ARMY
12.2 Small Business Innovation Research (SBIR)
Proposal Submission Instructions

INTRODUCTION

The US Army Research, Development, and Engineering Command (RDECOM) is responsible for execution of the Army SBIR Program. Information on the Army SBIR Program can be found at the following Web site: https://www.armysbir.army.mil.

Solicitation, topic, and general questions regarding the SBIR Program should be addressed according to the DoD Program Solicitation. For technical questions about the topic during the pre-release period, contact the Topic Authors listed for each topic in the Solicitation. To obtain answers to technical questions during the formal Solicitation period, visit http://www.dodsbir.net/sitis. Specific questions pertaining to the Army SBIR Program should be submitted to:

John Smith
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army.sbir@us.army.mil
US Army Research, Development and Engineering Command (RDECOM)

ATTN: AMSRD-PEB
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Aberdeen Proving Ground, MD 21005-5201
TEL: (703) 399-2049
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The Army participates in three DoD SBIR Solicitations each year. Proposals not conforming to the terms of this Solicitation will not be considered. Only Government personnel will evaluate proposals.

Please note, due to recent changes in SBIR policy, Phase II efforts following a Phase I award resulting from the 11.1 and subsequent Solicitations will have a maximum dollar amount of $1,000,000. Phase II efforts following a Phase I award prior to the 11.1 Solicitation will continue to have a maximum dollar amount of $730,000.

PHASE I PROPOSAL SUBMISSION

Army Phase I Proposals have a 20-page limit including the Proposal Cover Sheets (pages 1 and 2 are added electronically by the DoD submission site---Offerors are instructed to NOT leave blank pages or duplicate the electronically generated cover pages THIS WILL COUNT AGAINST THE 20 PAGE LIMIT), as well as the Technical Proposal (beginning on page 3, and including, but not limited to: table of contents, pages intentionally left blank, references, letters of support, appendices, technical portions of subcontract documents [e.g., statements of work and resumes] and all attachments). Therefore, a Technical Proposal of up to 18 pages in length counts towards the overall 20-page limit. ONLY the Cost Proposal and Company Commercialization Report (CCR) are excluded from the 20-page limit. As instructed in Section 3.5. d of the DoD Program Solicitation, the CCR is generated by the submission website, based on information provided by you through the "Company Commercialization Report" tool. Army Phase I proposals submitted over 20-pages will be deemed NON-COMPLIANT and will not be evaluated. This statement takes precedence over Section 3.4 of the DoD Program Solicitation. Since proposals are required to be submitted in Portable Document Format (PDF), it is the responsibility of those submitting the proposal to ensure any PDF conversion is accurate and does not cause the proposal to exceed the 20-page limit.

Phase I proposals must describe the "vision" or "end-state" of the research and the most likely strategy or path for transition of the SBIR project from research to an operational capability that satisfies one or more Army operational or technical requirements in a new or existing system, larger research program, or as a stand-alone product or service.

Phase I proposals will be reviewed for overall merit based upon the criteria in Section 4.2 of the DoD Program Solicitation.

PHASE I OPTION MUST BE INCLUDED AS PART OF PHASE I PROPOSAL

The Army implements the use of a Phase I Option that may be exercised to fund interim Phase I activities while a Phase II contract is being negotiated. Only Phase I efforts selected for Phase II awards through the Army's competitive process will be eligible to have the Phase I Option exercised. The Phase I Option, which **must** be included as part of the Phase I proposal, should cover activities over a period of up to four months and describe appropriate initial Phase II activities that may lead to the successful demonstration of a product or technology. The Phase I Option must be included within the 20-page limit for the Phase I proposal.

COST PROPOSALS

A firm fixed price or cost plus fixed fee Phase I Cost Proposal ($150,000 maximum) must be submitted in detail online. Proposers that participate in this solicitation must complete Phase I Cost Proposal not to exceed a maximum dollar amount of $100,000 and six months. A Phase I Option Cost Proposal not to exceed a maximum dollar amount of $50,000 and four months. The Phase I and Phase I Option costs must be shown separately but may be presented side-by-side in a single Cost Proposal. The Cost Proposal DOES NOT count toward the 20-page Phase I proposal limitation. When submitting the Cost Proposal, the Army prefers the small businesses complete the Cost Proposal form on the DoD Submission site, versus submitting within the body of the uploaded proposal.

Phase I Key Dates	
Phase I Evaluations	July - August 2012
Phase I Selections	August 2012
Phase I Awards	October 2012*

**Subject to the Congressional Budget process*

PHASE II PROPOSAL SUBMISSION

Army Phase II Proposals have a 40-page limit including the Proposal Cover Sheets (pages 1 and 2 are added electronically by the DoD submission site---Offerors are instructed to NOT leave blank pages or duplicate the electronically generated cover pages THIS WILL COUNT AGAINST THE 40 PAGE LIMIT), as well as the Technical Proposal (beginning on page 3, and including, but not limited to: table of contents, pages intentionally left blank, references, letters of support, appendices, technical portions of subcontract documents [e.g., statements of work and resumes] and all attachments). Therefore, a Technical Proposal of up to 38 pages in length counts towards the overall 40-page limit. ONLY the Cost Proposal and Company Commercialization Report (CCR) are excluded from the 40-page limit. As instructed in Section 3.5. d of the DoD Program Solicitation, the CCR is generated by the submission website based on information provided by you through the "Company Commercialization Report" tool. Army Phase II proposals submitted over 40-pages will be deemed NON-COMPLIANT and will not be evaluated. Since proposals are required to be submitted in Portable Document Format (PDF), it is the responsibility of those submitting the proposal to ensure any PDF conversion is accurate and does not cause the proposal to exceed the 40-page limit.

Note: Phase II proposal submission is by Army invitation only.
Generally, invitations to submit Phase II proposals will not be requested before the fifth month of the Phase I effort. The decision to invite a Phase II proposal will be made based upon the success of the Phase I contract to meet the technical goals of the topic, as well as the overall merit based upon the criteria in Section 4.3 of the DoD Program Solicitation. DoD is not obligated to make any awards under Phase I, II, or III. For specifics regarding the evaluation and award of Phase I or II contracts, please read the DoD Program Solicitation very carefully. Phase II proposals will be reviewed for overall merit based upon the criteria in Section 4.3 of the solicitation.

Invited small businesses are required to develop and submit a technology transition and commercialization plan describing feasible approaches for transitioning and/or commercializing the developed technology in their Phase II proposal. Army Phase II cost proposals must contain a budget for the entire 24 month Phase II period not to exceed the maximum dollar amount of $1,000,000. During contract negotiation, the contracting officer may require a cost proposal for a base year and an option year. These costs must be submitted using the Cost Proposal format (accessible electronically on the DoD submission site), and may be presented side-by-side on a single Cost Proposal Sheet. The total proposed amount should be indicated on the Proposal Cover Sheet as the Proposed Cost. Phase II projects will be evaluated after the base year prior to extending funding for the option year.

BIO HAZARD MATERIAL AND RESEARCH INVOLVING ANIMAL OR HUMAN SUBJECTS

Any proposal involving the use of Bio Hazard Materials must identify in the Technical Proposal whether the contractor has been certified by the Government to perform Bio Level - I, II or III work.

Companies should plan carefully for research involving animal or human subjects, or requiring access to government resources of any kind. Animal or human research must be based on formal protocols that are reviewed and approved both locally and through the Army's committee process. Resources such as equipment, reagents, samples, data, facilities, troops or recruits, and so forth, must all be arranged carefully. The few months available for a Phase I effort may preclude plans including these elements, unless coordinated before a contract is awarded.

FOREIGN NATIONALS

If the offeror proposes to use a foreign national(s) [any person who is NOT a citizen or national of the United States, a lawful permanent resident, or a protected individual as defined by 8 U.S.C. 1324b (a) (3) – refer to Section 2.3 of this solicitation for definitions of “lawful permanent resident” and “protected individual”] as key personnel, they must be clearly identified. **For foreign nationals, you must provide technical resumes, country of origin, and an explanation of the individual’s involvement. Please ensure no Privacy Act information is included in this submittal.**

OZONE CHEMICALS

Class 1 Ozone Depleting Chemicals/Ozone Depleting Substances are prohibited and will not be allowed for use in this procurement without prior Government approval.

SBIR FAST TRACK

Small businesses participating in the Fast Track program do not require an invitation. Small businesses must submit (1) the Fast Track application within 150 days after the effective date of the SBIR Phase I contract and (2) the Phase II proposal within 180 days after the effective date of its Phase I contract. See Section 4.5 in the DoD Program Solicitation for additional information.

CONTRACTOR MANPOWER REPORTING APPLICATION (CMRA)

The Contractor Manpower Reporting Application (CMRA) is a Department of Defense Business Initiative Council (BIC) sponsored program to obtain better visibility of the contractor service workforce. This reporting requirement applies to all Army SBIR contracts.

Offerors are instructed to include an estimate for the cost of complying with CMRA as part of the cost proposal for Phase I ($100,000 maximum), Phase I Option ($50,000 maximum), and Phase II ($1,000,000 maximum), under "CMRA Compliance" in Other Direct Costs. This is an estimated total cost (if any) that would be incurred to comply with the CMRA requirement. Only proposals that receive an award will be required to deliver CMRA reporting, i.e. if the proposal is selected and an award is made, the contract will include a deliverable for CMRA.

To date, there has been a wide range of estimated costs for CMRA. While most final negotiated costs have been minimal, there appears to be some higher cost estimates that can often be attributed to misunderstanding the requirement. The SBIR Program desires for the Government to pay a fair and reasonable price. This technical analysis is intended to help determine this fair and reasonable price for CMRA as it applies to SBIR contracts.

- The Office of the Assistant Secretary of the Army (Manpower & Reserve Affairs) operates and maintains the secure CMRA System. The CMRA Web site is located here: https://cmra.army.mil/.

- The CMRA requirement consists of the following items, which are located within the contract document, the contractor's existing cost accounting system (i.e. estimated direct labor hours, estimated direct labor dollars), or obtained from the contracting officer representative:

  (1) Contract number, including task and delivery order number;
  (2) Contractor name, address, phone number, e-mail address, identity of contractor employee entering data;
  (3) Estimated direct labor hours (including sub-contractors);
  (4) Estimated direct labor dollars paid this reporting period (including sub-contractors);
  (5) Predominant Federal Service Code (FSC) reflecting services provided by contractor (and separate predominant FSC for each sub-contractor if different);
  (6) Organizational title associated with the Unit Identification Code (UIC) for the Army Requiring Activity (The Army Requiring Activity is responsible for providing the contractor with its UIC for the purposes of reporting this information);
  (7) Locations where contractor and sub-contractors perform the work (specified by zip code in the United States and nearest city, country, when in an overseas location, using standardized nomenclature provided on Web site);

- The reporting period will be the period of performance not to exceed 12 months ending September 30 of each government fiscal year and must be reported by 31 October of each calendar year.

- According to the required CMRA contract language, the contractor may use a direct XML data transfer to the Contractor Manpower Reporting System database server or fill in the fields on the Government Web site. The CMRA Web site also has a no-cost CMRA XML Converter Tool.

Given the small size of our SBIR contracts and companies, it is our opinion that the modification of contractor payroll systems for automatic XML data transfer is not in the best interest of the Government. CMRA is an annual reporting requirement that can be achieved through multiple means to include manual entry, MS Excel spreadsheet development, or use of the free Government XML converter tool. The annual reporting should take less than a few hours annually by an administrative level employee.

Depending on labor rates, we would expect the total annual cost for SBIR companies to not exceed $500.00 annually, or to be included in overhead rates.

