustable speed power converters in an effort to improve overall motor efficiency and controllability. However, the use of PWM converters introduces voltage stresses and harmonics that in turn lead to heating stresses that had not existed in fixed speed motor applications.

This topic seeks to explore the development of motor insulation materials/methods to allow the use of PWM technology in ship propulsion applications at voltages equal to or greater than 2 kV. This presents some unique technical challenges from the standpoint of the availability of viable motor insulation materials/methods. The primary challenge is in the balance between voltage breakdown, void filling, mechanical strength and thermal resistance. The material solution or method proposed should maximize the current capability without overheating the motor while at the same time creating a motor footprint that is supportable by the host platform. The solution proposed must address voltage, corona, and partial discharge withstand while providing a 25+ year operating life. Solutions should target a motor space and weight goal of 310 tons and 157 ft3 and should address general machinery arrangement configuration considerations to facilitate easy access for installation, maintenance and repair.

PHASE I: Demonstrate the feasibility of a motor insulation material/method. The concept feasibility should be supported by in-house generated experimental data, literature search results, and/or appropriate analytical modeling. Establish performance goals and metrics to analyze the feasibility of the proposed solution. Develop a test and evaluation plan that contains discrete milestones for product development for verifying performance and suitability.

PHASE II: Develop and demonstrate prototype materials/methods as identified in Phase I. In a laboratory environment, demonstrate that the prototype meets the performance goals established in Phase I. Material candidates should be tested using relevant IEC and IEEE test methods to determine if thermal performance has improved while still maintaining long electrical life. Develop a cost benefit analysis and a Phase III testing and validation plan.

PHASE III: Working with the Navy and industry, as applicable, transition the technology to commercial and military power distribution applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The commercial shipping industry has been interested in the development and application of electric propulsion systems technology. This technology is a key enabler that would allow the use of PWM motors on higher power motor applications. This technology will also allow for increased motor insulation life for all PWM driven motor applications.

REFERENCES:
All references are available at http://ieeexplore.ieee.org/Xplore/guesthome.jsp

1. "DEALING WITH MOTOR WINDING PROBLEMS CAUSED BY INVERTER DRIVES" Mark Fenger, Steven R. Campbell, Iris Power Engineering Inc. Jan Pedersen, Techwise A/S.
2. M.T. Wright, S.J. Yang, and K. McCleay, General Theory of Fast-Fronted Interturn Voltage Distribution in Electrical Machine Windings, Proc. IEEE, Part B, July 1983, p 245.
3. B.K. Gupta, et al, Turn Insulation Capability of Large AC Motors, Parts 1, 2, 3, IEEE Trans EC, December 1987, p 658.
4. A.L. Lynn, W.A. Gottung, D.R. Johnston, Corona Resistant Turn Insulation in AC Rotating Machines, Proc. IEEE Electrical Insulation Conference, Chicago, October 1985, p 308.
5. E. Persson, Transient Effects in Applications of PWM Inverters to Induction Motors, IEEE Trans IAS, September 1992, p1095.

KEYWORDS: PWM; Motor Insulation; Insulators; Partial Discharge; Corona; Thermal Conduction

N06-143 TITLE: Secure Dynamic Configuration of Real Time Networks

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Enable dynamic control of real-time TCP/IP networks by field commanders.

DESCRIPTION: Communication technology and the proliferation of real-time networks have flattened war-fighting organizations, making the common operational picture and commander's intent available throughout the chain of command.

Most of the real-time networks in use are hub-centric; that is, they require interaction with a central network component in order to change network configuration and security characteristics. In a hub-centric network, switching a user from one command group to another costs time and can create bottlenecks.

In addition, all communications networks define necessary levels of security. However the bulk of communication users, whether in combat or in emergency response situations, do not hold security clearances. Therefore the communication network must be able to support simultaneous operations of classified and unclassified users in order to respond to many operations, both combat situations involving Coalition Allies and peacetime disasters such as the Tsunami or Katrina.

This solicitation seeks innovative software applications that allow real-time dynamic control, configuration, and security management of real-time TCP/IP networks. The proposed product will improve the war-fighting or first-responder commander's control of network configuration. In addition, it will allow real-time control over security implementations to optimize his ability to conduct operations.

This application must support operations in networks such as Force XXI Battle Command Brigade and Below (FBCB2), the Movement Tracking System (MTS), and the Global Personnel Recovery System (GPRS). The architecture and network interface for such an application has been prototyped by the Personnel Recovery Extraction Survivability aided by Smart-Sensors (PRESS) Advanced Concept Technology Demonstration (ACTD). A focused initiative is needed to further validate this concept and its ability to support real-time management of dynamic networks.

PHASE I: Develop a concept for an application capable of interfacing with multiple TCP/IP-based networks to allow real-time management and dynamic control of the networks at the war-fighting or first-responder commander's level. Define a design and demonstrate a simple prototype of the application with a simulated field unit and internet-connected client.

PHASE II: Based on Phase I, develop and demonstrate a prototype tool or model for supporting dynamic, real-time network control. Conduct one or more lab or controlled experiments to validate the tool and quantifiably demonstrate its benefit in improved network control performance with a small number of moving field units that shows position tracking on several internet-connected clients. Create, modify, and delete groups dynamically.

Change units between groups and change visible names on the units. Prepare guidelines and documentation for tool transition to an operational setting. Validate, standardize and document underlying software for application purposes.

PHASE III: Based on Phase II, develop security features including dynamically changing security key codes when creating, modifying, or deleting groups. Field test the tool in an operational setting and produce improved performance measures. Update guidelines and documentation to include security functions for tool transition to an operational setting in accordance with applicable security guidelines. Implement the tool in a comprehensive package that would include an intuitive graphical user interlace (GUI). Demonstrate the ability of the tool to support simultaneous operations of classified and unclassified users and comply with government-approved security implementation.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology product could be applied to any TCP/IP network and tremendously enhance the civil sector's emergency response to disasters.

REFERENCES:
1. PRESS ACTD Implementation Directive, Jun 01
2. PRESS ACTD Management Plan, Dec 02

KEYWORDS: Dynamic; interoperability; real time control, secure

N06-144 TITLE: Automating the Production of Terrain Databases

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: The lack of geospatial information (feature and attributes) at the required resolution, accuracy and currency is a major limiting factor in automating the production of terrain databases. The objective of this topic is to solicit research to extend the range of features and attributes that are extractable by automated means from innovative geospatial data sources.

DESCRIPTION: Joint Forces Command, Special Operations Command and Topographic Engineering Center have collaborated on a process for automating the production of Modeling and Simulation (M&S) geospatial databases in a process called Geospatial Intelligence Database System (GIDS). Significant progress has been achieved by leveraging commercial-off-the-shelf tools which can extract features from innovative source data such as Light Detecting and Ranging (LIDAR) but to date, automated feature extraction from LIDAR has been limited to buildings and vegetation. Researchers seeking to automatically extract features and attributes from imagery have achieved some success for linear features such as transportation and waterways networks, but with confidence levels of 60-80% that generally do not meet user expectations for applications such as operations, mission planning and mission rehearsal. There is an urgent need for research that would extend the range of feature classes that can be automatically extracted from LIDAR and/or other innovative data sources or through combinations of sources such as LIDAR with correlated Hyperspectral Imagery or Multi-Spectral Imagery.

PHASE I: Develop the design approach and demonstrate feasibility to meet the above requirements for extending the range of features and attributes extractable through automation from geospatial source data. The offeror should possess some existing capabilities for automating the extraction of features and attributes from one or more sources upon which the proposal could build.

PHASE II: Develop and produce a prototype extending the range of features and attributes extractable through automation from geospatial source data.

PHASE III: Produce an integrated process capable extending the range of features and attributes extractable through automation from geospatial source data.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology would greatly facilitate M&S applications interoperability with Command and Control, Mission Planning , Mission Rehearsal and

other military applications and would serve other government sectors such as the Homeland Infrastructure Foundation Level Data Working Group. It would be used during Disaster Relief by both military and non-military responders to ensure a common operational picture of an area that has been significantly altered by the forces of nature.

REFERENCES:
O'Brien, M., et al, Information Fusion for Feature Extraction and the Development of Geospatial Information, 7th International Conference on Information Fusion, June 2004.
http://www.fusion2004.foi.se/papers/IF04-0976.pdf#search='automated%20features%20extraction%20terrain

KEYWORDS: Geospatial Intelligence (GEOINT), Mapping, Charting, Geodesy and Imagery (MCG&I), Geospatial Information Systems (GIS), Automated Feature Extraction (AFE), Automated Data Extraction (ADE), Light Detecting and Ranging (LIDAR)

N06-145 TITLE: Mounting of Acoustic Vector Sensors on UUVs

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors

ACQUISITION PROGRAM: PEO-IWS via PLUS via UPS

OBJECTIVE: Support the development of mounting systems that could be faired into the hull of a UUV and provide isolation from hull vibrations without significantly reducing the sensitivity to waterborne signals.

DESCRIPTION: Vector sensors have been shown to operate very effectively in free field applications and are showing promise in the area of towed array configurations. The four channel (combination three axis accelerometers and hydrophone) sensors allow narrower beams to be generated with a smaller number of sensors over a smaller foot print than can be obtained from simple hydrophones; however, they have been shown to be sensitive to vibrations when rigidly mounted to moving platforms. The effort would support the development of mounting systems that could be faired into the hull of an ASW support UUV and provide isolation from hull vibrations without significantly reducing the sensitivity to waterborne signals.

Discovery of an ideal solution to this problem is unlikely. Current thinking points to using a towed array of sensors attached to the UUV to maximize the isolation of the sensors from the vehicle. Other the other extreme, a tight coupling of the sensor to the vehicle would make the vehicle itself a part of the sensor, possibly enhancing the response at some frequencies, but likely introducing vibrational resonances at others. Ad hoc solutions include foam isolation and bungee cord setups.

For submarine applications, vector sensor towed arrays are already in development. Should a suitable solution to the mounting problem be developed, their use in hull arrays could be developed as well.

In addition to underwater applications there is the potential for using vector sensors to improve systems that acoustically detect shock wave and muzzle blast form gunfire to pinpoint the location of snipers. These HMMWV applications clearly require some sort semi-rigid mounting system.

PHASE I: Identify, analyze and recommend a preliminary design for the candidate mounting system.

PHASE II: Develop and demonstrate the mounting system identified in Phase I.

PHASE III: Installation, testing, and data acquisition from a number of vector sensors mounted/faired into the hull of a UUV.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The smaller footprint for acoustic sensors that could be realized by using vector sensor arrays has potential benefit to the both land based and off-shore oil and gas exploration and production industries. Acoustic well logging and cross-well seismic surveys can often resolve dynamic reservoir production processes much better than conventional surface seismic efforts, but

sensor size down hole is always a consideration. Ref 5. describes a 10-level hydrophone system used for a cross-well survey with an analysis bandwidth from 200 to 2000 Hz. The Wilcoxon TV-001 vector sensor which has operational bandwidth from 5Hz–7kHz, would provide much finer spatial resolution across a much greater bandwidth in a similar configuration. The small footprint of this sensor is suitable for down hole applications, but may have to be mounted in some sort of fairing in order to safely move it in and out of the well hole. The ocean seismology sector of the industry is also interested in these sensors for Marine Mammal monitoring, mainly for the left-right ambiguity resolution.