DISCRETIONARY TECHNICAL ASSISTANCE

In accordance with section 9(q) of the Small Business Act (15 U.S.C. 638(q)), the Army will provide technical assistance services to small businesses engaged in SBIR projects through a network of scientists and engineers engaged in a wide range of technologies. The objective of this effort is to increase Army SBIR technology transition and commercialization success thereby accelerating the fielding of capabilities to Soldiers and to benefit the nation through stimulated technological innovation, improved manufacturing capability, and increased competition, productivity, and economic growth.

The Army has stationed six Technical Assistance Advocates (TAAs) across the Army to provide technical assistance to small businesses that have Phase I and Phase II projects with the participating organizations within their regions.

For more information go to: https://www.armysbir.army.mil/sbir/TechnicalAssistance.aspx.

COMMERCIALIZATION PILOT PROGRAM (CPP)

The objective of the CPP effort is to increase Army SBIR technology transition and commercialization success and accelerate the fielding of capabilities to Soldiers. The CPP: 1) assesses and identifies SBIR projects and companies with high transition potential that meet high priority requirements; 2) matches SBIR companies to customers and facilitates collaboration; 3) facilitates detailed technology transition plans and agreements; 4) makes recommendations for additional funding for select SBIR projects that meet the criteria identified above; and 5) tracks metrics and measures results for the SBIR projects within the CPP.

Based on its assessment of the SBIR project's potential for transition as described above, the Army utilizes a CPP investment fund of SBIR dollars targeted to enhance ongoing Phase II activities with expanded research, development, test and evaluation to accelerate transition and commercialization. The CPP investment fund must be expended according to all applicable SBIR policy on existing Phase II contracts. The size and timing of these enhancements is dictated by the specific research requirements, availability of matching funds, proposed transition strategies, and individual contracting arrangements.

NON-PROPRIETARY SUMMARY REPORTS

All award winners must submit a non-proprietary summary report at the end of their Phase I project and any subsequent Phase II project. The summary report is unclassified, non-sensitive and non-proprietary and should include:

- A summation of Phase I results
- A description of the technology being developed
- The anticipated DoD and/or non-DoD customer
- The plan to transition the SBIR developed technology to the customer
- The anticipated applications/benefits for government and/or private sector use
- An image depicting the developed technology

The non-proprietary summary report should not exceed 700 words, and is intended for public viewing on the Army SBIR/STTR Small Business area. This summary report is in addition to the required final technical report and should require minimal work because most of this information is required in the final technical report. The summary report shall be submitted in accordance with the format and instructions

posted within the Army SBIR Small Business Portal at https://portal.armysbir.army.mil/SmallBusinessPortal/Default.aspx and is due within 30 days of the contract end date.

ARMY SUBMISSION OF FINAL TECHNICAL REPORTS

A final technical report is required for each project. Per DFARS clause 252.235-7011 (http://www.acq.osd.mil/dpap/dars/dfars/html/current/252235.htm#252.235-7011), each contractor shall (a) submit two copies of the approved scientific or technical report delivered under the contract to the Defense Technical Information Center, Attn: DTIC-O, 8725 John J. Kingman Road, Fort Belvoir, VA 22060-6218; (b) Include a completed Standard Form 298, Report Documentation Page, with each copy of the report; and (c) For submission of reports in other than paper copy, contact the Defense Technical Information Center or follow the instructions at http://www.dtic.mil.

ARMY SBIR PROGRAM COORDINATORS (PC) and Army SBIR 12.2 Topic Index

Participating Organizations		PC	Phone
Aviation Missile RD&E Center (AMRDEC A)		**Linda Taylor**	**(256) 876-2883**
A12-075	Numerical Model of Variable Surface Roughnesses for Parasite Drag Estimation		
A12-076	Advanced Seal Technology for Helicopter Drive System Application		
A12-077	"Smart-Feed" Selective Ammunition Feed System for Machine Guns and Auto Cannons		
A12-078	Low Cost Cockpit head tracking and gestural recognition		
A12-079	ASP Motion Base for Stabilized Mounts		
A12-080	Lightweight, High Effectiveness, Low-Cost Recuperators for Small Turbine Engines in Army Unmanned Aerial Systems		
Aviation Missile RD&E Center (AMRDEC M)		**Otho Thomas** **Dawn Gratz**	**(256) 842-9227** **(256) 842-8769**
A12-081	Analysis Tools for Composite Laminate Material Properties Prediction		
A12-082	Advanced Nonintrusive Dispense Tracking Diagnostics for Aerospace Delivery Vehicles		
A12-083	Residual Property Prediction for Damage Composite Structures		
A12-084	Innovative Semi-Active Laser (SAL) Signal Processing Techniques in Noisy Environments		
A12-085	Rapid Scene Creation for Multispectral Terrain Signature Models and Simulations		
A12-086	Flexible, Compact Acoustic Transducer Arrays		
Army Test & Evaluation Command (ATEC)		**Nancy Weinbrenner**	**(443) 306-9346**
A12-087	Sensitive and Diagnostic Mental Workload Classifier		
A12-088	Alternative Source for Neutron Generation		
Engineer Research & Development Ctr (ERDC)		**Theresa Salls**	**(603) 646-4591**
A12-089	Free-Space Optical Communications: Light Detection and Ranging Enhanced Data Delivery		
A12-090	Processes or Materials for Vertebrate Cell Storage and Maintenance		
A12-091	Field-portable Quantitative Test for Chlorinated Organic Compounds in Water		
A12-092	Environment and Conflict: Developing a Framework for Vulnerability Assessment.		
A12-093	System for Application of Biopolymer for Revegetation of Soil		
A12-094	Downscaling Techniques for Ground State Information		

<u>Natick Soldier RD&E Center</u>		**Arnie Boucher**	**(508) 233-5431**
		Cathy Polito	**(508) 233-5372**
A12-095	Improved Solar Shade (ISS) with Enhanced Durability and Performance		
A12-096	Anthropometric Casualty Estimation Methodologies		
A12-097	Non-invasive Detection System for Assessment of Oxidative Status		
<u>PEO Aviation</u>		**Dave Weller**	**(256) 313-4975**
A12-098	Multi-functional Integrated Drive System Sensor (MIDSS) for Rotorcraft		
A12-099	Air-to-Air Targeting Algorithms for Turreted Gun Systems		
<u>PEO Command, Control and Communications Tactical (C3T)</u>		**Angel Pomales-Crespo**	**(443) 395-8375**
A12-100	3 kW Lightweight Efficient Generator		
<u>PEO Missiles and Space</u>		**George Buruss**	**(256) 313-3523**
		Myron Chenault	**(256) 876-5527**
A12-101	Nonlethal Warhead for Miniature Organic Precision Munitions		
<u>PEO Soldier</u>		**Todd Wendt**	**(703) 704-2856**
A12-102	Cordless Battery Charging		
A12-103	Downrange Crosswind Sensor for Small Arms Fire Control		

DEPARTMENT OF THE ARMY PROPOSAL CHECKLIST

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

____ 1. The proposal addresses a Phase I effort (up to **$100,000** with up to a six-month duration) AND (if applicable) an optional effort (up to **$50,000** for an up to four-month period to provide interim Phase II funding).

____ 2. The proposal is limited to only **ONE** Army Solicitation topic.

____ 3. The technical content of the proposal, including the Option, includes the items identified in Section 3.5 of the Solicitation.

____ 4. **Army Phase I Proposals have a 20-page limit including the Proposal Cover Sheets (pages 1 and 2 are added electronically by the DoD submission---Offerors are instructed to NOT leave blank pages or duplicate the electronically generated cover pages THIS WILL COUNT AGAINST THE 20-PAGE LIMIT), as well as the Technical Proposal (beginning on page 3 and including, but not limited to: table of contents, pages intentionally left blank, references, letters of support, appendices, technical portions of subcontract documents [e.g., statements of work and resumes] and all attachments). Therefore, the Technical Proposal up to 18 pages in length counts towards the overall 20-page limit. ONLY the Cost Proposal and Company Commercialization Report (CCR) are excluded from the 20-pages. As instructed in Section 3.5, d of the DoD Program Solicitation, the CCR is generated by the submission website based on information provided by you through the "Company Commercialization Report" tool. Army Phase I Proposals submitted over 20-pages will be deemed NON-COMPLIANT and will not be evaluated. This statement takes precedence over Section 3.4 of the DoD Program Solicitation. Since proposals are required to be submitted in Portable Document Format (PDF), it is the responsibility of those submitting the proposal to ensure any PDF conversion is accurate and does not cause the proposal to exceed the 20-page limit.**

____ 5. The Cost Proposal has been completed and submitted for both **the Phase I and Phase I Option** and the costs are shown separately. The Army prefers that small businesses complete the Cost Proposal form on the DoD Submission site, versus submitting within the body of the uploaded proposal. The total cost should match the amount on the cover pages.

____ 6. Requirement for Army Accounting for Contract Services, otherwise known as CMRA reporting is included in the Cost Proposal (offerors are instructed to include an estimate for the cost of complying with CMRA).

____ 7. If applicable, the Bio Hazard Material level has been identified in the technical proposal.

____ 8. If applicable, plan for research involving animal or human subjects, or requiring access to government resources of any kind.

____ 9. The Phase I Proposal describes the "vision" or "end-state" of the research and the most likely strategy or path for transition of the SBIR project from research to an operational capability that satisfies one or more Army operational or technical requirements in a new or existing system, larger research program, or as a stand-alone product or service.

____ 10. If applicable, Foreign Nationals are identified in the proposal. An employee must have an H-1B Visa to work on a DoD contract.

Army SBIR 12.2 Topic Index

A12-075 TITLE: Numerical Model of Variable Surface Roughnesses for Parasite Drag Estimation

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: PEO Aviation

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: To develop a numerical model for variable surface roughness distributions that can be implemented into computational fluid dynamics simulations for the estimation of the parasite drag of an aircraft.

DESCRIPTION: Surface roughness can be a significant contributor to the drag of an immersed body such as an aircraft [1]. Current Army aircraft can employ a number of materials, paints and protective coatings over the wetted surfaces of the vehicle that can have significantly different surface compositions and textures. Exposure to harsh environments and sunlight can cause oxidation of paints and protective coatings and corrosion of metals which roughen the exposed surfaces. In addition, the effects of roughening and scouring due to rain and sand abrasion can alter the roughness characteristics of leading edge surfaces. The resulting differences in roughness height result in changes in parasite drag [1], which ultimately affects the performance and operational capability of the aircraft through engine power required for flight.

Current computational fluid dynamics (CFD) methodologies are not able to geometrically simulate surface roughness with respect to the time and computational resources typically available for engineering drag estimation of complex shapes. Rather, the fluid dynamic effects of surface roughness are approximated through turbulence models [2,3], transition models [4], or wall functions [5,6]. These roughness models typically assume a single characteristic surface roughness applies over the entire body [7]. This assumption can result in an over- or under-prediction of the aircraft’s true aerodynamic drag, depending on the cumulative relative differences between the assumed roughness and the actual distributed roughnesses.

The objective of this topic is to advance the state-of-the-art CFD in aerodynamic drag estimation due to parasite drag contributions from variable surface roughnesses, such as glasses, bare metals, protective coatings and paints. The desired ultimate end-product will be a numerical model that can be implemented into CFD software to estimate the parasite drag for an Army aircraft for flight within its design envelope. Equivalent sand-grain size roughness for the applicable surfaces would range from 0 to 200 microns. The ideal numerical model would cover a range in Mach number from the subsonic to the transonic regime, and would be applicable for a range in Reynolds number up to the tens of millions (O(10^7)). In the ideal implementation, the model would interact with a CFD solver through a boundary condition interface rather than requiring highly refined computational meshes that approximate the rough surfaces. This boundary condition interface could involve such physical characteristics as equivalent sand-grain sizes and concentrations.

PHASE I: Identify innovative methods for modeling variable surface roughness distributions in computational fluid dynamics simulations utilizing current engineering-practice CFD meshes. Provide preliminary verification and validation approaches to support the activity. Identify the experimental data sets that will be used for validation.

PHASE II: Develop and implement software modules implementing the new roughness model consistent with a component or system level flow simulation tool. Demonstrate the level of accuracy improvements in aerodynamic drag estimation and additional simulation cost in applying the model. Incorporate the model into current state-of-the-art CFD simulation tools useful for complete air vehicle aerodynamic drag estimation.

Phase II deliverables may be subject to International Traffic in Arms Regulation (ITAR) control for the algorithmic implementation of the numerical model, dependent upon any previously existing distribution limitations for the CFD software into which the numerical model is integrated.

PHASE III: If successful, the end product will be a numerical model for variable surface roughness distributions that can accurately estimate parasite drag for purposes of engineering analysis. For both military and civilian applications, this numerical model will be applicable for implementation into production-level CFD codes for estimating the total drag of a complete aircraft, as well as the constituent components of the aircraft. The accuracy of the aircraft drag estimates will be such that the results from the CFD simulations can be used as the basis for total aircraft aerodynamic performance estimation, estimation of engine power required, and to provide aerodynamic force and moment inputs to other engineering disciplinary tools such as computational structural mechanics and dynamics analysis software packages.

In addition, military application of the model will allow evaluation of aircraft performance degradation due to deployment in regions of the world with high probabilities of surface roughening due to sand, rain and other environmental factors. The model will then allow for trade-off studies on the effect of different protective coatings versus operational capability impacts from aerodynamic drag.

REFERENCES:

1. Hoerner, S.F., Fluid-Dynamic Drag, Hoerner Fluid Dynamics, Bakersfield, CA, 1992.

2. Spalart, P.R., “Trends in Turbulence Treatments,” AIAA 2000-2306, American Institute of Aeronautics and Astronautics, Jun. 2000.

3. Aupoix, B., and Spalart, P.R., “Extensions of the Spalart-Allmaras turbulence model to account for wall roughness,” International Journal of Heat and Fluid Flow, vol. 24, pp. 454-462, 2003.

4. Standish, K., Rimmington, P., Laursen, J., and Paulsen, H.N., “Computational Predictions of Airfoil Roughness Sensitivity,” AIAA 2010-460, American Institute of Aeronautics and Astronautics, Jan 2010.

5. Suga, K., Craft, T.J., and Iacovides, H., “An analytical wall-function for turbulent flows and heat transfer over rough walls,” International Journal of Heat and Fluid Flow, vol. 27, pp. 852-866, 2006.

6. Apsley, D., “CFD Calculation of Turbulent Flow with Arbitrary Wall Roughness,” Flow, Turbulence and Combustion, vol. 78, pp. 153-175, 2007.

7. Bons, J.P., and Christensen, K.T., “A Comparison of Real and Simulated Surface Roughness Characterizations,” AIAA 2007-3997, American Institute of Aeronautics and Astronautics, Jun 2007.

8. Meakin, R., Atwood, C., and Hariharan, N., "Development, Deployment, and Support of a Set of Multi-Disciplinary, Physics-Based Simulation Software Products," AIAA 2011-1104, American Institute of Aeronautics and Astronautics, Jan. 2011.

9. Venkateswaran, S., Wissink, A., Datta, A., et al., "Overview of the Helios Version 2.0 Computational Platform for Rotorcraft Simulations," AIAA 2011-1105, American Institute of Aeronautics and Astronautics, Jan. 2011.

10. Morton, S., McDaniel, D., Sears, D., et al., "Kestrel: A Fixed Wing Virtual Aircraft Product of the CREATE Program," AIAA 2009-338, American Institute of Aeronautics and Astronautics, Jan. 2009.

KEYWORDS: Fluid mechanics; aerodynamics; computational fluid dynamics; parasite drag; surface roughness; skin friction; boundary layer; turbulence modeling

A12-076 TITLE: Advanced Seal Technology for Helicopter Drive System Application

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: PEO Aviation

OBJECTIVE: Develop and demonstrate advanced high speed seals for helicopter drive system application. The objective is to develop low cost, low friction, high speed seals as an alternative to existing seal technology.

DESCRIPTION: There is currently a need in the Army for advanced seals in helicopter gearboxes. These seals are used to keep fluids from escaping the gearbox. The helicopter industry has typically used carbon face seals for high speed (surface speed) applications. These carbon face seals require cooling and a lubricant supply. They also have a low tolerance for misalignment and a low tolerance to debris on the sealing surface (i.e. grit on the face). Large diameter magnetic face seals are also used in the industry, and have problems with being very temperamental and causing significant leaks. Elastomeric lip seals are also used, but are limited in high speed applications, create sleeve wear, and generate heat.

Experience has shown that seal failure is one of the leading drivers for gearbox removals. These failures impact not only costs, but also availability of aircraft. In order to reduce the occurrence of seal failures and improve aircraft reliability, an improved seal is needed. This topic seeks an innovative solution or a new approach in design in order to improve gearbox seals beyond the state of the art. The technology should be designed to be affordable, scalable and capable of application across multiple Army helicopter platforms. Minimal impact on the existing gearbox hardware is desired.

The development, demonstration, and validation of a gearbox seal is required for this topic. The specific seal locations targeted for this topic are the: main gearbox shaft seals, nose gearbox shaft seals, intermediate gearbox shaft seals, and tail gearbox shaft seals. The proposed improved seal does not have to be developed for implementation in all locations, but the proposal must state the specific location targeted for development. Due to high shaft speeds, the proposed seal should be capable of speeds between 5,000 to 13,000 RPMS. Shaft diameters vary, and the seal design should be scalable between 2 to 5 inches. Due to the high temperature environment, the proposed seal design should be capable of temperatures up to 500 degrees Fahrenheit. Performance parameters can be established through models and/or experiments that would lead to the construction and demonstration of a seal to validate these parameters.

PHASE I: During Phase I, the contractor shall design an improved gearbox seal for the proposed location. Specific metrics of this design are that it must be capable of speeds between 5,000 to 13,000 RPMS, be scalable between 2 to 5 inches, and be capable of withstanding temperatures of 500 degrees Fahrenheit. At the end of Phase I, the contractor shall demonstrate the feasibility of the proposed concept. This feasibility demonstration can be done through the use of modeling and simulation, or a prototype test. Experimental data (from testing) of materials and/or components should be provided to demonstrate that the proposed concept meets the metrics.

PHASE II: The contractor shall further develop the prototype seal based on the Phase I effort for implementation on a relevant hardware platform. Offerors are encouraged to work with an Army helicopter OEM to tailor their design towards a specific application, and improve the chance for transition. The capabilities of the advanced seal will be validated by conducting additional bench or rig testing. This testing may be on a rig of the offerors choosing, but access to a Government test rig will not be provided.

PHASE III: This technology could be integrated in a broad range of military/civilian aircraft where high speed seals are used. The potential exists to integrate and transition this system into existing and future Army gearboxes, such as those for the Apache, Chinook, Black Hawk, and Kiowa Warrior. This technology should also be applicable to ground platform PTOs and pumps.

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(2) ADS-50-PRF: Rotorcraft Propulsion, Performance Qualification Requirements and Guidelines, New weblink from TPOC 5/30/12: http://www.redstone.army.mil/amrdec/rdmr-se/tdmd/Documents/ADS50R5.pdf

(3) AMCP 706-20: Helicopter Engineering Part Two Detail Design (http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA033216&Location=U2&doc=GetTRDoc.pdf)

(4) USAAVRADCOM-TR-80-D-19: Advanced Transmission Components Investigation Program. Bearing and Seal Development (http://www.dtic.mil/docs/citations/ADA090675)

KEYWORDS: Drive System, Seal, transmission, gearbox, reliability

A12-077 TITLE: "Smart-Feed" Selective Ammunition Feed System for Machine Guns and Auto Cannons

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PEO Aviation

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 compact, lightweight, high-rate ammunition feed system that will enable an airborne machine gunner to select a specific type of round for a particular shot. This will allow efficient use of rapidly evolving , force multiplying ‘smart rounds’ including precision guided munitions, as well as current ammunition. Benefits include improved lethality, reduced collateral damage, improved vehicle performance due to reduced ammunition carriage, efficient use of expensive smart rounds, and potential for application across many vehicle and high-rate-of-fire weapon types.

DESCRIPTION: Modern sorting systems take advantage of non-contact sensors, advanced computer algorithms, and precision actuation systems to sort heterogeneous items quickly and accurately. Mail, packages, luggage, farm produce, and manufactured components are commonly sorted in a highly efficient manner using such systems (reference 1).

Microelectromechanical (MEMs) technologies and high speed digital communications are enabling the development of ‘smart’ rounds for small caliber (12.7 – 30 mm) weapons (references 2a – 2e). These smart rounds and specialized rounds are force multipliers but are expensive compared to typical rounds (references 2b, 3) and must be used judiciously.

Military vehicles, as well as stationary ground emplacements, use machine guns and autocannons as offensive and defensive weapons. Current gun systems typically feed rounds from magazines or ammunition belts which are loaded with predetermined mixes of various munitions, e.g. ball, high explosive incendiary (HEI), tracer, etc. These mixes are always a compromise and may not be optimum for a particular engagement. Introducing additional / custom mixes becomes a logistical burden. Some guns use dual feed mechanisms (M242 Bushmaster) to enable more flexibility in selecting rounds, but that approach is clearly limited in growth capability.

If shooters are to use smart rounds in an effective and affordable manner, weapon systems must have the ability to load a specified round at a particular time. Certain large caliber, low rate-of-fire weapon systems have developed robust selective feed systems (reference 4), but no such systems exists for the small caliber weapons commonly used on aircraft, boats, and light vehicles. Previous efforts to address this issue have had limited success, achieving operationally representative 325 rounds/minute loading rates but suffering from heavy, immature mechanisms prone to jamming (reference 5).

A successful Smart-Feed system has application across a broad spectrum of weapon systems and portable sorting systems. High-rate-of-fire weapons ranging from 12.7mm machine guns, to 20/25/30mm auto cannons, to 40mm grenade launchers are likely candidates based on currently active smart round development programs (references 2a – 2e). Such weapons are widely used on ground vehicles, helicopters, boats, and in ground emplacements by militaries and civil authorities around the world. A smart feed system would also enable the use of a turreted gun to deploy programmable countermeasure flares in any pattern desired rather than being restricted to finite sectors as is done today. Smart-Feed technology would enable high-speed, portable sorting / dispensing systems for commercial applications such as; in medical research labs where space is limited and hundreds of identically shaped but uniquely labeled specimen vials must be meticulously manipulated, or in mobile / emergency distribution sites where filling of customized supply orders or routing of packages could be done at high-speed from varied stocks of standard sized item containers.

The present Topic will concentrate on the development, integration, and demonstration of a selective ammunition feed system (Smart-Feed) for machine guns and auto cannons such as those commonly used on Army helicopters. Key capabilities of the system will include; near real-time inventorying of rounds, reliable and accurate mechanization of ammunition selection and feeding, lightweight and compact configuration, speed of operation in continuous and burst modes, and safety of operation. The fully provisioned Smart-Feed system shall impose no penalties for space, weight, and power when compared to current ammunition storage / feed systems.

PHASE I: Demonstrate feasibility of system. The awardee shall; create a conceptual design based on the AH-64D Apache helicopter, use modeling and simulation to assess the key capabilities summarized below, compare and contrast the resulting design to the existing AH-64D ammunition system (reference 6). Early coordination with AH-64D manufacturer is encouraged. Efforts result in Technology Readiness Level (TRL) 2 system.