REFERENCES:
1. G. L. D'Spain, W. S. Hodgkiss, and G. L. Edmonds, "The simultaneous measurement of infrasonic acoustic particle velocity and acoustic pressure in the ocean by freely drifting Swallow floats," IEEE J. Ocean. Eng. 16, 195-207 (1991).
2. Nehorai, A., and Paldi, E., 1994, “Acoustic Vector-Sensor Array Processing,” IEEE Trans. on Signal Proc., Vol. 42, No. 9, 2481-2491.
3. Gabrielson, Gardner, D. L., and Garrett, S. L., 1995, A simple neutrally buoyant sensor for direct measurement of particle velocity and intensity in water, J. Acoust. Soc. of Am., Vol. 97, pp. 2227-2237
4. Cray, B. A., and Nuttall, A. H., 2001, “Directivity factors for linear arrays of velocity sensors,” J. Acoust. Soc. Of Am., Vol. 110, pp. 324-331
5. Jorge O. Parra, Chris L. Hackert, Michael Bennett, and Hughbert A. Collier,
“High-Resolution Acoustic And Seismic Investigation of Carbonate Rock Properties,” Paper presented at Society of Petroleum and Well Log Analyst (SPWLA), International Symposium, June 22-25, 2003, Galveston, Texas

KEYWORDS: AUV; UUV; Vector Sensor; acoustic velocity sensor; mounting; vibration isolation

N06-146 TITLE: Passive Combustion Control for Turbine Engine Noise Reduction

TECHNOLOGY AREAS: Air Platform, Ground/Sea Vehicles, Materials/Processes

OBJECTIVE: Investigate passive combustion control techniques such as porous matrix inserts in the combustion chamber to reduce combustion-generated noise, thereby reducing the audible noise spectrum from turbine engines used for propulsion of aircrafts and weapons.

DESCRIPTION: Combustion instabilities and the resulting pressure oscillations that lead to excessive noise could produce degradation in performance and ultimately excessive vibrations and failure of the propulsion system. A number of investigations have addressed active control of combustion instability, and the exhaust noise from jet engines, and several passive combustion control technologies have focused on emission control. Some of the techniques investigated earlier can have a profound effect on noise control if properly modified. Pours matrix insert in turbine engine combustors have shown to produce a uniform temperature distribution (pattern factor) and reduced emissions, and elimination of hot spots. Techniques like this will have an impact on noise reduction as well because they also address some of the factors that lead to excessive combustion-generated noise. Since they do not require elaborate sensors and actuators and feed back control systems, the modifications to be implemented will be simple, cost-effective and reliable.

PHASE I: Design and fabricate (or procure) porous inserts and test simple combustor configuration (cylindrical/backward step) with the inserts placed in appropriate locations and determine the combustion noise reduction. Evaluate the dependence of noise reduction on location, thickness etc. of the inserts. For other passive control techniques also, determine the parametric dependence of noise reduction.

PHASE II: From the information obtained in Phase I, design and fabricate the components required for insertion/conversion of an existing small turbine engine. Perform elaborate parametric testing and prepare noise reduction spectrum over extended frequency range at various ambient conditions of pressure temperature and velocity. Evaluate dependency of the technology on the fuel used. Develop computational tools for performance evaluation, prediction and optimization.

PHASE III: Design, fabricate and package the new components to be added in a government-provided full size engine. Perform comprehensive tests to evaluate the effectiveness of the technique in overall sound pressure level reduction as well as in the audible spectra. Validate the computational model developed in Phase II with the performance parameters obtained in Phase III. Extend the prediction capability to other specific engines and configurations, and make the models available as user-friendly codes. Provide a test matrix for the integrated system operation.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Application of passive combustion control to combustion could prove to be one of the most effective, simple and reliable methodology for noise control and reduction. Further, techniques such as porous inserts improve performance of the turbine engine by providing uniform combustion, reducing combustion oscillations and emissions. Reduction in combustion-generated vibrations and elimination of hot spots increase the engine life and consequently maintenance cost will be reduced. The technology developed here can be applied to commercial aircrafts, ship propulsion and service engines, as well as land-based turbine engines. Aircraft engine and aircraft manufactures, surface ship builders and the power industry will benefit from this program. Existing engines may also be retrofitted with passive combustion control with multiple benefits.

REFERENCES:
1. Witton, J.J. and E. Noordally, "Porous Media Burners for Clean Engines", Combustion Processes in Propulsion (Gabriel D. Roy, Ed.), Academic Press/Elsevier, 2005, pp. 139-144
2. Ellzey, J.L., A.J. Barra, and G. Diepvens, "Simulations of a Porous Burner for a Gas Turbine", Combustion Processes in Propulsion (Gabriel D. Roy, Ed.), Academic Press/Elsevier, 2005, pp. 145-156
3. Singh, S. and R.E. Peck, "An Innovative Method for Reducing Gaseous Emissions from Power Turbine Combustors", Advances in Chemical Propulsion (Gabriel D. Roy Ed.) CRC Press, 2002, pp. 463-476

KEYWORDS: Combustion control; noise reduction; turbine engines; porous inserts; pattern factor; audible spectra; aircrafts; weapons

N06-147 TITLE: Intelligent Retrieval of Surveillance Imagery

TECHNOLOGY AREAS: Information Systems, Human Systems

ACQUISITION PROGRAM: MARCORSYSCOM, PM Intel

OBJECTIVE: Develop the content-based retrieval tools and architecture that enable users of intelligent video surveillance systems to easily conduct video-based forensics and IMINT from video imagery and display entire event histories for a given target or alerting event, regardless of whether the video data was tagged during acquisition.

DESCRIPTION: Intelligent video surveillance systems offer potential advantages for force protection and anti-terrorism in terms of automated alerts that improve the effectiveness of responses to threats and reduce manpower requirements for watchstanders. Intelligent video systems can automatically detect, classify and track persons, vehicles, and watercraft and infer threat potential through activity recognition. Such systems also offer the possibility of searching for patterns of intrusion or surveillance over an extended time course. Intelligent video architectures developed for force protection can be enhanced to provide forensic video analysis and IMINT. Such IMINT and forensic applications require the storage of large amounts of appropriate imagery, together with tagging metadata, when available. This metadata can be as simple as timestamps, camera ID and alert messages and or it can include markups on target class and video event ontologies. However, not everything in a scene can be tagged, and some video imagery may also be available with no tags. In order to fully exploit surveillance imagery there needs to be a capability for querying the database by either semantic queries for metadata search or by content-based image retrieval. The content-based image retrieval should be able to handle both those cases where sample images of a specific "target" are presented or where the analyst can iteratively search for a class of related "targets" within the imagery database. Recent research on content-based image retrieval, boosted retrieval and weakly supervised learning of image hierarchies have provided new tools for retrieval and retagging of data that could be employed in a user-centric search.

In order to support both Force Protection and Intelligence missions these image retrieval and indexing tools ultimately need to be integrated into a knowledge management architecture that includes cataloging of the sensor data, the ability to handle non-video imagery and geospatial information, context information, event and activity recognition metadata and user-centered tools for retrieval of imagery and activities, image exploitation and decision support. The interface should be intuitive and make the best use of human visual perceptual skills. A number of image retrieval systems have been developed that focus on web content or broadcast video. The focus of this topic is on imagery data obtained outdoors, both visible and thermal, especially non-tagged data. Targets of interest include watercraft, vehicles and persons.

PHASE I: Identify, refine and evaluate content-based image retrieval techniques suitable for use in an intelligent surveillance system. Develop a knowledge management architecture that supports forensic ability for both tagged and untagged imagery, and is capable of representing video activity. Develop a querying schema suitable for both imagery and human activity. Test for storage and retrieval of images.

PHASE II: Develop a prototype system. Demonstrate forensic ability to retrieve history linked to target images from a large image library. Demonstrate human-in-the loop retrieval of related targets. Demonstrate end-to-end system with data acquisition from multiple cameras and data collection over an extended period of time. Demonstrate forensic retrieval of event history linked to a recognized activity. Develop and present performance metrics on retrieval accuracy, speed, flexibility for different image sources, and scalability for library size.

PHASE III: Design interfaces to defense systems for support IMINT within an intelligent video surveillance system. Show rapid reconfiguration changes between Force Protection mode and forensic mode.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The commercial potential is in the large security and surveillance industry (facility protection), and in forensics for law enforcement.

REFERENCES:
1) International Journal of Computer Vision, Jan-Feb. 2004 Special Issue on Content-Based Image Retrieval. 2) A Sparse Object Category Model for Efficient Learning and Exhaustive Recognition. R. Fergus, P. Perona, A. Zisserman, CVPR 2005 3) CLUE: Cluster-based Retrieval of Images by Unsupervised Learning. IEEE Transactions on Image Processing, V. 14, no. 8, pp. 1187-1201, 2005. 4)
http://www.niso.org/standards/resources/UnderstandingMetadata.pdf

KEYWORDS: Intelligent Video Surveillance; Imagery Retrieval; Video Forensics; IMINT

N06-148 TITLE: Collaborative Knowledge Management for Net-Centric Systems

TECHNOLOGY AREAS: Information Systems, Human Systems

OBJECTIVE: Develop a collaborative ability for spatially separated, networked warfighters to maintain tightly coupled shared awareness during fluid, quick-response asymmetric warfare operations. Address the problem by novel application of cognitive principles to the design of Web-based information display and retrieval technologies.

DESCRIPTION: To combat the ever expanding array of asymmetric threats the country faces, the US Military continues to transform itself by harnessing networked information sources to empower its warfighters with information dominance over their opponents. FORCEnet is one vision of a transformed, future network-centric Navy, which would afford its warfighters unparalleled access to near real-time operational data through the wide application of Web-enabled technologies. However, providing access to this vast array of real-time information is only the first step towards establishing information dominance. In the quick-response cycle of mission planning and execution that characterizes asymmetric warfare, spatially and temporally dispersed, networked team members must maintain a shared understanding of the battlespace as events unfold. Significant investment has been made in the collection, fusion, delivery and display of tactical and sensor information but the human–centric aspect of using this data to build knowledge for decision making has been largely ignored. For example, shared whiteboards and map overlays promote SA, but lack integration with individual and team knowledge processing capabilities required for

truly net-centric operations. Large networked databases provide depth of data, but lack integration with mission visualization and shared SA tools. Knowledge wall technology displays advance the FORCEnet concept, but rely on the user to link and integrate that information. Conducting true net-centric operations requires visualized, shared, dynamic integration of mission, logistic, and asset information couched in a human-centric graphical user interface. What is needed are innovative collaborative technologies, grounded in cognitive theory, to enable networked warfighters to maintain closely-coupled shared situation awareness of dynamic events.

PHASE I: Identify key issues in the cognitive processes that support maintaining shared situation awareness over time. Develop a prototype of a low bandwidth, web-based collaborative technology for maintaining common situational awareness that instantiates and demonstrates these cognitive principles.

PHASE II: Develop a functioning, web-based experimental testbed of the collaborative technology in the domain of joint force mission planning and execution. Propose metrics to assess the impact of these technologies on shared understanding and team performance.

PHASE III: Incorporate the collaborative technology in a planned operational test environment at PACOM's HQ21 installation or a fleet battle experiment. Validate the technology and demonstrate its benefit in maintaining team shared awareness in this operational setting. Develop guidelines and documentation for tool transition to an operational setting.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Private-sector applications would include any collaborative or team problem solving situation where it is necessary to maintain a team consensus on an issue or product in a dynamically changing environment, such as stock trading.

REFERENCES:
1. ForceNet: Turning Information into Power: Vice Admiral Richard W. Mayo, U.S. Navy, and Vice Admiral John Nathman, U.S. Navy; U. S. Naval Institute Proceedings, February 2003
2. Moreland,E.L. (1999) Transactive memory: learning who knows what in work groups and organizations. In L.L. Thompson, J.M. Levine, & D.M. Messick (Eds.) Shared cognition in organizations: the management of knowledge (pp. 3-31). Mahwah, NJ: Lawrence Erlbaum Associates.
3. Kruse, J. & Adkins, M. (August 2005). The technology trap. U. S. Naval Institute Proceedings, 31, 59-62.

KEYWORDS: Collaborative; Shared meaning; Human-centric; Change awareness; Visualization; Web-based

N06-149 TITLE: Automated, Real Time Bi-directional Communication Instrumentation of Combat Attire for Anti-Terrorism Operations

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: Develop an unobtrusive, real time, bi-directional communication system that can be embedded in the combat attire of the counter-terrorism dismount warfighter for the capture of individual location and action information with subsequent presentation to the unit commander and other team members via the tactile modality.

DESCRIPTION: Unobtrusively sending and receiving time critical information to and from the warfighter during combat operations and counter-terrorism efforts can increase both individual and team performance and overall survivability. Due to personal safety constraints with respect to situation awareness, the dismount warfighter often requires unobstructed vision and hearing as well as the ability to automatically communicate his status. This type of advanced communication system could be achieved by instrumenting the warfighter's attire and with sensors to automatically deliver status information and haptic feedback actuators to receive command information.

Human skin is capable of detecting and distinguishing a variety of tactile stimuli, including tapping, vibration, pressure, pain, temperature, and texture. The number and type of stimuli that can be detected simultaneously is dependent on a number of factors such as where the stimuli are presented on the body and the distance and time between presentation of two distinct stimuli. The fingertips, for example, contain about 100 times more receptors per square centimeter than the skin on the back, contributing to the fact that the two-point threshold distance (distance

required between 2 stimuli) on the fingertips is 2 to 3 millimeters (mm) while the arm senses two points but only when they are 35 to 40 mm apart. A stimulus in the real world typically activates several kinds of receptors simultaneously; this integration of sensations allows humans to experience an ice cube as both smooth and cold, for example. As this information is sent to higher brain centers, sensations also take on meaning because of past experiences. Thus the potential for the warfighter to receive a vast amount of information through the skin exists. By, combining various types of tactile stimulation such as pressure, vibration, and temperature, as well as displaying the information at various points of the body, exploiting proprioceptive sensing, the special operations warfighter could receive messages and commands with spatial significance. Where the stimuli are presented and in which combinations could also relay relevant information to the warfighter.

If the actions and/or status of each team member could be captured via instrumented sensors in a warfighter's combat attire, a real time snap shot status of the entire operation could be conveyed instantly to every warfighter via tactile representation. Additionally, real time, continuous situational data of team members would allow the unit commander to "watch" in real time the progression of the operation, communicating with individual members as needed. Voice communications over the radio only allow one member of the unit to supply a report at any given time, making it difficult for special operations warfighters to conceptualize the status of the operation. Instrumentation of each team member could provide data such as body posture, movement, and weapon status (to include direction pointing). If the unit commander has the information about which team members are walking, running, standing, prone, kneeling, and/or firing weapons, he will be able to make well informed critical decisions based on a significantly better understanding of the situation at any given time. Even with the lack of physiological monitoring, these data could indicate potential causalities (e.g., prone, no movement, not firing). Additionally, direction of enemy, ammunition depletion, and severity of enemy engagements could be ascertained. The data must be in a form that can be transmitted over existing communication systems using minimal bandwidth and power.

The sensor instrumentation suite and tactile communication system will need to be portable, low power, and light weight for successful deployment with the warfighter, and must be seamlessly integrated into the body equipment and combat attire on special operations forces.

PHASE I: Preliminary design and proof of concept in which a feasibility assessment of an Information Collection and Communication System will be conducted. Requirements and design specifications for a fully deployable system should be developed and documented in the final report along with a detailed work plan for development and testing.

PHASE II: Development and demonstration of Phase I design. This phase must include data collection to verify system performance capabilities and will be provided in a final system evaluation report. This final report will also include a lessons learned document, including (re) design recommendations. An option would be provided to support a field evaluation of the system.

PHASE III: Develop an Information Collection and Communication System that capitalizes on the results of the Phase 2 effort, and fully integrate with Navy/Marine Corps acquisition programs

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The fully, immersive gaming and entertainment industry would benefit from a system such as described in this topic. The system could be incorporated into existing gaming systems. Additionally, law enforcement SWAT teams could benefit from these communication technologies.

REFERENCES:

1. Lindeman, R.W., Sibert, J.L., Mendez-Mendez, E., Patil, S., and Phifer, D., Effectiveness of Directional Vibrotactile Cuing on a Building-Clearing Task, Proceedings of the SIGCHI conference on Human factors in Computing Systems (2005), pp. 271 - 280

2. Lindeman, R.W., Cutler, J.R. (2003). Controller Design for a Wearable, Near-Field Haptic Display, Proc. of the 11th Symp. on Haptic Interfaces for Virtual Environment and Teleoperator Systems (2003), pp. 397-403.

3. Lindeman, R.W., Yanagida, Y., Sibert, J., and Lavine, R., Effective Vibrotactile Cueing in a Visual Search Task, Human-Computer Interaction -- INTERACT'03, M.Rauterberg et al.(Eds.), Published by IOS Press,(c) IFIP,2003,pp. 89-96

KEYWORDS: Instrumentation; Warfighter Status, Information Presentation

N06-150 TITLE: Streaming data capture box

TECHNOLOGY AREAS: Information Systems, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Radio Frequency Antennas & Topside Program Manager, code PMW 180-D4/E2

OBJECTIVE: Develop high speed data bus and memory management unit to allow capture in real time of 10-100 Tb data sets representing, for example, several minutes of data arriving at terabit per second rates.

DESCRIPTION: Image capture/processing/ and display systems are continually increasing the number of pixels per frame in order to improve the resolution. Indeed a high resolution computer display monitor in 256 color mode needs over 10 Terabits of data per second. Data compression and optical transmission techniques are quite mature once the data has been sensed and massaged by the initial processor, but getting the electronic digital data from the sensor into the processor initially is an issue. Moreover, when data from several imaging sensors is fused, compression must be undone before differences in areas of activity and of pixel area are handled. Compression is also inconsistent with reconstruction of blank/damaged data areas using values from previous/adjacent pixels. Thus development of a higher speed, electronic data input bus is essential. It is also desirable to increase the data storage capacity that can be fed by such an input bus. For example, in many contexts it is desirable to capture RF signals for periods of 10's of minutes using RF receivers that collect at 1 Terabit per minute or more.

PHASE I: Design and simulate an electronic bus/memory unit capable of capturing and storing 10 Tbits of data arriving at 1 Terabitps or more. Use of COTS were appropriate is desirable.

PHASE II: Demonstrate a preproduction unit capable of capturing and storing 10 Tbits of data at 1 Tbps input rate into a compact memory unit. Design must build-in possibility to cascade memory units to provide longer data records and a scheme to increase the input data rate to 10 Tbps.

PHASE III: Such units will find application in imagery fusion and SIGINT systems where they will be useful in image processing and performance testing. Applications in both single antenna and active arrays are foreseeable.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The fusion of imagery is also a commercial process, e.g. in the digital movie industry where animation and live action or multiple exposures are fused. Additionally, the proposed unit should have application in network routing switches where contention (overlapping-in-time presence of multiple signals) is an issue, and deep buffering is required. This is especially likely in switches implementing tiered transmission priorities or operating near capacity. Having a faster digital data bus available would also aid conventional general processor design by providing better interconnects between major components. Better (bigger/faster) memory management schemes can also improve recording equipment including digital cameras. The proposed units would also be useful in searches for extra-terrestrial intelligence where the waveform of interest is poorly defined and in the test equipment market.

REFERENCES:
1) Ew 101: A First Course in Electronic Warfare by David Adamy (Artech House Radar Library) (Hardcover) -- look under transient digitizers, DRFM, test data for SIGINT hardware

2) See an existing product of closely related type: http://www.agile.co.za/gage/pdf/CG-3250.pdf

KEYWORDS: high speed data capture, image processing, data fusion, data buffering, data bus, data storage

N06-151 TITLE: Advanced Fiber Optic Connectors for Condition Based Maintenance (CBM)

TECHNOLOGY AREAS: Materials/Processes, Sensors

OBJECTIVE: To develop a new class of fiber optic connectors and other fiber optic components (such as beam splitters, 90 degree reflectors, stress relief elements, fiber conduits, etc) targeted for structural health monitoring applications of military assets (such as submarines, ships and aircrafts). These connectors and components will be very light, have a small foot print; they will be very thin and flexible, easy to interconnect, easy to mount on the surfaces of materials; and finally, they will be reliable and durable.

DESCRIPTION: As a result of the limited amount of resources for buying new military systems, many of our platforms are going through life extension programs (in some cases going well beyond their original design life). As a result there has been a need to increase the number and extent of inspections in order to maintain a minimum level of safety. This in turn has led to reduced readiness and increased costs for fleet operations and support. To address many of these challenges the Navy has been investigating new approaches to maintenance and inspections. Some of these include Condition Based Maintenance (CBM), Reliability Centered Maintenance (RCM), Health and Usage Monitoring (HUMS), and Prognosis. Most of these approaches rely on the use of distributed sensors (accelerometers, thermometers, ultrasonic sensors, strain gauges, fiber optic sensors) which monitor key parameters of the components and structures.

Fiber Optic sensors (such as fiber Bragg Gratings (BG), Fiber Fabry Perrot Interferometers (FFPI), and Long Period Gratings (LPG) to name a few) have been successfully demonstrated for many structural health monitoring applications. Despite their tremendous potential in this area, they have not transitioned to major applications. One of the problems associated with these sensors is with the interconnections that are required in large scale structures. Currently these interconnects are large, heavy, and difficult to mount to the surfaces of materials. Also, they require specialized equipment and expertise when applied to optical fibers in the field. In turn, this makes field repairs of optical fibers difficult. This effort seeks new ideas which would address these difficulties. Intuitively one would want connectors that are easy to apply to fibers, are light, have small foot prints, are flexible, yet make connections that have low losses and are robust.