KEY CAPABILITY.................AH-64D CURRENT..................SBIR GOAL
Firing Rate.............................600 rounds / min.......................300 rounds / minute
Capacity of Magazine...............1200 rounds @ 0.77 lb ea ....400 rounds @ 0.77 lb ea
Size (magazine only)................42"D x 36"W x 18"D.................no larger
System Weight*.......................1165 lbs..................................775 lbs (66% of current)
Power....................................3 HP hydraulic+electric prime.....no higher
Reliability...............................10,000 MRBF**........................no less
Selection Accuracy...................Not applicable...........................95%

*includes full ammo load, magazine, feed chuting, transfer drive unit. Items 3a through 3c, 4 on reference 6.
**MRBF = mean rounds between failure

Smart-Feed will use the existing feed chute interfaces on the M230 chain gun (reference 7). The Government will provide technical drawings as required. A particular challenge is how to deliver the selected round(s) from the magazine to the feeder at the gun turret. Specification of the desired type of round, corresponding fusing parameters, and rate of fire will be done by a system other than the Smart-Feed system. Interaction with the 'smarts' of each round (i.e. setting fusing, arming, initializing parameters) will be done by a system other than the Smart-Feed system and need not be demonstrated. Communications between the aircrafts fire control system and Smart-Feed need not be addressed under the Phase 1 or Phase 2 efforts. Rounds are randomly loaded into the ammunition carriage container.

PHASE II: Demonstrate proof of concept. The awardee shall; design and build a Smart-Feed system for the AH-64D chain gun, demonstrate key capabilities in a benchtop environment, employ M848 dummy rounds for all demonstrations. Other types of M230 ammunition shall be simulated by repainting dummy rounds with appropriate color code bands. Efforts result in a TRL 4 system.

PHASE III: The Smart-Feed technology will be validated in a ground-based live-fire demonstration, thereby resulting in a TRL 6 system ready for subsequent integration onto specific military boats, ground vehicles, and helicopters.

The awardee shall design and build a Smart-Feed system compatible with the mechanical, electrical, hydraulic, and digital communications interfaces of the AH-64D helicopter. The system shall be live-fire tested on the ground using a Government furnished test stand or aircraft including an AH-64 gun turret. Operating commands (inventory status, type / number / rate of rounds to be delivered, etc.) shall be provided to the Smart-Feed system in a digital format compatible with that of the AH-64, but need not be generated by the aircraft.

The basic technology for lightweight compact commercial sorting / dispensing products will also have been proven. Adaptation of the technology will enable portable systems useful in temporary or emergency instances where customized logistics supply orders must be rapidly and accurately built up for distribution. Customized orders for medical supplies, food, tools, or hazardous waste response supplies could be rapidly dispensed onsite from pre-stocked trucks, thereby reducing response times and reducing potentially critical errors.

REFERENCES:
1. Warehouse picking systems, automated picking with S-Pemat,
http://www.youtube.com/watch?v=lQDtp7d7cnA&feature=player_detailpage

2. Smart ammunition
a. DARPA EXACTO 50 caliber,
http://www.darpa.mil/Our_Work/TTO/Programs/Exacto/Extreme_Accuracy_Tasked_Ordnance.aspx
b. 25mm Grenade, http://en.wikipedia.org/wiki/XM25_Individual_Airburst_Weapon_System
c. 30mm Airburst, http://www.dtic.mil/ndia/2008gun_missile/6360ElmerErik.pdf
d. 35mm Airburst, http://www.dtic.mil/ndia/2005garm/tuesday/buckley.pdf
e. 40mm Grenades, http://homepages.solis.co.uk/~autogun/grenades.htm

3. Cost of M789 Ammunition for AH-64 gun, NSN= 1305-01-268-9373-B129,
http://www.dlis.dla.mil/webflis/pub/pub_search.aspx

4. NLOS-C Ammunition Handling System,
http://www.pica.army.mil/TechTran/stories/library/2008/nlos-c.asp

5. Modification and Analysis of the 40mm Selective Feed System,
http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA363145&Location=U2&doc=GetTRDoc.pdf

6. Test Results for 30-Millimeter Weapon System Inconclusive, Figure 1.1, page 11, GAO Report GAO/NSIAD-93-134, http://gao.justia.com/department-of-defense/1993/4/apache-helicopter-nsiad-93-134/NSIAD-93-134-full-report.pdf

7. M230 30mm Chain Gun, http://en.wikipedia.org/wiki/M230_Chain_Gun

KEYWORDS: ammunition feed, scalable effects, precision guided munitions, smart weapons, selective feed, machine gun, auto cannon, dispensing, collateral, lethality, ammunition handling, package picking, logistics order

A12-078 TITLE: <u>Low Cost Cockpit head tracking and gestural recognition</u>

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: PEO Aviation

OBJECTIVE: Develop a system to track pilot head, hand, and arm positions and movements in a rotorcraft cockpit using advanced human-machine interface technology like those used in gaming systems to identify gestures, movements, and head tracking (approximate eye aim-point).

DESCRIPTION: Current Head Position Sensing systems, like those on Helmet Mounted Displays like the Apache IHADSS, pose a significant challenge and so tend to be a rather high cost component to install and maintain. HMD designs must sense the elevation, azimuth and tilt of the pilot's head relative to the airframe with high precision even under high "g" maneuvers and during rapid head movement. Two basic methods are used in current HMD technology - optical and electromagnetic. Optical systems employ infrared emitters on the helmet (or cockpit) and infrared detectors in the cockpit (or helmet), to measure the pilot's head position. The main limitations are restricted fields of regard and sensitivity to sunlight or other heat sources. Electromagnetic sensing designs use coils (in the helmet) placed in an alternating field (generated in the cockpit) to produce alternating electrical voltages based on the movement of the helmet in multiple axes. This technique requires precise magnetic mapping of the cockpit to account for ferrous and conductive materials in the seat, cockpit sills, and canopy to reduce angular errors in the measurement. Current aviation HMD designs use the pilot's eye aimpoint (actually head angle) as a pointing device to give aircrew the ability to target nearly any point in the environment seen by the pilot. These systems allow targets to be designated with minimal aircraft maneuvering, minimizing the time spent in the threat environment, and allowing greater lethality, survivability, and pilot situational awareness.(1)

New technology from the gaming world has the potential to substantially reduce the cost of adding head tracking to conventional helicopters, as well as the ability to do body tracking and gesture recognition to support future intelligent cockpits. In Nov 2010 Microsoft released the Kinect™ for Xbox, and it became a sensation holding the Guinness World Record for being the "fastest selling consumer electronics device". The Kinect™ provides 3 basic capabilities: advanced gesture recognition, facial recognition and voice recognition. Soon after its release, open source drivers for the Kinect™ were released which spurred an avalanche of application development by third party developers. Applications include 3D mapping, browser control, motion controllers, 3D teleconferencing, and basic visual SLAM (simultaneous localization and mapping). The Kinect™ has a range limit of 1.2–3.5 m (3.9–11 ft) and an angular field of view of 57° horizontally and 43° vertically. The Kinect™ can simultaneously track up to six people, including two active players for motion analysis with a feature extraction of 20 joints per player. The depth sensor consists of an infrared laser projector combined with a monochrome CMOS sensor, which captures video data in 3D under any ambient light conditions. Similar technologies are being developed by other game system developers (PS2 Eye Toy, etc.) and by other companies with similar application (head tracking and gesture recognition) and are indeed applicable to this effort.

Head tracking, along with gesture recognition, has the potential of being an integral part of future advanced/intelligent cockpit technologies enabling abilities like helmet/head/face tracking, virtual controls and displays, pilot physical status assessment (consciousness/fatigue/tunneling/injury), cockpit damage, and identifying objects/areas of interest internal and external to the cockpit using head tracking,

On an aircraft its potential applications include both cockpit and passenger cabin, with the main area of interest being the cockpit. The ability to track a pilot's head to determine what he is looking at is one of the main tasks. This can be used to estimate current object of interest, help identify when a pilot is becoming overly focused on a single display or control (cognitive tunneling), and identify areas/locations of interest to the pilot, for example, when reacting to threats.

The primary focus for this effort will be to determine the feasibility of using gaming or other low cost technologies like the Kinect™ in a modern cockpit and adapting it into an application suitable for Army helicopter cockpits and other aviation systems. Key questions to be answered by this effort include: 1) can the gaming technology be adapted to work within the physical environment of an aviation cockpit and/or cargo bay; 2) What is the impact on the overall cockpit (electromagnetic interference (EMI), SWAP (space, weight, and power), avionics system integration, mounting, reliability, impact on other systems like night vision goggles, system airworthiness, etc.); 3) what modifications to the system are needed to make it applicable to Army aviation; and, 4) what is the overall performance and accuracy of system in head tracking, motion/body tracking, face recognition, etc. Other issues to resolve are how many systems and how best to arrange them to support different cockpit configurations and the ability of the system to self calibrate and compensate for variation in the cockpit environment. Ultimately the feasibility of such a system needs to be verified in a true cockpit environment.

PHASE I: Assess the feasibility of using head and gesture tracking gaming technology in a cockpit environment, to include assessing body mapping accuracies, fidelity of gesture recognition, and overall system ruggedness. Develop a concept for integrating a system in a variety of cockpit configurations (side-by-side and tandem). Conduct proof of concept testing for key subsystems to validate that a viable system can be integrated into a cockpit.

PHASE II: Develop software to do body tracking and gesture recognition. Build a prototype system to track body movement (especially head) and recognize various mission relevant gestures and support human machine interactions in a cockpit mock up. Conduct testing to assess the software's ability to determine what the pilot is doing, what controls and systems he is interacting with, and what is his primary interest (specific screen of control inside the aircraft or where outside the vehicle he is looking) in real-time. The offeror shall integrate a breadboard system into a surrogate commercial cockpit and demonstrate its functionality in a flight.

PHASE III: In follow-on research the offeror needs to work with an army rotorcraft manufacturers to integrate the system into a army cockpit. Additional efforts will also be required to integrate this technology with cockpit software and interfaces that can utilize the information from the system to interact better with the pilot.

This system would have key applications to both commercial and military cockpits with greatest impact on those systems that do not have head tracking capabilities like the Blackhawk, Kiowa Warrior, and Chinook. Besides being applicable to aircraft cockpits, this system would also have application to almost all ground vehicles, C2 Vehicles, even fixed workstations: any work station where an operator is interacting with displays and control. Commercial application for such a ruggedized system are nearly endless and would include: monitoring vehicles and facilities for home land security and industry at large; a variety of automotive, trucking, commercial airline, etc. for monitoring operator status; and support aiding systems, and monitoring safety in shops, hangers, construction sites, etc.

REFERENCES:
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2. Kinect for Windows SDK Beta - Microsoft Research, http://research.microsoft.com/en-us/um/redmond/projects/kinectsdk/

3. L.-P. Morency, C. Sidner, C. Lee, and T. Darrell. “Contextual recognition of head gestures.” In ICMI, 2005. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.73.1790&rep=rep1&type=pdf

KEYWORDS: cockpit, head tracking, Kinect, gesture recognition, aviation

A12-079 TITLE: ASP Motion Base for Stabilized Mounts

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PEO Aviation

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 lightweight agile motion base having a high axial load capacity and capable of high precision pointing over a small range of angular displacements. Such a mechanism would enable lightweight stabilized mounts for the forward firing weapons and laser designators used onboard military aircraft and ground vehicles.

DESCRIPTION: Problem: Military helicopters such as the MH-6, OH-58, UH-1, MH-60M DAP, and ARH-70 employ fixed forward firing machine guns and auto cannons as weapons. These installations are lightweight and simple, but require the pilot to point the aircraft with high precision in order to hit their targets. Many ineffective rounds are expended due to unexpected motions encountered in the dynamic flight environment of combat. Turreted systems such as that used on the AH-64, and pintle mounted systems such as used in the doors / windows / ramps of AH-1, UH-60, CH-47, CH-53, and V-22 allow off-axis shots but are an order of magnitude heavier than fixed gun mounts and are also subject to wasted rounds due to aiming errors during dynamic flight. The wasted rounds mean heavier ammunition loadouts are required to do the mission, and also increase the risk of collateral damage.