PHASE I: Demonstrate, in a laboratory environment, a new optical fiber connector. Demonstrate its easiness to attach to an optical fiber, to interconnect between fibers with low insertion losses (typical of standard optical fiber connects) and to surface mount onto a structural component. The contractor shall demonstrate connector robustness and reliability under shock and vibration environments (MIL-SPEC-810). It is advisable that the small business contractor collaborate or coordinate with a major fiber optic connector manufacturer from the inception of the program to facilitate the transition if the program becomes successful.

PHASE II: Develop other fiber optic components such as 90o reflectors and conduits for optical fibers. The 90o reflectors will also be light, thin, with small foot print and easy to interconnect with optical fibers. The conduits are for carrying optical fibers loosely inside of them between two sensing point. These conduits serve the purpose of protecting the fiber, of constraining them from freely moving throughout the structure while providing some room for them to accommodate large strains in the structure. Finally, the contractor will demonstrate mass production capabilities for these fiber optic components.

PHASE III: Retrofit a fiber optic health monitoring system aboard a ship, submarine or aircraft and demonstrate its robustness, repairability, and reliability.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The requirement for structural health monitoring is applicable to the commercial world. Widespread fatigue damage, corrosion damage and engine maintenance have been determined to be a major source of problems for commercial ship and aviation systems. These systems require health monitoring. Therefore, commercial ship and aviation industries would benefit significantly from these fiber optic components as well.

REFERENCES:

1) E.Udd, “Fiber Sensors for Smart Structures”, Optical Fiber Sensors: Proceedings of the 6th International Conference, OFS 89, ed. H. J. Arditty, J. P. Dakin, and R. Th. Kersten, Springer-Verlag Berlin Heidelberg pp392-399 (1989).
2) D. W. Jensen, J. Pascual and J. A. August, “Performance of graphite/bismaleimide laminates with embedded optical fibers. Part I: uniaxial tension”, Smart Materials and Structures 1(1) pp24-30 (1992).
3) James S. Sirkis, “Optical and mechanical isotropies in embedded fibre optic sensors”, Smart Materials and Structures 2(4) pp255-259 (1993).
4) B. A. Sjögren, “Static strength of CFRP laminates with embedded fiber-optic edge connectors”, Composites part A: applied science and manufacturing 32(2) pp189-196 (2001).
5) A K Green and E Shafir, “Termination and connection methods for optical fibres embedded in aerospace composite components”, Smart Materials and Structures 8(2) pp269-273 (1999).

KEYWORDS: Fiber, Optic, Connectors, CBM, Sensors, Structural Health Monitoring

N06-152 TITLE: Desulphurization of Logistic JP-5 Jet Fuel for Enhanced Fuel Cell Operations

TECHNOLOGY AREAS: Air Platform, Ground/Sea Vehicles

ACQUISITION PROGRAM: PMA-263, Unmanned Aerial Vehicles (UAVs); Joint Strike Fighter; PMA-290

OBJECTIVE: Develop advanced methods for the desulphurization of logistic JP-5 jet fuel to ensure compatibility with the stringent electrical, operational, and environmental requirements of compact fuel cell systems to be utilized in Naval aviation applications.

DESCRIPTION: JP-5 is currently the most widespread aviation fuel used by the Navy. It is a kerosene-type fuel with a complex mixture of hydrocarbons comprised of hundreds of different major hydrocarbon components, numerous hydrocarbon and non-hydrocarbon components in trace concentrations, and additives. The actual composition will vary depending on the crude source, refinery process, and product specifications. To control chemical and physical requirements of this fuel the military maintains MIL-PRF-5624 specification requirements limiting the amounts of various detrimental elements including sulfur.

Sulfur is a naturally occurring element in crude oil that is detrimental to the operational performance of the fuel cell catalyst required for power generation. MIL-PRF-5624 states that sulfur-containing compounds called mercaptans (which are undesirable because of there corrosive nature and their offensive odor) may not exceed 0.002 mass percent and the total amount of sulfur cannot exceed 0.30 mass percent maximum. The level of sulfur in the fuel has a marginal effect on the specific energy of the fuel but does affect various other characteristics. Commercially, the Environmental Protection Agency (EPA) has mandated “that by 2005 the nation’s largest oil refineries must reduce the sulfur content of gasoline by 90%, from an average of 300 parts per million (ppm) to 30 ppm.” Further steps are to be taken to reduce these numbers even more for diesel fuels.

Fuel cells are seen as an enabling technology for both legacy and future aircraft platforms with such benefits as reduced maintenance, increased fuel efficiency, and reduced emissions. The ONR and NAVAIR are currently working on a program to develop a compact (micro-scale) fuel cell reformer for naval aviation applications to enable the transition of desulphurized JP-5 jet fuel into a pure hydrogen fuel required for fuel cell power generation. The two primary fuel cell types currently being investigated for Naval aviation applications are Proton Exchange Membrane (PEM) and Solid Oxide Fuel Cell (SOFC). Many more types are currently available and are still in consideration for use. Under this program effort, it was determined that the sulfur content of the JP-5 fuel had a severe detrimental effect on the maintenance and life of the fuel cell by reducing catalyst activity and inhibiting cell life.

The Navy and other DoD agencies are investigating state of the art desulphurization technologies for shipboard, ground, and other applications. Most current efforts are being developed for large-scale process methods for stationary or shipboard applications. Such methods include hydrodesulphurization, catalytic distillation, sulfur adsorbents, and fuel distillation. The requirements for these defense applications, and as a result the requirements for the desulphurization process, differ considerably from Naval aviation requirements. When possible, this effort

will leverage the desulphurization technology being developed under other Navy and DoD efforts, however there are specific Naval aviation requirements that will guide the research and innovation.

To address these differences, it is the intent of this topic to focus innovative research on solving the technical challenges associated with reducing sulfur content in logistic JP-5 jet fuel to minimize damage and increase life of the fuel cell system while also meeting the stringent size, weight, electrical, operational, and environmental requirements of Naval aviation applications. The goal is to reach sulfur levels in the low parts per million (ppm) to parts per billion (ppb) region. The desulphurization process must be integrated and operated with the compact 1 KW breadboard fuel processor and fuel cell system that is currently being developed by ONR and NAVAIR for Naval aviation applications. Due to severe size and weight restrictions, Naval aviation applications require very compact fuel cell systems. The desulphurization process and the purity of the hydrogen produced will have a significant impact on the power density of the overall fuel cell system. Operational requirements include cold temperature start (-55C), short start-up times (1-8 minutes), short duty cycles (1-2 hours on and 22-23 hours off per day, operating daily), air supply/intake (not available in purified form), and water management (no storage, water must either be recycled or removed). Electrical requirements include MIL-STD-704 power quality, high load inrush currents, rapid response to load changes, transients, and faults. Environmental requirements include temperature (-55C to 91C), altitude (up to 70,000 ft), shock (20G/11ms operational, 40G/11ms crash), vibration (17G functional, 28G endurance), and EMI (MIL-STD-461). In addition to meeting these requirements, the desulphurization process and overall fuel cell system must prove to be cost-effective including meeting applicable acquisition, maintenance, reliability, and other operations and support goals. Applicable Naval aviation requirements will be further defined throughout the solicitation process. Results of this effort should include the design, development, and testing of new or improved processes for sulfur removal including but not limited to advanced catalysts, adsorbent beds, reforming reactions, hydrodesulphurization, or various other desulphurization concepts. This topic can also be extended to current JP-5 use to minimize pollutants and maintain adherence to current and future military regulations and/or EPA civilian mandates.

PHASE I: Define a technical approach and develop an implementation plan for the desulphurization of JP-5 jet fuel to be compatible with the 1KW breadboard fuel processor and fuel cell system that is currently being developed for Naval aviation applications. The proposed desulphurization process must be compatible with the stringent size, weight, electrical, operational, and environmental requirements of Naval aviation applications. Validate the approach analytically or provide test data or bench top hardware that would validate the approach.

PHASE II: Design, develop, and demonstrate a prototype system for desulphurizing JP-5 jet fuel for Naval aviation applications. Demonstration can include a high-fidelity laboratory environment and/or aircraft ground demonstration.

PHASE III: Package and integrate the desulphurizing system into a complete fuel cell system. Perform a functional evaluation of the reduced-sulfur content JP-5 fuel displaying the improved performance of the overall fuel cell system. Perform a flight evaluation of the fuel cell system.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The successful implementation of a refining process for minimizing or removing sulfur in JP-5 jet fuel can be widespread and range across various gasoline or diesel sulfur-containing fuels. The commercial aviation industry can utilize the technique and/or process to further reduce there operating costs and adhere to EPA and FAA mandates for reduced environmental emissions. Benefits could also carry into the commercial fuel cell sector with a primary impact on reforming operations.

REFERENCES:
1. An Emissions Mission: Solving the Sulfur Problem; Oak Ridge National Laboratory ReVIEW Magazine http://www.ornl.gov/info/ornlreview/v33_3_00/emissions.htm, Vol. 33, No. 3, 2000.

2. Aviation Fuels Technical Review, Ch. 5, Aviation Turbine Fuel Refining, Chevron Product Corporation http://www.chevron.com/prodserv/fuels/bulletin/aviationfuel/5_at_fuel_refining.shtm, 2004.

3. MIL-PRF-5624, Performance Specification, Turbine Fuel, Aviation, JP-5.

KEYWORDS: desulphurization; reforming; sulfur; JP-5 jet fuel; fuel cell

N06-153 TITLE: Semantical Machine Understanding

TECHNOLOGY AREAS: Information Systems, Human Systems

OBJECTIVE: Develop a quick-reaction capability to extract specified semantic content from large volumes of unstructured multilingual text and represent it mathematically. Use these representations to identify events, relationships and trends to enable interoperable knowledge sharing and intelligence analysis across joint and coalition forces.

DESCRIPTION: Defense Transformation has changed warfighting tactics from use of platform-based large-scale initiatives to quick reaction, team-based mobile force operations in discrete events. There will be increased operations with Joint, Coalition, Non-Government and Volunteer Organizations which will require analysis of open-source (uncertain, conflicting, partial, non-official) data. Teams will consist of culturally diverse partners with rapidly changing team members and various organizational structures. These characteristics will put increasingly difficult demands on short turn-around, high stakes, crisis driven intelligence analysis. In order to respond to this challenge, more powerful information analysis tools are needed that can quickly extract meaning and intent from large volumes of data. There are a number of extant tools for data mining including advanced search engines, key word analysis and tagging technology but better tools are needed to achieve advanced information discovery which provide more focused and directed content rather than line-item search results. Key to such a capability is automated understanding of intent or meaning and the ability to represent it in a language/ culture free format. This solicitation proposes building such a capability by selecting the most promising data search and visualization/presentation tools and combining them with newly developing semantic analysis tools for the delivery of event-specific information. The final product will be a data/text analysis tool that can perform semantic searches and provide language/culture-free information in a format that can be used for discovery of events, relationships and trends.

PHASE I: Review current technology and tools for semantic search methods that have established empirical evidence of effectiveness. Select top candidate/s, or combinations thereof for matching with commercially available text analysis tools for development of a prototype concept of machine understanding of meaning. Incorporate these tools into a computational model or automated agent to enable the collection of real-time data which can provide the capability to search by entity, concept or meaning extraction.

PHASE II: Develop a web-based experimental testbed of the search technology in the domain of intelligence analysis for coalitions operations. Develop a prototype, based on empirically validated techniques and evaluate in a simulated or representative operational environment. Provide metrics and measures to assess performance improvement in an intelligence analysis or decision making environment. Provide functional and design guidelines to assure the extensibility of the prototype to other operational venues.

PHASE III: Incorporate the search technology in a planned operational test environment at a Navy or Defense Intelligence Analysis venue. Validate, standardize and document underlying software for application purposes and implement in a field experiment. Coordinate with user subject matter experts to instantiate a working model with actual data, get user commitment for training and maintenance of the application. Collect performance data to validate improved performance Develop guidelines and documentation for tool transition to an operational setting.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Private-sector applications would include any information analysis situation that involves high data volume and quick response requirements. This would include state and local emergency support teams for crisis action planning and humanitarian aid response. Business applications, such as corporate knowledge management or textual research would also be a target.

REFERENCES:
1. Gorman, J. C., Foltz, P. W. Kiekel, P. A., Martin, M. A. & Cooke, N. J. (2003) Evaluation of Latent Semantic Analysis-based measures of communications content. In Proceedings of the 47th Annual Human Factors and Ergonomic Society Meeting.

2. Gerber, Cheryl (2005) Smart Searching. In Military Information Technology, Vol 9, Issue 9.

3. Foltz, P. W. (2002) Quantitative cognitive models of Text and Discourse Processing. In The Handbook of Discourse Processes. Mahwah, NJ: Lawrence Erlbaum Publishing.

KEYWORDS: Semantics, text mining, machine learning, discourse analysis, knowledge management

N06-154 TITLE: Simulation, Mission Rehearsal, and Training Tools (SMRTTs) for Counter-Terrorism Operations

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: ONR 30, Human Performance, Training, & Survivability

OBJECTIVE: To develop simulation, mission rehearsal, and training tools to assist Marines, Seals, allies, and coalition forces in USMC counter-terrorism operations.

DESCRIPTION: Paper maps have been critical to military operations for hundreds of years. Over the last decade, we have seen the introduction of digital maps, which simply displays the two-dimensional paper map on a computer screen. With the addition of GPS, the two-dimensional digital map becomes an excellent tool for navigation. The world is, however, three-dimensional. The next great advance is providing warfighters with tools to allow them to develop and visualize the three-dimensional battlefield. To date, mission rehearsal applications have concentrated on using overhead imagery to develop three-dimensional databases. While this is an excellent tool for air operations mission rehearsal, it does not have the resolution required for rehearsing infantry operations.

Marines require easy-to-use tools that allow them to build their own local simulation and mission rehearsal databases for supporting counter-terrorism operations during deployment. Areas and objects of interest can change rapidly, and the ability to quickly collect geospatial information about them is crucial. This capability is especially critical in urban areas and includes the interiors of buildings. If Marines can rapidly build local databases and "stitch" them into larger preexisting databases, a simulation and mission rehearsal capability can be realized which could greatly improve counter-terrorism training and operations.

An additional challenge facing troops today is the requirement to work with Joint and Coalition forces. Often, the specific Tactics, Techniques and Procedures (TTPs) used by one branch of the military differs significantly from those used by other branches. Similarly, Coalition forces may have completely different, culturally driven, sets of TTPs. Therefore, an additional aspect of the mission rehearsal tool would be the ability to demonstrate, either through text, scripting or manipulation of actual objects, what doctrinal approaches (and biases) each participating team brings to the exercise, before moving to actual plan execution. Just as language can be a significant barrier to communication with our allies, so too can two-dimensional maps. The two-dimensional map is like a foreign language to many cultures and this becomes a significant barrier to communication. If we can present the geospatial images in a more natural manner, including different team member's doctrinal approaches, we can eliminate this barrier. So instead of a building looking like a square on a map, it actually looks like the building it represents, and affords participants the chance to see other members' strategies.

With the use of SMRTTs, each new area and object of interest will be represented and integrated with larger preexisting databases. When actual mission rehearsals of the areas are conducted by our troops, the information from the rehearsal will be stored in a library of mission rehearsal cases for counter-terrorism. During the training of coalition forces, the library of cases can be retrieved to facilitate training with minimal use of live instructors and the performance of our coalition forces can automatically be compared to the performance of Marines who performed the actual mission. This comparison can then be provided in the form of an after action review. Ultimately, instructors will be able to multiply their effectiveness by leveraging this multi-use technology.

PHASE I: Develop a prototype system to visualize and manupulate interior and exterior of buildings in an urban terrain databases developed using man or vehicle portable data collection systems. These databases must be able to

be stitched into existing simulation databases easily and manipulated to reflect local intelligence such the destruction of a builiding. The system should demonstrate the capability to store and retrieve simulation mission rehearsals from a library, comparing performance by Marines to performance by coalition forces in an after action review, thus supporting reduced instructor involvement during coalition training.

PHASE II: Implementation of Phase 1 plan and refinement of the tools and applications. This phase will demonstrate the ability to rapidly tailor the after action review to the specific culture in the native language.

PHASE III: Full implementation of the SMRTTs system. This will include man-portable and vehicle-borne systems that can automatically generate geospatial databases in near real-time. The system will have a mechanism for configuration management and storage of the data and combining it with other sources of information such as UAVs and videos.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: As the war on terrorism continues, other federal, state, and, local agencies will require tools such as these to monitor areas and buildings of interest, conduct mission rehearsal, and provide training to their employees. In addition, rapid and inexpensive geo-specific databases would be useful to real estate, architecture, and urban planning.

REFERENCES:
1. Security Cooperation Education and Training Center Desktop Guide, Jan 05.
scetc.tecom.usmc.mil/PubsHome.asp
2. Security Assistance Management Manual (DoD 5105.38-M)
3. Combatant Commander Initiatives (10 U.S.C. 166a)
4. Regional Defense Counter-Terrorism Fellowship Program (Section 8125 of Public Law 107-117).
5. Center for Advanced Operational Cultural Learning (CAOCL). www.tecom.usmc.mil/caocl/
6. The Infantry T&R Manual, NAVMC DIR 3500.87. www.tecom.usmc.mil/gtb
7. Ground Training Branch, Training and Education Command, MCB Quantico. www.tecom.usmc.mil/gtb

KEYWORDS: Simulation; training; mission rehearsal; 2D and 3D data collection; culture; language; after action review.

N06-155 TITLE: High Sensitivity Midwave Infrared Laser Detection Using Sum Frequency Generation

TECHNOLOGY AREAS: Sensors, Weapons

ACQUISITION PROGRAM: PMA-201 Conventional Strike Weapons

OBJECTIVE: Develop a high conversion efficiency method of converting infrared energy into the visible spectrum using sum frequency generation techniques. This will enable elimination of the cryo-genically cooled MWIR sensor used in current infrared missile seeker LADAR applications.

DESCRIPTION: The performance of currently available laser detectors in the midwave infrared (MWIR/3-5 micrometers) is inferior to their silicon-based counterparts operating in the visible and near-infrared region. Typically, they have small active areas, low gain, low electronic bandwidth, and poor noise characteristics. Oftentimes, they require cryogenic cooling which translate to larger size, higher power consumption, and higher cost. This project aims to eliminate the need for MWIR detectors by demonstrating a nonlinear optical conversion technique, sum frequency generation, whereby a MWIR signal is frequency-shifted to the visible spectrum for detection. As an example, the parameter used to measure a sensor's sensitivity is called the specific detectivity (D*). The difference between visible band silicon detectors and MWIR semi-conductor detectors can be as high as two-orders of magnitude, in favor of silicon detectors.

PHASE I: Develop a conceptual design of a LADAR and verify with component testing in the laboratory. For example, use a laser diode as the pump source to optically pump a nonlinear optical crystal and to generate the summed frequency output. Demonstrate detection with silicon visible band detector. Characterize and describe the sensitivity of the detection.

PHASE II: Develop and build a prototype LADAR sensor, using the technology proven in phase 1, for use as a missile seeker, and test in a simulated environment.

PHASE III: The LADAR sensor would become an incremental upgrade to the seeker sensor in an existing missile program.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technologies develped under this SBIR project can lead to sensors for both military and commerical applications. High sensivity mid-infared sensors can be used to detect hazardous and deadly chemical agents and be used for lidar detection system for ranging applications.

REFERENCES:
1. R. L. Sutherland, Handbook of Nonlinear Optics, New York, Marcel Dekker, Inc., 1996.
2. G. D. Boyd and D. A. Kleinman, "Parametric Interaction of Focused Gaussian Light Beams," J. Applied Physics, Vol. 39, 1968, p. 3597.
3. K. L. Vodopyanov, O. Levi, P. S. Kuo, T. J. Pinguet, J. S. Harris, M. M. Fejer, B. Gerard, L. Becouarn, and E. Lallier, "Optical parametric oscillation in quasi-phase-matched GaAs," Optics Letters, Vol. 29, No. 16, Aug. 2004, pp. 1912- 1914.

KEYWORDS: LADAR; sum frequency generation; nonlinear crystal; mid-infrared detection, optical pumping

N06-156 TITLE: Time-Synchronized Underwater Ranging

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors

ACQUISITION PROGRAM: Unmanned Undersea Vehicles (UUV) Program Office, PMS 403; ACAT IV

OBJECTIVE: develop and demonstrate the ability to perform one-way 1m or better accuracy acoustic ranging using acoustic modems integrated with miniature atomic clocks that are small, low power and have low enough drift to support the specified ranging accuracy for weeks between re-synchronization.

DESCRIPTION: Ranging between systems underwater is typically accomplished through a series of communications and range is estimated using the round trip travel time from one system to the other; i.e. vessel 1 sends an interrogation and vessel 2 replies, vessel 1 determines the range by the total elapsed time divided by 2. If the two vessels have clocks, then ranging could be accomplished by sending a time stamp and the recipient can determine range by comparing the received time stamp with its own clock time. However, off-the-shelf clock technology is either too large, consumes too much power or has too high a drift for application on a UUV. New chip-based atomic clock technologies have demonstrated very low power (NIST clock is 75mW), very small size (4mm on a side) and very low drift (100 nsec/year). Clock synchronization on the order of 100 microsec between vessels is needed to achieve 1m range resolution. Acoustic signals robust against multi-path will be required. The acoustic modems used in this project must be compatible with existing/emerging navy UUV modems. A method will need to be developed to allow accurate synchronization between two systems while underwater using acoustic communications.

PHASE I: Propose design, specifications and development cost for an integrated chip-scale atomic clock and acoustic modem. Propose approach to underwater clock synchronization between two or more systems. Estimate of achievable ranging accuracy and underwater synchronization accuracy.

PHASE II: Develop and deliver (4) prototype integrated atomic clock and acoustic modem systems.
Demonstrate ability to achieve 1m or better ranging using 1 way acoustic communications.
Demonstrate ability to clock synchronization between systems underwater to 100 microsec or better.
Integrate and demonstrate the new modems with a Navy program of record UUVs.