The standard of performance for aerial gunnery from an OH-58D is to achieve at least one hit out of 70 shots fired at a wheeled vehicle between 800 – 1200m distant (see ref 1). This improves to one hit in 30 shots for the AH-64 with a stabilized gun turret using current technology. Some OH-58D flight crews consider their machine guns to be area suppression weapons rather than point target weapons, preferring to use expensive guided missiles (see ref 2) in order to minimize collateral damage (see ref 3).

Modern technology enables highly accurate stabilized weapons turrets by incorporating direct-drive brushless stepper motors, lightweight and stiff composite gimbal assemblies, and computerized stabilization / fire controls (see references 4-6). However, these gimbal / motor assemblies are still too heavy for application as stabilized mounts for forward firing guns.

Payoff: The resulting Agile, Small-deflection, Precision (ASP) Motion Base would serve as the heart of a stabilized mount for forward firing weapons. Such a mount would allow precision pointing of the weapon throughout the firing sequence, reducing the number of shots required. Fewer shots required results in more stowed kills per loadout, or lighter weight ammo loads with a corresponding improvement in aircraft lift and reduction in sustainment costs. Fewer round fired also minimizes the risk of collateral damage.

Technical Approach: The ASP motion base should be capable of small (±7°) azimuth and elevation deflections at low (<10 Hz) bandwidths to compensate for inaccuracies in aircraft pointing ability and / or play in any recoil mechanisms employed. The ASP motion base must also have a precise position control capability to enable good performance when driven by a stabilization algorithm and when subjected to the gun firing and aircraft maneuver loads. The fundamental design of the ASP motion base must be scalable for the weight and recoil forces of the full range of guns / cannons currently used on US military rotorcraft. Integrating the actuation system with the structure may reduce weight and hysteresis. Ideally, the ASP motion base will also incorporate a highly efficient integrated recoil mechanism to further reduce weight on the aircraft.

PHASE I: The awardee shall demonstrate the feasibility of the ASP motion base assembly using modeling and simulation. Loads shall be based on an M3P machine gun as employed on an OH-58D helicopter. Critical technological factors such weight, pointing accuracy, control response, actuation power required, failure modes and effects, scalability, and manufacturability shall be assessed.

PHASE II: The awardee shall design, build, and demonstrate the functionality and performance of the ASP motion base on a moving platform. Applied loads shall be based on an M3P machine gun as employed on an OH-58D helicopter. Closed-loop position control shall be demonstrated, but stabilization control need not be. Critical technical measures to be demonstrated include; pointing accuracy while under load of better than 0.1 milli-radians at frequencies higher than the gun firing rates (19 Hz), fail-safe failure modes, system weight less than 40 pounds (3x the current OH-58D mount, 15%-20% of ground vehicle turret (refs 7,8)), power required less than 30 amps at 28 volts DC.

PHASE III: The awardee shall design, build, and demonstrate the functionality and performance of an inertially stabilized forward-firing gun mount using the ASP motion base technology. The stabilized mount shall replace the existing mount on an OH-6, UH-1, or OH-58 helicopter, and be flight tested under live fire conditions. Critical technical measures for the ASP-based system include; at least a 5:1 improvement in hits per round, cause no increase in takeoff weight while providing at least the same number of stowed kills, be capable of integrating with existing fire control systems.

Phase III will result in a proven capability ready for adaptation to fielded military helicopters, boats, or ground vehicles, manned or unmanned. The proven ASP motion base technology may also benefit non-DoD applications by providing lightweight devices that can precisely point devices that impose large axial loads. Remote-control water cannons on top of Fire Department tower trucks, vectoring thrust rocket nozzles for satellite launchers, and mobile telescope / dish antenna tracking mounts are all viable candidates for this technology. It may also improve resistance to earthquakes for freestanding slender columns (towers) by providing active stabilization, similar in concept to that used by the Segway scooters.

REFERENCES:

1) FM 1-140, Appendix B, Tables VIII, http://www.globalsecurity.org/military/library/policy/army/fm/1-140/AB.HTM , superceded by FM 3-04.140

2) U.S. Army Awards Lockheed Martin $170 Million Contract for HELLFIRE II Missile Production, http://www.lockheedmartin.com/news/press_releases/2006/USArmyAwardsLockheedMartin170Millio.html

3) Video, Kiowa Rains Death from Above, http://www.military.com/video/operations-and-strategy/air-strikes/kiowa-rains-death-from-above/663171871001/

4) THL-20 Turret System, Janes Air Launched Weapons, Issue 53, pg507

5) The Inertial Reticle Technology (IRT) Applied to a .50 Cal. M2 Heavy-Barrel Machine Gun Firing from a High-Mobility Multipurpose Wheeled Vehicle (HMMWV), Timothy L. Brosseau et al, http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA377015&Location=U2&doc=GetTRDoc.pdf

6) Autonomous Rotorcraft Sniper System, http://www.sdl.usu.edu/programs/arss

7) Remote Operated Small Arms Mount, http://www.dtic.mil/ndia/2004arms/session7/wasil.ppt

8) Common Remotley Operated Weapon Station (CROWS-II), http://en.wikipedia.org/wiki/Common_Remotely_Operated_Weapon_Station

KEYWORDS: flexure, gimbal, turret, pintle, stabilized, gun, cannon, helicopter, vectoring nozzle, accuracy, precision, mount, collateral damage, lethality, earthquake, motion base

A12-080 TITLE: Lightweight, High Effectiveness, Low-Cost Recuperators for Small Turbine Engines in Army Unmanned Aerial Systems

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: PEO Aviation

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 and demonstrate lightweight, high effectiveness, low cost recuperators for small turbine engines to power small manned and unmanned aerial systems for increased reliability and operational capability.

DESCRIPTION: Tactical requirements for Army manned and unmanned aerial systems are exceeding current capabilities for performance (payload, range, time on station), reliability, maintainability, and supportability. Mission requirements such as increased power, extended endurance, low altitude maneuverability in urban environments without detection, and high reliability are becoming paramount. These requirements are currently not fully realized with conventional rotary, internal combustion, or turbine-based propulsion. Electrical power requirement for advanced payloads is also increasing, which adds weight to the air vehicle. Turbine based propulsion systems offer improved power to weight ratio over typical internal combustion engines, however, do not compete well in fuel efficiency in small size engines due to increased clearances and losses. The addition of recuperation can improve small turbine fuel consumption across the operational spectrum, such that it is competitive with internal combustion engines. This would allow Army manned and unmanned aerial systems to take advantage of the turbine engine's inherent reliability and durability, while reducing the weight advantage somewhat. Therefore, for a successful recuperated small turbine engine (30-700 horsepower) to be developed for application to Army manned and unmanned aerial systems, it will be critical for the recuperator to be lightweight, have high effectiveness for good fuel consumption characteristics, use low-cost manufacturing techniques, and be durable/reliable so that overall engine performance, cost, and reliability/durability is achieved. The objective of this topic is to develop lightweight, high effectiveness, low cost, and durable/reliable recuperators for small turbine engines, which offer potential for increased engine power to weight ratio and reliability, in order to meet current and anticipate future needs of Army manned and unmanned aerial systems. Current conventional engines are sized to provide enough power and speed for takeoff capability, often leading to a propulsion system which operates inefficiently at other operating conditions. An advanced recuperated propulsion system would need to be able to meet different operational requirements of a small/mid-sized manned and unmanned aircraft, which include full power takeoff capability, high part-power cruise fuel efficiency for improved endurance, and quiet operation capability. Additional capabilities required for both Army manned and unmanned aerial systems include the ability of the engine to operate off of heavy-fuel (JP-8, diesel) and ability to provide power to electrical payloads.

PHASE I: During Phase I effort, key components of the proposed recuperated engine concepts should be developed and validated to substantiate the ability to provide a lightweight, high effectiveness, low cost, and durable/reliable recuperator that can be integrated into a current or future turboprop/turboshaft engine system. A lightweight recuperator design will increase the weight of the engine system by no more than 80%. The target specific fuel consumption (sfc) reduction for the recuperated engine system will be 35% less than that of the baseline engine system.

PHASE II: Phase II will fully develop, fabricate, and demonstrate the full recuperated turboprop/turboshaft engine system in a ground test environment.

PHASE III: Phase III options should include endurance testing and integration of the enhanced propulsion system into the airframe and demonstrate the performance of the system with flight testing in an Army manned or unmanned aerial system mission environment.

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3. Ward, M.E., 1995, “Primary Surface Recuperator Durability and Applications,” Turbomachinery Technology Seminar paper TTS006/395, Solar Turbines, Inc., San Diego, CA.

4. Oswald, J.I., Dawson, D.A., and Clawley, L.A., 1999, “A New Durable Gas Turbine Recuperator,” ASME paper 99-GT-369, Am. Soc. Mech. Engin., New York, NY.

KEYWORDS: unmanned aerial system, recuperated turbine engine, heavy fuel engine, power to weight ratio, fuel efficiency, low noise, low-cost manufacturing

A12-081 TITLE: Analysis Tools for Composite Laminate Material Properties Prediction

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PEO Aviation

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: Successful fielding of lightweight composite material components requires dependable material property data early in the design cycle. Full sets of laminate data can be costly and time consuming to generate. The objective is thus to develop the analysis techniques for reliable prediction of fiber reinforced polymer matrix composite material properties based on ply level material property data.

DESCRIPTION: Fiber reinforced polymer matrix composite materials continue to rapidly improve in terms of structural performance. After a new material becomes commercially available, however, there is often a significant lapse in time before that material can be successfully integrated into a structure. Large amounts of data must be collected before there is adequate confidence in the material properties to invest in designing hardware with that material system. The laminate level material strength properties are heavily dependent on fiber orientation, and it is necessary to have thorough knowledge of these laminate level material properties for design. These properties are longitudinal and transverse tension and compression, longitudinal and transverse open hole tension and open hole compression, shear, bearing, and compression after impact. Currently available analytical tools have been repeatedly demonstrated to fall short in terms of their ability to reliably predict the aforementioned material properties based on ply level material property data. Having analysis techniques that can reliably predict laminate level material properties based on reduced sets of ply level material property data could prove invaluable early in the design cycle of fiber reinforced composite structures. This could greatly improve the rate at which advanced material systems mature and thus bring benefit to missile and aviation systems in terms of weight and insensitive munitions performance.

PHASE I: Develop and demonstrate analytical approaches to predicting laminate level tensile and compressive coupon material strength properties with a limited amount of ply level material property data. Ply level data shall include unidirectional axial and transverse tension and compression material property data.

PHASE II: Develop a modeling tool that allows the user to create a set of material property strength data for a pre-defined laminate. This modeling tool should be able to predict a set of material strength property data that includes tension, compression, open hole tension, and open hole compression all in both the axial and transverse directions. This predicted data set shall also include shear and bearing properties. The statistical nature of each of these properties should be able to be predicted using the modeling tool. Understanding the statistical nature of the predictions is key to getting reliable allowable material strengths early in the design cycle. The inputs to the analysis tool should be limited to basic ply level material property data as well as matrix material properties. This phase should successfully demonstrate the accuracy of the predictions across relavent environmental conditions including room temperature/dry, cold temperature/dry, and elevated temperature/wet.

International Traffic in Army Regulation (ITAR) control is required.