PHASE III: Transition of the developed modem will be accomplished through planned product improvements to Navy UUVs and other systems utilizing acoustic modems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology will be applicable to commercial underwater systems including UUVs and digital transponder systems that are being used by the offshore oil and construction industries.

REFERENCES:
1) http://tf.nist.gov/ofm/smallclock (NIST atomic clock on a chip)
2) http://www.eurekalert.org/pub_releases/2003-09/oonr-oon090203.php (Kernco atomic clock funded by ONR and AFRL)
3) http://www.kernco.com/pdfs/ULAC_Press_Release.pdf

KEYWORDS: acoustic modems; atomic clock; time

N06-157 TITLE: Holographic Polarimetric Laser Radar for Surveillance and Discrimination

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PMs-480 Afloat AT/FP PM, Shipboard Protection Systems increment 3

OBJECTIVE: To prove the application of the key technologies, predict field performance and conduct field tests of a prototype holographic laser radar. This sensor architecture has the potential application as a sensor for surveillance at short ranges and automated target discrimination.

DESCRIPTION: A holographic volume grating device is feasible for use in low cost, lightweight polarimetric active imaging sensor (LADAR) applications. It can be used in the receiver of a polarimetric laser radar system. The holographic beam splitter (HBS) optics can be applied to detect the polarization states of targets, greatly increasing the performance of automated target identification algorithms and reducing false alarms.

Laser radar imaging is practical for short-range surveillance (such as in-port threat defense). This laser radar would be capable of automated detecting, tracking, and discriminating air and surface targets/threats. It would be small, lightweight and low cost compared to LADAR's currently under development. From an optical system standpoint, this architecture would not require optical coherence which greatly relieves the manufacturing and alignment tolerances of the system.

PHASE I: Develop a physics based engineering model of the holographic laser radar system. This system model should include the major components, such as the optics of the HBS Stokesmeter receiver, laser transmitter, operating wavelength, focal plane array and signal/image processing. The resulting analysis should predict the field performance of the system.

PHASE II: Build the LADAR receiver (Stokesmeter) and transmitter system. Do component performance tests in laboratory. Integrate the components and test in lab. Setup the prototype polarimetric LADAR system for demonstration and field test. Laboratory and field demonstration of the shape detection/discrimination capability of the prototype LADAR system is the goal.

PHASE III: Develop and build the a prototype laser radar system for surveillance sensing or missile seeker application. The surveillance sensor application would be a product incremental improvement in the SPS program. It would provide the capability to detect, track and discriminate threat surface and air targets while in foreign port (when US combatant use of main weapon system radars are often prohibited by local authorities).

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology would result in low cost active imaging systems for commercial vessels and / or aircraft. Active imaging systems provide increased capability to image through obscuring phenomena, such as rain, dust or fog. Safety of flight/navigation

would be greatly increased by providing situational awareness to the operator/pilot from the current reliance on radio navigation aids and/or radar.

REFERENCES:
1. "Polarization of Holographic Grating Diffraction II. Experiment," Tsu-Wei Nee, Soe-Mie F. Nee, Mark Kleinschmit and Seliem Shahriar, JOSA-A, 21, 532-539, 2004.
2. "Ultra-fast Holographic Stokesmeter for Polarization Imaging in Real Time", M.S. Shahriar, J. T. Shen, R. Tripathi, M. Kleinschmit, T. W. Nee S. F. Nee, Optics Letters, 29, 298-300, 2004.

KEYWORDS: LADAR; Polarization; Holographic; Stokesmeter

N06-158 TITLE: Rugged Low Heat Leak Cryogenic Seals and Electrical Quick Disconnects

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: PMS-500 DDX

OBJECTIVE: Develop cryogenic seals and quick disconnects for both cryogenic fluid and electrical power feedthroughs to be used in a Navy shipboard environment.

DESCRIPTION: The Office of Naval Research (ONR) and Defense Advanced Research Projects Agency (DARPA) are developing systems that operate in a cryogenic environment such as propulsion motors, dc degaussing cables, and power electronics. A future combatant could have several discrete or interconnected cryogenic and superconducting systems with a variety of sealing and connection requirements. Cryogenic seals and electrical connections that can be used without impacting the mission are necessary for these types of systems.

The various systems being developed cover a wide temperature range from 4.2K up to 80K and also have different cooling mediums such as liquid and gaseous helium and liquid nitrogen. For survivability and maintenance purposes the ability to quickly connect or disconnect cryogen and electrical power transfer lines without impacting the systems they support would be necessary.

The current state of the art in cryogen seals in a vacuum environment use one time copper seals with "knife edge" flanges. These copper seals are not reusable and are only suitable for cryogen only lines. There is no current commercially available product for the quick connection of both an electrical and cryogen flow in the same device.

A system that would benefit from such a combination of electrical and cryogen connection would be the High Temperature Superconducting (HTS) Degaussing system. The system is being developed to use gaseous helium at 55K to cool a superconducting cable. The degaussing application is a distributed cable system throughout the ship. When damage occurs to one section of cable it would be necessary to replace it. It is envisioned that spare cables could be carried on the ship with quick disconnects on the ends that would encompass both the helium flow and up to 40 superconducting wires.

Novel and innovative ideas or approaches for cryogenic seals and superconducting electrical connections are desired. The approaches should fill a need by an existing program such as the propulsion motors, HTS degaussing or power electronic developments.

PHASE I: Identify applications of the novel connection or seal design within potential Navy electrical power systems. Define basic requirements based on application. Determine the feasibility of developing a cryogenic connection and/or seal for use in Navy systems. Complete preliminary designs of a shipboard cryogenic connection and/or seal.

PHASE II: Develop full scale prototypes to demonstrate and validate the systems capabilities. Based on prototype, develop a conceptual design, with cost estimates, of a shipboard cryogenic connection and/or seal.

PHASE III: Transition the technology to commercial and military cryogenic or superconducting applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The resulting cryogenic seal or connection will be directly applicable to commercial and military in the expanding market of cryogenics. As cryogenics move from a laboratory environment to field uses new fittings will be needed to make the systems more user friendly. There is potential for a diverse market from physics research laboratories, electric propulsion motors, and electrical utility cables.

REFERENCES:
1. Fitzpatrick, B. "High Temperature Superconducting Degaussing System Assessment," to be published in the proceedings of ASNE Day 2005, April 2005.
2. Snitchler G., Gamble B., Kalsi S.S., "The performance of a 5 MW high temperature superconductor ship propulsion motor" Applied Superconductivity, IEEE Transactions on Volume 15, Issue 2, Part 2, June 2005 Page(s):2206 – 2209
3. RJ Thome, W Creedon, M Reed, E Bowles, K Schaubel - Power Engineering Society Summer Meeting, 2002 IEEE, 2002
4. Curcic, T.; Wolf, S.A., "Superconducting hybrid power electronics for military systems", Applied Superconductivity, IEEE Transactions on Volume 15, Issue 2, Part 2, June 2005 Page(s):2364 - 2369
5. "Shipboard Electric Power Distribution: AC Versus DC Is Not the Issue, Rather, How Much of Each Is the Issue"; LCDR John V. Amy Jr. PhD, Mr. David H. Clayton and Mr. Rolf O. Kotacka; All Electric Ship 98 Conference.2nd ed., vol. 3, J. Peters, Ed. New York: McGraw-Hill, 1964, pp. 15-64.
6. Henry Hegner, Bipin Desai: "Integrated Fight Through Power", IEEE Power Engineering Society, Chicago, USA, July 2002.

KEYWORDS: HTS; Cryogenic; Seal; Superconductor; HTS; Connector; Quick Connect; Power Electronics; Electrical Distribution

N06-159 TITLE: Next Generation Data Base Modeled on Human Neurological Processes

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Develop an advanced next generation database model that uses a neurologically inspired design based on data cell and link cell synaptic interactions to support new and unique advanced data analysis, entity relationship association, and associative search capabilities. This will replace the traditional relational database management system (RDBMS) indexing methods.

DESCRIPTION: Current data mining and data analysis applications are designed primarily to address commercial business intelligence requirements. Business Intelligence (BI) has been defined as, "…a broad category of applications and technologies for gathering, storing, analyzing, and providing access to data to help enterprise users make better business decisions. BI applications include the activities of decision support systems, query and reporting, online analytical processing (OLAP), statistical analysis, forecasting, and data mining." Conventional RDBMS-based BI applications are records-based, transaction oriented, and demand massive resource overhead for table joins and index management. A cell-based approach to database design would enable the data model to store, process, and manipulate data much like the human brain, thereby permitting more effective and flexible use of the database and the underlying data. Performance gains are possible with cell based indexing which captures, aggregates, and handles data in native "cellular format" cells vice traditional indexes. Additionally, cellular database techniques facilitate "value pooling," a dimension that aggregates clusters of cell "associations." Entity relationship of "link cells" provides a powerful link analysis and knowledge discovery function, and opens the possibility of further advances in innovative data analysis capabilities.

PHASE I: Develop a prototype cellular datebase concept demonstrator capable of advanced data mining, link analysis, associative search, and entity relationship association using both structured and non-structured data.

PHASE II: Finalize design from Phase I Concept. Evaluate the prototype in a limited objective experiment to validate database proof of concept and obtain operational feedback from analysts. Incorporate lessons learned into prototype development.

PHASE III. Based on Phase II outcome, test revised database application in major operational exercise or experiment event. Upon successful conclusion, initiate efforts to transition technology to commercial sector and military high-value knowledge discovery (KD) initiatives.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Relational database technology is ill-suited for many data analysis applications. Data is a genuinely valuable asset and BI applications strive to covert previously raw, un-discovered corporate knowledge into actionable information of value to decision makers. A next generation cell structured database design presents a break through for BI because it greatly enhances existing data analysis capabilities.

REFERENCES:

- 1) Future Trends in Data Management, Michael Scofield, dated 22 Feb 2005 @ http://www.mlgsca.mlanet.org
- 2) Anthology from VLDB (Proceedings from International Conference on Very Large Data Bases, Framingham MA 22-24 Sept 1975 @ http://www.informatik.uni-trier.de
- 3) Data Mining Techniques, Neural Networks, courtesy of StatSoft @ http://www.statsoft.com/textbook/stdatmin.html

KEYWORDS: Cell-Generation; Business Intelligence (BI); Knowledge Discovery; Novel Advanced Data Mining; Link Analysis; Entity relationship association; Neurological Design.

N06-160 TITLE: Autonomous seafloor geotechnical property sensor

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors, Battlespace

ACQUISITION PROGRAM: Oceanographer of Navy, Mine Warfare, Space and Naval Warfare. S&T

OBJECTIVE: Develop a geotechnical sensor that is autonomous or may be integrated with an autonomous underwater vehicle. The sensor would sample on a dense spatial array a number of geotechnical properties such as shear and bearing strengths and store them for post-mission analysis or transmit directly to the surface for real-time analysis.

DESCRIPTION: We seek innovative approaches to providing rapid geotechnical assessment of the seafloor from an autonomous platform. These approaches may be integrated with or adapted from an existing autonomous platform, or they can include development of a new platform. The sensor might utilize acoustic or mechanical sampling methods, or develop another approach.

PHASE I: Propose a sampling methodology, determine the feasibility and determine its expected accuracy and resolution. Compare the expected specifications with those required by existing or future Naval operations.

PHASE II: Develop a prototype and test its performance, verifying its actual accuracy and resolution. The prototype must be able to accurately and rapidly characterize seafloor geotechnical properties over an area of about 1 square kilometer. The data must be reliably stored or transmitted for subsequent analysis.

PHASE III: Prepare the sensor for operational testing during a Naval exercise. Determine its potential for operational effectiveness and suitability, and provide documentation.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: A capability to obtain detailed characterization of seafloor geotechnical properties would benefit private and public environmental assessment including engineering, geological, biological, and chemical properties related to soil stability, sedimentation and erosion and pollution, particularly near harbors.

REFERENCES:

1. Stoll, R. D. and T. Akal 1999:"XBP-A tool for rapid assessment of seabed sediment properties,Sea Technology, Vol 40, No. 2, pp. 47-51.
2. Stoll, R. D. and Y-F Sun, 2004. Using Static and Dynamic Penetrometers to Measure Sea Bed Properties, www.onr.navy.mil/sci_tech/ocean/reports/docs/cg/04/cgstoll.pdf
3. D. Elsworthn and D.S. Lee, 2005. Indentation of a free-falling lance penetrometer into a poroelastic seabed. Int. J. Numer. Anal. Meth. Geomech., 29:141–162.
4. Lambert DN, Walter DJ, Young DC, et al., 1999. Acoustic sediment classification developments, SEA TECHNOLOGY 40 (9):35

KEYWORDS: strength; shear strength; mud; MCM; acoustic; penetrometer

N06-161 TITLE: Broadband Doppler-Sensitive Waveforms for Energy-Constrained Distributed Active Sonar Systems

TECHNOLOGY AREAS: Information Systems, Sensors

ACQUISITION PROGRAM: PMA-264 Air Multi-static Program (ACAT III)

OBJECTIVE: Develop and evaluate broadband Doppler-sensitive waveforms and innovative signal and information processing for detection, classification, and localization (DCL) of both high- and low-Doppler targets on multistatic ASW active sonar systems operating under energy constraints.

DESCRIPTION: A distinct advantage of distributed or multistatic active sonar systems is the ability to detect, classify and localize targets in large areas of the search field that are moving with narrowband Doppler-sensitive waveforms. However, slowly moving targets and targets in regions of low radial velocity (i.e., low-Doppler targets) require the transmission of an additional broadband Doppler-insensitive waveform and are typically plagued by clutter generated false alarms. Broadband Doppler-sensitive waveforms may have the ability to meet the DCL needs for both high- and low-Doppler targets while reducing the overall energy transmitted by the active sonar source. If successful, this approach will allow increased persistence of energy-constrained sonar systems and reduce the risk to marine mammals arising from anthropogenic sound in the marine environment.

The problem to be solved in this effort is the development and evaluation of candidate broadband Doppler-sensitive waveforms meeting the DCL needs of both high- and low-Doppler targets as well as the receiver signal processing and advanced information processing required to exploit these waveforms. Waveform and receiver design must account for realistic Doppler-spreading induced by the environment (e.g., surface or scatterer motion) and the sonar system (random source and receiver motion). Evaluation of the waveforms and algorithms must occur at least at the localization (tracker output) level and should be compared with a reasonable baseline waveform of equal transmit energy. Waveforms with bandwidth-to-center-frequency ratios that may be efficiently generated by existing source technology should be considered. Note that "low-Doppler" includes targets with zero radial velocity.

PHASE I: Development and simulation analysis of proposed broadband Doppler-sensitive waveforms and relevant signal and information processing. Waveforms, detection and normalization algorithms should be developed and evaluated accounting for an appropriate amount of environment- and system-induced Doppler spreading. It is emphasized that innovative solutions not only to the waveform design, but also the detection and normalization algorithms in the receiver processing are required. Initial research and development on tracking algorithms appropriate for the proposed broadband Doppler-sensitive waveform should result in an analysis plan for Phase II evaluation and implementation.

PHASE II: Extend and refine the signal and information processing algorithms to include tracking of both low- and high-Doppler targets. Performance must be quantified at the track output level and include comparison with an equal-energy baseline waveform comprising continuous-wave and frequency-modulated pulses followed by a tracker exploiting detections from both waveforms. Data from a sea-trial of opportunity (e.g., via ONR's LWAD Program) is to be acquired and evaluated for both the proposed and baseline waveforms with a focus on tracking targets with low and high Doppler amid clutter.

PHASE III: Extension of the tracking algorithm to multiple targets and multiple sensors, acquisition and analysis of a larger data set in a cluttered multi-target environment, and packaging of software for implementation in fleet systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Successful development of broadband Doppler-sensitive waveforms and their corresponding signal and information processing would be immediately applicable to homeland security applications of diver detection and harbor defense. Other fields that might benefit include the aerospace industry for tracking airplanes or spacecraft and biomedical engineering for tracking tracer particles in turbulent fluid or for the Doppler imaging of blood flows.

REFERENCES:
[1] Costas, J., "A Study of a class of detection waveforms having nearly ideal range-Doppler ambiguity properties," Proc. IEEE, vol. 72, pp. 996-1009, Aug. 84.
[2] Cox, H. and H. Lai, "Geometric comb waveforms for reverberation suppression," Proceedings of the Twenty-Eighth Asilomar Conference on Signals, Systems and Computers, Vol. 2, pp 1154-1189, 1994.
[3] Collins, T. and P. Atkins, "Doppler-sensitive active sonar pulse designs for reverberation processing," IEE Proceedings on Radar, Sonar and Navigation, 145:6, pp 347-353, December 1998.
[4] Brill, M., X. Zabal, M. Harman, and A. Eller, "Doppler-based detection in reverberation-limited channels: effects of surface motion and signal spectrum," Proceedings of Oceans 1993 Conference, vol. 1, pp. I220-I224, Oct. 1993.
[5] Rago, C., P. Willett, and Y. Bar-Shalom, "Detection-tracking performance with combined waveforms," IEEE Transactions on Aerospace and Electronic Systems, 34:2, pp 612-624, April 1998.
[6] Sun, Y., P. Willett, and R. Lynch, "Waveform fusion in sonar signal processing," IEEE Transactions on Aerospace and Electronic Systems, 40:2, pp 462-477, April 2004.

KEYWORDS: Active sonar; multi-static ASW; signal processing; sonar tracking; broadband waveforms; Doppler-sensitive

N06-162 TITLE: Dexterous Robotic Manipulator for Small Robotic Platforms

TECHNOLOGY AREAS: Ground/Sea Vehicles, Electronics

ACQUISITION PROGRAM: PMS-Explosive Ordnance Disposal (PMS-EOD)

OBJECTIVE: Develop a robotic dexterous manipulator that can handle and interact with small items such as wires or blasting caps without damaging or causing actuation of the device.

DESCRIPTION: The manipulators currently available for explosive ordnance disposal (EOD) robotic platforms cannot adequately manipulate small items, such as wires and blasting caps. The current manipulators are limited because of the small number of degrees of freedom available and the joint by joint control that is predominantly used. They also are limited because the operator does not receive any feedback on the amount of force the manipulator is applying; it is difficult to hold sensitive items without dropping or damaging them. Currently, the limited dexterity of the manipulators can be augmented by movements of the base platform (e.g. grab an object and then move the platform back), but in truly unstructured environments this may not be possible.

The developed manipulator should be able to accomplish two types of tasks. The first task is to grip a blasting cap or wire protruding from a target and remove the item by pulling straight back, without moving the robot base or damaging the item griped. The manipulator will be attached to a fixed base located up to 3 feet from the target. The blasting cap or wire will be located in an arc of plus or minus 60 degrees from a line connecting the center of the base and the target. The blasting cap or wire can be located up to two feet above the height of the robots base. The second task is to pick up a wire or blasting cap from the ground without damaging the item. The wire or blasting cap should then be able to be inserted into a target like that described for the first task. Robotic control for these tasks must be accomplished by either a human operator viewing the scene remotely and controlling the manipulator, an autonomous controller or some combination of the two.

PHASE I: Develop a concept and preliminary design for a manipulator that can accomplish the tasks in the description.

PHASE II: The contractor needs to demonstrate accomplishment of the tasks in the description. The manipulator does not need to be mounted on a robotic platform for the first demonstration. If successful, a demonstration of the manipulator mounted on either a EOD Mk1 Mod 0 (Pack Bot EOD) or Mk2 Mod 0 (Foster-Miller Talon) robot would be required.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology can be utilized by the EOD and by police department bomb squads. This capability could be adapted to other robotic platforms to perform any dexterous task in a hazardous environment.

REFERENCES:
1. Lewis, F.L.; "Robot Manipulator Control: Theory and Practice (Control Engineering 15)"; Marcel Dekker; 2nd Rev (December, 2003); ISBN 0824740726
2. Nguyen, H.G. and J.P. Bott, "Robotics for Law Enforcement: Beyond Explosive Ordnance Disposal" Technical Report 1893, Space and Naval Warfare Systems Center, San Diego, CA, November 2000.
3. Overview of EOD Robotic Efforts: www.jointrobotics.com/Dec05/Tab%20H%20-%20Coppock.pdf
4. EOD Mk1 Mod 0 Information: http://www.irobot.com/sp.cfm?pageid=109
5. EOD Mk2 Mod 0 Information: http://www.foster-miller.com/lemming.htm
6. Blasting Cap Data sheets: http://www.dynonobel.com/dynonobelcom/en/global/productsandservices/northamerica/Technical+Information/technicalinformation/initiationsystems/electricdetonators.htm

KEYWORDS: improvised explosive device; IED; robotic manipulator; dexterous manipulator; EOD; haptics

N06-163 TITLE: Bi-Directional Power Converters

TECHNOLOGY AREAS: Ground/Sea Vehicles, Electronics

ACQUISITION PROGRAM: PEO SHIPS, PMS 500 (ACAT I)

OBJECTIVE: Development and demonstration of a low voltage, low power (~100 kW) prototype bi-directional power conversion module. The use of innovative passive (inductor and capacitor) technologies is encouraged to maximize power conversion power density and efficiency. Successful demonstration of the prototype could transition to the Compact Power Conversion Technologies program and then to a follow on flight of DD(X) and baseline CG(X) platforms.