PHASE III: Weight reduction is of great importance in many aviation and missile structures. The ability to reliably predict laminate material properties using ply level material property data and understanding the accuracy of the predictions can drastically reduce the design cycle and allow the use of high performance material systems more quickly as they become commercially available. This technology can be used across a number of applications where weight reduction is important. This is considered pervasive technology and can be applicable to future weight reduction efforts for multiple Army systems including Javelin, JAGM, and TOW. It has the potential to find uses in both military and commercial applications. An example would be to create an analysis code that could be integrated into a commercial finite element analysis code such as Abaqus. This would allow users to quickly evaluate different laminates in their designs prior to committing to a material system early in the design cycle.

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KEYWORDS: Analysis, Fiber Reinforced Composites, Progressive Failure, Material Allowables, Strength Prediction, Finite Element Modeling

A12-082 TITLE: Advanced Nonintrusive Dispense Tracking Diagnostics for Aerospace Delivery Vehicles

TECHNOLOGY AREAS: Weapons

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: To develop accurate nonintrusive techniques to track sub-missile dispense in very high speed flows.

DESCRIPTION: Missile carriage has been both proposed and used as a practical means for the delivery and dispense of sub-missiles while offering the advantage of quick response out to a considerable range. Here the term sub-missile covers a broad spectrum to include munitions, airframes, ISR (Intelligence, Surveillance, and Reconnaissance) platforms, supplies, flechettes, and even warhead fragments. Such sub-missiles may themselves be powered, unpowered, guided, unguided, intelligent, or passive devices. Regardless of the type, clean dispense from the carrier missile remains a key problem area for the designer with sub-missile-to-missile, and sub-missile-to-sub-missile interactions to be resolved. Often the dispense technique for a particular design can only be validated through flight testing which is problematic enough and especially so at endoatmospheric conditions and flight Mach numbers from the supersonic into the hypersonic range.

Recently, the Army has developed a shock tunnel based ground test facility that permits free flight stage separation and sub-missile dispense. The facility is unique in that it can produce the flow conditions required to duplicate flight conditions of interest to missile developers (fully duplicated flight conditions) with all the advantages provided by a ground test facility for accurate test measurements. Principally because of the extremely short facility run times (typically 10 to 100 milliseconds) the types of instruments commonly used are limited primarily to pressure, heat transfer rates, and accelerometer measurements.

What is needed then for sub-missile dispense ground testing is an accurate nonintrusive technique to track a finite number of dispense objects in three-dimensions. The number of objects to track could be simply one for an ISR platform to as many as one hundred for flechettes. The existing nonintrusive laser methodologies for flowfield velocity measurements, LDV (laser doppler velocimetry) and PIV (particle image velocimetry), might possibly be adapted for this particular application since flowfield seeding is not an issue. Starring array CCD cameras and tomographic techniques offer another possibility. Still, issues with the short run times and flowfield line-of-sight access must be addressed.

PHASE I: This solicitation seeks innovative ways to make nonintrusive three-dimensional measurements (position and velocity) of sub-missiles during free flight dispense in a ground test facility at flight Mach numbers from 2 to 12 and altitudes from sea level to 80 km. Positional accuracies to +/- 2.5 mm over a spherical envelope of 2.5 m diameter are desired. Technical approaches will be formulated for new and innovative ways to make these measurements. These approaches shall be distilled into a measurement concept(s). Phase I will then produce one or more preliminary designs for innovative measurement devices.

PHASE II: The concepts formulated in Phase I will be developed and refined in order to design and build an instrument. The instrument shall be demonstrated in an aero-propulsion facility defined by the Government. A test program demonstrating the capability of the instrument will be formulated and the instrument tested in this facility. Test measurements shall be validated by comparison with known experimental results or well characterized analytical results.

PHASE III: If successful, the end result of this Phase-I/Phase-II research effort will be a validated aero-propulsion measurement instrument. The transition of this product will require additional tests to insure the validity, accuracy, and range of the measurements. Furthermore, practical limits to the number of dispense objects which can be tracked will need to be developed.

For military applications, this technology is directly applicable for validation testing of all systems utilizing missile delivery and sub-missile dispense to include stage separation and shroud separation, wherein multi-body interactions must be characterized utilizing the tracking instrument and technology of this SBIR.

For commercial applications this measurement technology as an instrument has direct use for tracking particulates in a gas stream, e.g. coal particulates in a cyclone furnace.

The most likely customer and source of Government funding for Phase-III will be those service project offices responsible for the development of missile delivered sub-missiles to include munitions, airframes, ISR (Intelligence, Surveillance, and Reconnaissance) platforms, supplies, and fragmenting warheads.

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KEYWORDS: dispense, sub-missile, shock tube, ground test facility, tracking, nonintrusive diagnostics, LDV, PIV, tomography

A12-083 TITLE: Residual Property Prediction for Damage Composite Structures

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PEO Ground Combat Systems

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 novel modeling approach for predicting and quantifying the residual strength and stiffness of composite material structures, specifically compression after impact (CAI) strength.

DESCRIPTION: Advanced composite material systems are vital to the development of lightweight, multi-functional Army missile systems. In addition to reducing the weight of the structure, these material systems provide the ability to expand the function of the structure by tailoring stiffness and strength characteristics for numerous applications. Carbon fiber-reinforced epoxy structures have become very attractive for applications such as solid rocket motor cases, missile airframes, missile guidance housings, as well as many launch tubes and launcher primary structures. The Weapons Development and Integration Directorate within AMRDEC has identified a need to understand the operational fitness of these types of structures following impact events from a wide range of energy levels.

It is normally accepted that a limiting characteristic of thin composite structures of this nature is the response of the impacted material to compressive loads, such as buckling. It is also well documented that delamination is the predominant damage mode in composite materials subjected to impact damage. This delamination significantly affects the residual compressive strength in the structure and there have been numerous studies to characterize the compressive response of the impacted structure using a variety of approaches. Post-impact test-determined material properties, Hertzian law, force-energy relationships, load-rate sensitivity approaches, absorbed-to-impact energy ratio methods, hydro-code and semi-empirical methods are current approaches used to estimate residual strength.

Novel advanced composite material design and analysis approaches are sought to minimize the risk of damage by the combined effects of blast and fragmentation from sources such as warhead detonation as well as single low-energy impacts resulting from operations and maintenance impact accidents. Little work has been performed on understanding these combined effects on the residual strength of these structures. Additionally, a better understanding of the low energy single or multi-point impact characteristics on these materials/structures is sought.

AMRDEC seeks to advance the state of the art in post-impact determination of residual strength, including compressive residual strength of composite material structures used in defense applications.

A successful response to this topic will deliver a computer subroutine that contains novel mathematical/physical approaches that can accurately assess the residual compressive strength in impact-damaged composite material structures. The code would be easily interfaced with existing finite element or finite difference codes to perform design trade studies, preliminary designs, and residual strength and fitness assessment of the structures. The computer model would provide a test-proven method that can be used for design and inspection of composite material structures subjected to single and multi-point impact scenarios with varying impact energy levels. The high-energy events typically result from high velocity debris due to warhead detonation. The low energy events are attributed to accidental tool impact, handling or dropping, and low frequency, low amplitude vibration impacts due to ground transportation. Examples of critical structures are cylindrical solid rocket motor cases and airframes, launcher primary structures, and launch tubes. The goal of a three-phase SBIR process is the delivery of a novel test-proven and verified method for use in determining the residual compressive strength of composite structures for Army missile applications.

PHASE I: Phase I will evaluate the technical merit and feasibility of the proposed technology to determine residual compressive strength of advanced composite material structures. The awardee shall present an initial concept method as a required Phase I deliverable; supporting proof-of-principle data may be obtained by correlation with existing data or selected strategic testing. This should include a work flow for the subroutine, major parametric models to be included in the subroutine, and strategies for integrating the model into commercially available analysis codes. Projects seeking Phase II funding should consider: 1) a sound strategy for validating the technology on different material systems and structural configurations; 2) simplicity of use for design and analysis activities; and 3) development of new understanding of critical parameters and their sensitivities on the determination of residual compressive strength.

PHASE II: The initial approach verified in Phase I will be further developed and refined with the goal of maturing and expanding the computer model. The second phase will focus on expanding to validate the models using relevant material systems, configurations, impact conditions, and environmental conditions. Any processes/methods developed in Phase I will be expanded to perform more robust correlations based on real world impact and loading scenarios as defined by the appropriate AMRDEC Directorate. The awardee should interface with potential military and commercial customers to guide the scope of a potential Phase III effort.

International Traffic in Army Regulation (ITAR) control is required.

PHASE III: Phase III will demonstrate a mature analytical computer code/technology. The goal will be a tool that can assess residual strength in relevant composite material systems that are subjected to impact damage scenarios in their operating environment. It will be important also to understand the limitations of the model with respect to the different conditions for which it will be used. The awardee will deliver a product that can easily be integrated with existing computer codes. This will enable transition of the technology to defense and aerospace users. This is considered a pervasive technology but will have application for future Army weight reduction efforts for systems including TOW, Javelin, and JAGM.

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KEYWORDS: Fiber Reinforced Composites, Compression After Impact, Damage, Modeling, Structural Health, Progressive Failure

A12-084 TITLE: <u>Innovative Semi-Active Laser (SAL) Signal Processing Techniques in Noisy Environments</u>

TECHNOLOGY AREAS: Electronics

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: To develop and demonstrate semi-active laser (SAL) signal processing algorithms designed to optimize true target detection and tracking in noisy battlefield environments.

DESCRIPTION: The military's on-going need to maintain a precision strike capability for its SAL homing missiles and bombs depends upon industry to develop innovative signal processing techniques for discerning true target laser signal returns in the noisy electro-magnetic battlefield. As the employment of SAL-based seeker weapon systems increases, SAL countermeasures are likely to be fielded to degrade the war-fighter's offensive capability. Conventional SAL sensor designs utilize silicon-based detectors that measure laser returns in amplitude and time. The seeker's signal processing must be able to discriminate the coded true target return from false laser returns generated from natural or man-made sources, i.e. smokes, jammers and repeaters. These false laser returns include stretched pulses as well as correlated and non-correlated pulses with variable repetition rates. Legacy seeker designs were limited by the electronics available at the time; thereby, producing signal processing methods tailored to legacy electronics' processing capabilities and memory limitations. With the vastly improved processing and memory capabilities in modern electronics, alternative signal processing methods can implement in the seeker to optimize detection of the true target and reject false targets and noise. These techniques may include adaptive filters and other techniques that utilize characteristics (statistical, temporal, etc.) of the false target returns as discriminants. Since the engagement time for SAL weapon systems is short, these techniques must be able to be processed in real-time and within reasonable memory limitations for embedded systems. This SBIR effort will focus on developing new SAL signal processing algorithms that identify the true target's coded laser pulses in dirty battlefield environments, prototyping the new algorithms in a SAL seeker design using silicon-based detectors, and demonstrating the algorithms in a laser seeker laboratory at the US Army's Aviation and Missile Research, Development and Engineering Center. These algorithms should be compatible with contemporary SAL tracking methods. Data to be used to evaluate new algorithms will include randomly generated pulses and laser decoy pulses. A goal of this research into SAL signal processing algorithms is to maintain the viability of the existing SAL missile and bomb inventories as well as to assist future SAL seeker design efforts.

PHASE I: The proposal for Phase I should identify innovative signal processing approaches that optimizes true target pulse detection and tracking in noisy environments, including natural and active SAL noise sources. Modeling of the laser sources, seeker sensor, seeker electronics and signal processing of a prototype seeker design will be performed to quantify signal processing techniques in benign and dirty battlefield environments.

PHASE II: In Phase II, the signal processing algorithms will be programmed into a SAL seeker and demonstrated in an AMRDEC laser laboratory to evaluate the performance of the algorithms in benign and simulated dirty battlefield environments. Classified proposals are not accepted under the DoD SBIR Program. In the event that this effort will involve classified work in Phase II, companies invited to submit a proposal must have or be able to obtain the proper facility and personnel clearances in order to perform Phase II work. For more information on facility and personnel clearance procedures and requirements, please visit the Defense Security Service Web site at: http://www.dss.mil/index.html. International Traffic in Arms Regulation (ITAR) control is required.

PHASE III: Improvements to SAL seeker signal processing can be incorporated into contemporary SAL seeker designs for missiles, rockets and bombs as new countermeasure technologies are fielded. Programs that would benefit from this technological innovation would include, but are not limited to, the following programs: HELLFIRE, Griffin, JAGM and small guided munitions with SAL seekers. Commercial use of these signal processing algorithms includes potential technology transfer applications for optical communications in noisy environments.

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KEYWORDS: Keywords: semi-active laser (SAL) guidance, signal processing, dirty battlefield environment, laser seeker, missile, rocket

A12-085 TITLE: Rapid Scene Creation for Multispectral Terrain Signature Models and Simulations

TECHNOLOGY AREAS: Electronics

ACQUISITION PROGRAM: PEO Ground Combat Systems

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 technique or system to rapidly develop earthen background terrain model representation of actual world locations for use in electro-optical and infrared scene rendering applications.

DESCRIPTION: This SBIR seeks innovative approaches to decrease complexity and time associated with creating terrain models for Multispectral Terrain Signature Models and Simulations to a week or less. Current state of the art is to develop physics-based imagery relying on accurate, high-fidelity scenes characterized by their topography, terrain components (bushes, trees, roads, etc.) and the EO/IR characteristic of each. Scene sizes of 0.5 km X 0.5 km up to 10 km X 10 km are typically needed for such applications. Historically extensive labor and brute force usage of computer computational throughput has been leveraged to address terrain model developments and objectives. These attempts have been met with limited success and still require extensive amounts of labor and unique processes to complete hence there is need for an innovative approach to automating or semi-automating the processes. Computer computational throughput enhancements have been tried without much success for achieving our objectives. Examples of technical areas for consideration are level of detail method, anti-aliasing for computation rendering, clutter classification of real-world imagery, DTED extrapolation and /or surface model management. The goal for this task is to design, develop and demonstrate an innovative technique or techniques for rapidly developing real world background scenes compatible with and suitable for use in Army scene rendering codes for UAS, and missile simulations.

PHASE I: Design, develop and demonstrate a system process for creating earthen background terrain databases used by physic-based EO/IR scene rendering tools for integration into missile flight simulations. Metrics to quantify time improvements, end product accuracy and fidelity will be chosen or developed by the contractor. An actual world location will be selected to encompass many different natural and man-made background elements: trees, bushes, roads, buildings, etc. Attention to automate or semi-automate stage development of the current manual process is suggested to relieve bottleneck issues currently experienced.

PHASE II: Develop a prototype demonstration system for rendering earthen background scenes compatible with existing scene rendering system tools for missile flight simulations. The software architecture and system operational requirements will be clearly stated and compatible with existing Army tool suites. Comparisons of the new scene development technology will be evaluated against current development technologies for scene generations speed, complexity, definition, accuracy. Scene development time reduction shall be determine and documented.

Example: Scenes shall be developed for one real world location that encompasses many different natural and man-made background components such as trees, bushes, roads, buildings and so on at varying levels of fidelity. Metrics identified in Phase I will be used again to assess speed, accuracy, and fidelity improvements from background generation.

Classified proposals are not accepted under the DoD SBIR Program. In the event that this effort will involve classified work in Phase II, companies invited to submit a proposal must have or be able to obtain the proper facility and personnel clearances in order to perform Phase II work. For more information on facility and personnel clearance procedures and requirements, please visit the Defense Security Service Web site at: http://www.dss.mil/index.html. International Traffic in Arms Regulation (ITAR) control is required.

PHASE III: Earthen background scenes of real world locations are used in many simulations from missile development to intelligence gathering. Our goal is to generate EO/IR scenes capabilities for a wide variety of environmental conditions and geographical domains. This technology is targeted at scene rendering software integrated into flight simulations such as: Joint Air to Ground Missile (JAGM), Small Organic Precision Munition

(SOPM) / Switchblade, Javelin, and Small Diameter Bomb (SDB). Additional applications could be planning and rehearsal for soldiers, UAS devices to determine the best approach routes, time of day for mission execution, hazard identification or other limitations for mission success.
Additional commercialization opportunities are: land use monitoring for natural resources by NASA, disaster preparedness and boarder monitoring for Department of Homeland Security. Adding rapidly high fidelity scene generating capabilities to these organization's tools set for predictive models will improve their engagement modeling to support a better use of resources.

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KEYWORDS: Keywords: Electro-optical, infrared, synthetic scenes, physics-based backgrounds, modeling and simulation, integrated flight simulation, missiles, hyperspectral

A12-086 TITLE: Flexible, Compact Acoustic Transducer Arrays

TECHNOLOGY AREAS: Electronics

OBJECTIVE: Acoustic reconnaissance for Army applications has had limited usage due to the large size of the transducer arrays required for beamforming. The objective of the Phase I is to perform a feasibility study of a transducer technology that can be integrated with flexible substrates for applications in compact acoustic beamforming arrays.

DESCRIPTION: Acoustic reconnaissance has a variety of unique capabilities including spoofing immunity, ability to penetrate clutter, unique signature identification, jam resistance, low cost, low weight, and minimal power consumption[1, 2]. Acoustic arrays not only provide directional information but also limit background noise due to wind and other locally decorrelated noise. The significant disadvantage of acoustic reconnaissance is the size of the array. Direct size reduction of the individual transducers results in decreased sensitivity, increased noise floor and correspondingly poor sensor performance. Recent developments in acoustic transducers have indicated several promising materials for reducing the size of acoustic transducers[3] and most are compatible with current processing technologies[4]. As a result, the potential for compact acoustic transducers on flexible substrates is realistic in the near future. In conjunction with new transducer technology is the recent development of acoustic metamaterials[5, 6]. Acoustic metamaterials have the potential to enhance the signal by controlling and directing the incoming acoustic waves and aid in the size reduction of the overall array. The main objective of this solicitation is to investigate material solutions to reduce the size of transducer arrays without a large reduction in the sensitivity. The array itself should be flexible for the widest possible range of applications, including unmanned aerial systems. Incorporation of acoustic metamaterials is expected to aid in the sensitivity of the array. Frequency range of interest is 20Hz to 20 kHz. This solicitation is aimed at the development of the transducer array. The advancement of signal processing techniques is beyond the scope of this task.

PHASE I: Conduct a feasibility analysis of a flexible, compact, transducer array for acoustic beamforming. The transducers should be compatible with current microfabrication techniques.

PHASE II: Design and fabricate a prototype transducer array on a flexible substrate for acoustic sensing applications. Perform basic testing of the transducer parameters including sensitivity and noise floor.

PHASE III: Develop a manufacturing plan for transition from prototypes to initial production that is producible with a manufacturing process such as a wafer scale process to reduce components costs.

Low cost, compact acoustic transducer arrays that can be applied on a variety of surfaces have numerous dual use applications including collision avoidance for automobiles, imaging, and communications.

Collision avoidance of unmanned aerial systems is currently achieved with the aid of RADAR and optical sensors. However, the availability of the RADAR in the battlefield may be limited. Optical sensors often tend to yield falls results in identifying incoming UAS. Therefore, acoustic sensors can be used to augment the existing detection technologies. The flexible acoustic sensors can be mounted on a curved surfaces of the aircraft wing.

Unattended ground sensors currently used in the battlefield are mounted on flat surfaces and they have to be deployed manually. Sensors mounted on curved surfaces (e.g. spherical) can be air-delivered.

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KEYWORDS: acoustic transducer, transducer arrays, acoustic beamforming, acoustic metamaterials.

A12-087 TITLE: Sensitive and Diagnostic Mental Workload Classifier

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: The objective of this topic is to develop an automated mental workload classifier sensitive to systems and tasks, as well as diagnostic of different types of mental workload experienced.

DESCRIPTION: The measurement of Soldier mental workload during test and evaluation (T&E) is critical to understanding total system (comprised of the human and system) performance issues. Currently the measurement of mental workload is a two step process. First, a training session is conducted prior to the actual test event. The training session is used to build a model of each subject. During the training session, subjects are instrumented to acquire physiological data while they perform specific cognitive tasks having pre-assigned high and low states. The physiological data is then processed and psycho-physiological features of the subject’s mental state are extracted and used to build a linear model. Once the models are developed and trained, the actual test event can begin. During the test event, the model classifies new physiological data acquired from the subject while they perform specific tasks associated with a system. This approach provides a linear scale of the mental workload experienced by subjects. However, the approach is limited by only being able to determine when the mental workload was experienced and at what the level (high or low). Assessing total system performance issues with the current capability is challenging, if not impossible.

A more comprehensive measure of mental workload is necessary for T&E. The T&E community desires a mental workload measurement that is sensitive to the task or system and capable of diagnosing the type of mental workload experienced. A sensitive mental workload measure is needed to discriminate between the workload imposed by one system or task versus the workload imposed by another system or task. A diagnostic mental workload measure is required to discriminate between different types of mental workload (visual, auditory, cognitive, fine motor, gross motor, speech, and tactile) experienced during a task or activity. Such a capability will enable testers and developers to optimize mental workload by identifying when a particular type of mental workload occurred and the system component or task associated with that mental workload.

The ideal mental workload classifier would resemble the US Army Research Laboratory (ARL) Improved Performance Research Integration Tool (IMPRINT) mental workload model. The IMPRINT model decomposes mental workload into 7 types: visual, auditory, cognitive, fine motor, gross motor, speech, and tactile. These 7 types of mental workload are further decomposed into behaviors. Each behavior is associated with a numeric value. As the behaviors for each type of workload become more complex, their numeric value increases. This establishes an ordinal and interval scale of mental workload. The IMPRINT model also takes into account the fact that several mental workload types may be used simultaneously, thus creating conflict which impacts the overall mental workload experienced. Finally, the IMPRINT model considers strategies to mitigate or compensate for high workload. By combining these features, the IMPRINT model can predict subject mental workload over time, predict the type of mental workload experienced, and identify the task or system component associated with the mental workload. This powerful tool enables the optimization of mental workload for system design and analysis.

The intent of this SBIR is to develop a physical capability to replicate what IMPRINT can do in the modeling world. The desired outcome from this topic is a mental workload classifier for physiological data built around the IMPRINT model of mental workload. The classifier shall be capable of discriminating between mental workload types and associated behaviors. Additionally, the classifier shall be capable of accounting for conflicts between different types of workload. The desired product is a software application, and the associated source code, capable of operating on a Windows XP platform or greater.

PHASE I: The Phase I project shall determine the technical feasibility for developing a mental workload classifier based on the IMPRINT workload model. The feasibility study shall focus on the development of a classifier capable of discriminating between various types of workload. Phase I shall also include the design of an IMPRINT based mental workload classifier and the development of approaches for implementing the classifier. Phase I deliverables will include results from the feasibility study, the initial classifier design concept, initial development approach, monthly progress reports and a final report. The Phase I proposal shall emphasize the breadth of the commercial market for the proposed classifier and explain in detail how the proposed classifier will fit into the commercial market.

PHASE II: The Phase II project shall develop a prototype automated mental workload classifier and the associated methodology for implementing the classifier. Efforts during Phase II shall also include a validation study to ensure classifier results. The study shall compare classifier results against IMPRINT predicted workload for a specified task. Phase II deliverables include the software application for the mental workload classifier, source code for the classifier application, a technical manual on how to use the classifier, results of the classifier validation study, monthly progress reports, and a final report.