DESCRIPTION: As stated in the existing vision for the Navy's Power Conversion Module (PCM) is a non-isolated unidirectional AC-DC and DC-DC converter. There are several technical risks and issues (i.e., problems) with this choice for the interconnection of a port or starboard electrical distribution bus with a zone:

a) A single ground fault of an output of any converter in a zone with a simultaneous fault anywhere else in any zone throughout the vessel will fault the entire ship service network. This issues effectively defeats the Integrated Fight Through Power (IFTP) principle. Galvanic isolation prevents ship service power interruptions via ground faults in different zones. Therefore, the ships hull will only become a current path if multiple faults occur on direct-coupled converters in the same string (or zone).

b) Unidirectional power flow does not permit interzone distributed power source (such as fuel cells) access to the entire ship service network when desired. Converter topologies (e.g., buck/boost converter) can easily be used to provide the bidirectional function required for distributed power source architecture (beneficial for dark ship startup or possible low power quiet ops). As a result, emergency power can be used to provide power to vital loads (command, control, communications and computers) functions needed for warfighting missions.

c) Galvanically isolated bidirectional converter topologies are inherently mirror images thus lending themselves to Power Electronic Building Block (PEBB) concepts.

d) Through the use of a high frequency transformer link, any combination of voltages can be achieved. Therefore, this link governs the input and output voltages instead of topology or control strategies. This truly enables the Navy to take advantage of PEBB benefits because the engineering will be done once without the expense of recurring engineering costs. Also, more commercial distribution voltages can be selected for longitudinal buses as well as interzonal buses enabling better use of commercial-off-the-shelf(COTS) equipment. For example, instead of 1000 Vdc for the longitudinal bus and 800 Vdc for the interzonal bus, 700 Vdc could be used for both. This value will allow the use of 1200 V IGBT switches which have lower losses at the higher frequencies and is common for commercial drives.

PHASE I: Using available modeling tools and technology, design a proof of concept bi-directional power conversion module. Using design data, develop a "bread board" notionally 10-20 kW, proof of concept bi-directional power converter and demonstrate successful bi-direction power flow from DC and AC voltage sources. Using the results from the proof of concept demonstration and the design, scaling laws will be developed and used to design a 100 kW bi-directional power conversion module. Additionally, an investigation into high frequency transformer integration with the power conversion module will be made. This will facilitate the output of a variety of voltages and frequencies which would serve to govern input and output voltages instead of the more traditional costly path of topology re-design and risky implementation of alternative control strategies. A final phase I report will be written and delivered documenting the design, fabrication, and testing efforts.

PHASE II: Using results from Phase I, design, fabricate and demonstrate a 100 kW bi-directional power module. The module will be capable of either an AC or DC voltage and current input and output either AC or DC voltage or current. Best engineering practices will be used to maximize power density and power conversion efficiency, but not at the degradation of the bi-directional capability. The module will contain a high frequency transformer section which will optimize input and output voltage and frequency. A final report will be submitted that summarizes the 100 kW design and results of the bi-directional demonstration.

PHASE III: If this technology is proven to meet the requirements specified above at the end of Phase II, it will be transitioned to the Compact Power Conversion Technologies (CPCT). Under the CPCT program, this technology will be demonstrated 1) in simulation on the ONR funded Virtual Test Bed (VTB) and 2) in a full scale medium voltage demonstrator (TBD) together with global power system management capabilities. Successful demonstration could result in a transition to a follow-on flight DD(X) and Baseline CG(X).

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Private Industry has a vested interest in improving availability of power to their processes which produce products to generate profit. Bi-Directional power converters could result in more robust power distribution for private industry; the application of this technology limits faults to the local loads. The Bi-Directional power converter becomes a basic building block that industry can use to step to any voltage (within reason) and begin to use very high frequency magnetics (especially with nanocrystaline cores) with the objective to improve operating efficiency (less heat dissipation), and to an extent, improve power density. Although, power density is not as critical with land based industries as they are with ships with limited volume and footprint. However, availability is of importance to industry. Having the capability of incorporating interruptible power supply (UPS) with the system minimizes the risk of equipment going off line because of a low voltage fault.

REFERENCES:

1. Chang, J, Tom Sum, Anhua Wang "Highly Compact AC-AC Converter Achieving High Voltage Transfer Ratio" IEEE Transactions on Power Electronics (IES), 2 April 2002.
2. Klumpner, Christian and Frede Blaabjberg "Experimental Evaluation of Ride-Through Capabilities for a Matrix Converter under Short Power Interruptions" IEEE Transactions on Power Electronics (IES), 2 April 2002.
3. Simon, O., J. Mahlein, M. Muenzer, M. Bruckmann, "Modern Solutions for Industrial Matrix Converter Applications", IEEE Transactions on Power Electronics (IES), 2 April 2002.

KEYWORDS: Bi-Directional Power Control; Power Conversion Module; Galvanic Isolation; Ride-Through; Power Density; Fault Tolerance

N06-164 TITLE: Coherent Clocking in Digital Arrays

TECHNOLOGY AREAS: Information Systems, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Frequency Antennas & Topside Program Manager, code PMW 180-D4/E2

OBJECTIVE: Establish viable procedures for insuring that clock distribution errors do not contribute to effective clock jitter in digitally beam formed sensor arrays serviced by either single or multiple clocks.

DESCRIPTION: The virtues of active arrays, steered in the digital domain by true time delay, are increasingly accepted. However, there are problematic aspects of clocking, especially in case of element level digitization using distributed clocks. A familiar one is the issue of compensating for differences in data transmission time from the elements to the beam former. The one of interest here is the necessity for the sampling to occur at the same time at every element -- otherwise the errors act as effective clock jitter, degrading the limiting signal to noise ratio of the array. Were a high quality master clock at the full sampling rate Cs distributed to all the elements, the periodic nature of the clock means the maximum error in the sample time would be 1/Cs. But this solution is often viewed as too cumbersome and expensive to implement. Frequently individual Cs rate clocks are placed at every element and slaved to a lower rate master clock Cs'. This keeps them synchronized in the sense of having the same number of samples over intervals of many sample periods, a clear requirement. However, their short term errors -- cycle to cycle fluctuations and drift of average rate -- will still be independent and contribute to the effective aperture jitter. Decimating or otherwise temporally averaging high sample rate data from individual elements and spatially averaging data may decrease this jitter in a statistical sense. An experimentally validated study of the optimal method of clocking a distributed array is desirable.

PHASE I: Define an optimal scheme for clocking a spatially distributed, m element digital array designed to sample signals with 500 MHz information band width. Mathematically investigate the impact of several clocking schemes as a function of the inherent jitter distribution of potential clocks. Determine the differential cost per element of each choice including an estimate of distributing the master clock, if any, and determine what method produces the smallest aperture jitter.

PHASE II: Construct a 2 element demonstrator of this clocking theory and demonstrate the validity of conclusions drawn in phase 1. It is essential that the quantization noise of the ADC triggered by this clocking scheme not be dominated by sampling clock jitter. Aggregate aperture jitter below 100 fs is desired.

PHASE III: Integrate the optimized clocking scheme in a digital beam forming effort.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Active arrays are becoming widely popular as a way of realizing directional antennas. Thus this topic is relevant to the commercial communications world, especially the wireless one.

REFERENCES:
1) http://www.globalsecurity.org/space/systems/sbr-dbf.htm

2) www.mwrf.com/articles/articleID/11069/11069.html

3) www.analog.com/0,2890,3%255F%255F,46659,00.html

4) For small arrays, F. L. Walls, "PM and AM Noise of Combined Signal Sources," Proc. of 2003 Frequency Control Symposium and 17 European Frequency & Time Forum, Tampa, FL, May 4-8, 2003. For widely separated clocks or clock using sites, see S. Francis, B. Ramsey, S. Stein, J. Leitner, M. Moreau, R. Burns, R.A. Nelson, T.R. Bartholomew, and A. Gifford "Timekeeping and time dissemination in a distributed space-based clock ensemble," Proc. 2002 Precise Time & Time Interval Mtg., Reston, VA, pp 201-214, Dec., 2002.

KEYWORDS: digital beam forming, clock jitter, clock synchronization, clock screw, distributed arrays, aperture jitter

N06-165 TITLE: Near-Wall Turbulence and Skin Friction Measurements

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS 450 and DD(X)

OBJECTIVE: Enable measurements of steady and unsteady turbulence in the proximity of walls/surfaces at high Reynolds numbers and provide a self-contained skin-friction measurement gauge capability.

DESCRIPTION: At high Reynolds number conditions (10 to 1000 million), the important turbulent flow quantities (mean and instantaneous velocities) reside within 10s of microns from the wall. No current system can measure quantities with sufficient accuracy to gain an understanding of the flow (e.g., 3D pressure gradient effects, or wall roughness effects, etc) or to measure the wall skin friction. For design, the resistance is a key component in arriving at a viable propulsion system. For example, the friction drag of ships can, at least in principle, be reduced by the use of some form of lubrication at the hull-water interface. Efforts to explore that possibility are hindered by, inter alia, the lack of a means of making direct measurements of friction drag at points on the hull's surface. The objective here is to provide a means to understand the near-wall turbulence and to design a gauge that will remedy this deficiency. A somewhat simplified description of the problem is as follows: Assume a free-stream velocities of 35 ms-1 (with a smooth hull), the water in the layer immediately adjacent to the hull (the viscous sub-layer) is moving at a speed, uy, given, roughly, by uy ~ 1.1y, where y is the distance from the hull measured in microns and uy is in ms-1. The shear force imposed on a smooth hull is about 1000 Pa. A capability is needed that can measure the near-wall flow velocities and the stresses directly on the wall. The shear stress device should be flush with the hull.

PHASE I: Proof of concept demonstration with variations in Reynolds numbers (as high as 1 million) in a water channel/tunnel for a near-wall turbulence measurement system. For the shear-stress device, the contractor is expected to devise an instrument, and to produce a quantitative analytic description of its performance characteristics, that can be implemented in the form of an insert whose outer surface is flush with the hull and is of approximate dimensions 25 mm in length and 12 mm in width. It must be watertight, and able to withstand pressures of as much as 10 atmospheres. There must be no moving parts except for the strain needed to produce a change in the physical property used to effect the sensing. It is expected that the accuracy would be ± 1% or better and that the output would be a digitized sampled data stream.

PHASE II: For near-wall measurements, the contractor will develop and demonstrate the turbulence measurement system at high Reynolds numbers (10 million) on a flat plate in a water tunnel/channel and compare results with analytical theory of turbulence, providing mean and unsteady velocities to within 2-5 microns of the surface. For the shear-stress device, the contractor is expected to construct a prototype and demonstrate its properties in a (small) water tunnel.

PHASE III: For the near-wall measurement system, the contractor will prepare complete system and user-documentation. For the shear-stress device, it is expected that a successful result will be implemented in a large-scale high-speed measurement program aimed at fully characterizing the merits of various techniques of friction drag reduction.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Turbulent and resistance measurement systems are useful to both air and underwater application communities. This system would provide the unique capability for the commercial and military aircraft, submarine, and ship industries.

REFERENCES:
1. Fernholz HH, Janke G, Schober M, Wagner PM, Warnack D. New developments and applications of skin-friction measuring techniques. Meas Sci Technology 1996;7:1396-1409.

2. Hess DE, Fu TC, Feldman JP. Naval maneuvering research and the need for shear stress measurements. 24th AIAA Aerodynamic Measurement 3. Technology and Ground Testing Conference, 28 Jun-1 July 2004. AIAA 2004-2605.

4. Lauterborn W, Vogel A. Modern optical techniques in fluid mechanics. Ann Rev Fluid Mech 1984;16:223-244.

5. Miles RB, Lempert WR. Quantitative flow visualization in unseeded flows. Ann Rev Fluid Mech 1997;29:285-326.

KEYWORDS: turbulence; hydromechanics; underwater measurements; diagnostics; drag reduction; wall roughness; shear stress