PHASE III: The vision for this research effort is to develop a fully automated mental workload classifier and methodology for use in real time monitoring of subjects. This effort has the potential to transition to various military applications. One specific application is the Natick Soldier Center (NSC) Soldier Load Management program. The foundation for this program is to optimize the Soldier's physical and mental load. The classifier developed from this SBIR topic can play a vital role in the design of systems for the Soldier Load Management program and it can be embedded as a part of the fundamental technologies within the program to assess Soldier mental workload. Additional transition paths include the Test Resource Management Center (TRMC) Tri-Service Warfighter Performance Test Capability (TSWPTC) program. TSWPTC is aimed at identifying and developing critical Warfighter performance testing capabilities across DOD agencies. The program kicked off with a study which identified and prioritized gaps associated with Warfighter performance test capabilities. The number two gap identified was physiological state, which includes mental workload.

The Tactical Human Integration with Networked Knowledge (THINK) and High Definition Cognition ATOs are possible transition paths for this SBIR effort. These ATOs will benefit from the advanced mental state classification algorithms developed under this SBIR effort. The classifications algorithms have the potential to be applied to other psycho-physiological measurements for more in-depth understanding of neuro-cognitive process and aid in development of neuro-ergonomically designed Soldier-system interfaces.

Commercial transition paths include the growing brain computer interface (BCI) and ergonomics communities. With respect to the BCI community it is envisioned that the classifier developed from this effort will be easily adaptable to other brain measures or functions. This will allow BCI developers the opportunity to quickly tailor the classifier to meet their system needs. Additionally, the classifier has great potential for transitioning into the gaming market. There are a variety of systems currently being sold whereby users interact with a video game or even a toy via their brain waves. With the advanced classifier developed from this SBIR, developers can greatly enhance the types of mental interactions possible.

With respect to the ergonomics community there is a large interest in the assessment of operator performance based on ergonomic design concepts. Mental workload measures related to operator performance are of great interest to the ergonomics community, particularly in the automotive and aviation fields. Markets for the development and enhancement of air traffic controller technologies are a prime use case for highly sensitive and diagnostic mental workload classifiers.

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4. Additional information from TPOC on Topic A12-087. Uploaded in SITIS 5/9/12.

KEYWORDS: Mental Workload; Classifier; Test and Evaluation; Physiological; Improved Performance Research Integration Tool (IMPRINT)

A12-088 TITLE: Alternative Source for Neutron Generation

TECHNOLOGY AREAS: Nuclear Technology

ACQUISITION PROGRAM: PEO Ground Combat Systems

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 an alternative technology and methodology to conduct nuclear survivability testing of US weapons and Space Systems from the current approach that employs nuclear reactor. Develop a technology that can provide the Neutron and gamma environment for test and evaluation consistent with requirements established in Department of Defense Instruction (DoDI) 3150.09 and Army Regulation (AR) 70-75 that does not employ highly enriched nuclear materials. Effectively meeting this objective will dramatically reduce the life cycle cost associated with nuclear survivability testing by significantly eliminating the security and logistical requirements associated with the operation of a fast burst reactor.

DESCRIPTION: This SBIR Topic is seeking a technologically viable alternative to the Fast Burst Reactor (FBR) at White Sands Missile Range. This alternative should be capable of providing the Neutron radiation environment required for Nuclear Survivability Testing. The capability should not be considered an FBR Simulator, but rather a means of replicating that portion of the threat spectrum that the FBR presently supports. Such technology must eliminate the need for highly enriched Uranium or similar fuel as part of the test capability. The capability must also increase system availability and demonstrate a significantly reduced life cycle cost. The required minimum capability must be scalable to meet the following characteristics:
Burst and Steady state (Power) Modes
Burst Mode: up to 6.5E13 neutrons per square centimeter (n/cm2) of 45 microsecond pulse width
Steady State Mode up to 8 kW
Ability to provide mixed neutron/gamma environments

PHASE I: Conduct necessary Research and Development to identify and document all feasible options.
Describe and predict viable options to generate the required Neutron environments.
Provide Cost Estimates of all options researched as well as Pro/Cons of each option.
Conduct a feasibility study of all options researched and provide detailed results on cost and value.
Describe and document special facility requirements such as Power/Shielding/Diagnostics/Operational Issues/Safety.
Develop an initial design concept and model the key elements to include Neutron Generation, Controls, Diagnostics.
Develop a detailed analysis of predicted performance.
Phase I deliverables will consist of a Conceptual Design document, Predicted Performance, Facility requirements described above

PHASE II: Finalize the Design from the Phase I effort.
Provide a detailed plan for development of a prototype to include Modeling, Simulation and analysis.

Based on the Feasibility Study results of Phase I, Develop and Test a functional prototype.
Phase II Deliverables will include documenting the design of all key elements to include Neutron Generation, Controls,Diagnostics and addressing all Safety Requirements. The Prototype will be a deliverable.

PHASE III: The End State of this SBIR, if successful through Phase II, would be to replace the Fast Burst reactor at WSMR with a properly scaled develop system based upon the developed technology. This capability shall allow for survivability testing of items from component level (e.g. integrated circuits) all the way to System level (e.g. Tactical Ground Vehicle System). The most likely path for transition to an operational capability would be to seek funding through Army Investment and Modernization funds. Alternately funding may be obtained through the Office of the Secretary of Defense (OSC), Test Resource Management Center (TRMC) Central Test and Evaluation Investment Program (CTEIP). Commercial customers would benefit from Reduced Cost to test Satellite Systems/Components and DoD/White Sands Missile Range would benefit from a massive reduction in Security and Guard forces and logistical process required presently associated with operating a fast burst reactor.

REFERENCES:
1. Quadripartite Standardization Agreement (QSTAG) 244 "Nuclear Hardening Criteria for Military Equipment"

2. Army Regulation 70-75 "Survivability of Army Personnel and Materiel"

3. DoD Instruction 3150.09 "The Chemical, Biological, Radiological, and Nuclear (CBRN) Survivability Policy"

4. Standardization Agreement (STANAG) 4145 (NATO Document) "Nuclear Survivability Criteria for Armed Forces Materiel and Installations"

KEYWORDS: Neutron Sources, Nuclear Survivability, Linear Accelerators, Fast Burst Reactor, Neutron Radiation, Ionizing Radiation

A12-089 TITLE: <u>Free-Space Optical Communications: Light Detection and Ranging Enhanced Data Delivery</u>

TECHNOLOGY AREAS: Electronics

OBJECTIVE: Using a single laser source, demonstrate the capability to collect and transmit LiDAR (Light Detection and Ranging) data via free-space optical communications in an effort to expedite the delivery of tactical topographic information.

DESCRIPTION: LiDAR, or Light Detection and Ranging, is presently the fastest developing mapping technique in the geospatial sciences and is an invaluable asset to the Department of Defense (DoD). However, unless the expedited transmission of data is addressed, the capture, processing and delivery of LiDAR-generated tactical topographic products will not be possible in a manner advantageous to planners, field commanders, and ultimately the soldier.

Over the past 10 years, as laser scanning technology has developed, significant milestones have been achieved in efficiency of the collection of range points for mapping. For example, the time to collect 1 million range points has gone from 15 years using traditional survey methods, to 1.5 years using analytical stereo photogrammetry, to 6.7 seconds using a LiDAR operating at a Pulse Repetition Frequency (prf) of 150 kHz. Recently, with the development of flash LiDAR technology, full-waveform recovery, and Geiger-mode detection array-based systems, LiDAR is evolving from a topographic mapping-only system into a truly active remote sensing capability. As a remote sensing system, however, the tactical and terrain analysis benefits of LiDAR have yet to be fully realized, especially as the technology moves away from analog detection and processing (i.e., monopulse detection) to waveform digitization (i.e., full characterization of a target).

As LiDAR technologies become increasingly capable of delivering tens or even hundreds of returns per pulse, the utilization of this data will require novel delivery strategies and algorithmic processing approaches to make this information available to the Warfighter on an operationally-relevant timeline. To address the data capture and delivery issue, this SBIR solicitation seeks to explore the potential of enhancing LiDAR capabilities by using free-space optics (FSO) to deliver data using the same laser source that was used to acquire the data.

Presently, LiDAR acquisitions require anywhere from 48 hours to 14 days for meaningful product generation. This is typically based on first acquiring the data and either: 1) disk removal and transport to a processing facility or 2) radio frequency (RF) transmission of data in small packages to a processing facility. The recent adaptation of a free-space optics approach to data streaming is now moving data at a potential 10 Gbps or more providing faster through-put for processing. Furthermore, the advances in adaptive optics and real-time correction algorithms will provide for data continuity and quality control. While this capability development is being explored for the transmission of synthetic aperture radar (SAR) data, it has yet to be accomplished using the active source of a LiDAR system. The development of a dual-purpose laser system for data capture and delivery is considered to be a high risk / high reward technical obstacle.

PHASE I: Determine the technical feasibility of using short-wave infrared lasers, inherent to present-day LiDAR collection systems, as dual-use data transmission devices. Develop an innovative conceptual design which addresses laser attributes (e.g., wavelength- such as 1550nm, pulse rate, propagation, atmospheric effects such as scattering, absorption and scintillation), as well as payload / power issues in the adaptation of collection lasers to transmission lasers. This research should also present information on a realistic data streaming rate potentially achievable with such a conceptual system. Potential partners with regards to existing LiDAR collection systems should be identified.

PHASE II: Leveraging the results from Phase I, develop a prototype adaptable to a current theater-operational gimbaled LiDAR (preferably airborne system). Provide practical implementation demonstrating the acquisition of LiDAR data over a variety of topographies, and the subsequent pre-processing and data telemetry via free-space optics (using the same laser source) to transmit the data to a processing or collection facility. Address data continuity and quality control capabilities/limitations.

PHASE III: The expedited, FSO-based delivery of LiDAR data (via a novel, dual-use laser collection/transmission capability) would benefit both the mapping and tactical communities. From a commercial perspective, such advancement in geospatial data delivery would aid emergency response and disaster relief efforts. Technology transition would occur as integration into an existing LiDAR mapping system, and military applications would include expedited battlefield visualization and urban warfare planning.

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KEYWORDS: free-space optics, LiDAR, laser communications, data delivery, short-wave infrared, telemetry

A12-090 TITLE: <u>Processes or Materials for Vertebrate Cell Storage and Maintenance</u>

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop methods and/or materials to allow long-term storage of vertebrate cells under ambient conditions for use in portable cell-based toxicity sensors.

DESCRIPTION: As part of a research program to develop cell-based sensors for assessment of toxicity in environmental water samples the US Army Engineer Research and Development Center (ERDC) is seeking novel methods and materials for the long-term sustainment and storage of vertebrate cells. Unlike current biorecognition based sensors that utilize antibodies, aptamers, or other analyte-specific binding mechanisms, biosensors incorporating intact living cells can respond to emerging, unknown, or combinatorial chemical or biological threats and can act as broad spectrum screening tools(1). Many of the available rapid cell-based toxicity tests for water require significant control of environmental parameters, limiting their use under non-ideal field conditions(2). Current cell-based sensors are limited in utility and fieldability by the storage logistics and shelf life imposed by the use of vertebrate cell-based elements. The use of bacteria on portable, rapid toxicity sensors enables several long-term preservation methods such as freeze-drying or vacuum drying(3) that generally are not suitable for vertebrate cells. Importantly, the results of these bacterial cell-based biosensors cannot be directly extrapolated to vertebrate toxicity. Therefore, the use of vertebrate cells in portable, rapid toxicity sensors becomes ideal due to the direct translation of the toxicity information to a real time risk assessment. Significant advances in the development of biosensors utilizing mammalian cells have been made resulting in portable devices that improve the cell survivability(4) or storage conditions(5). To improve the fieldability and utility of cell-based sensing constructs we are seeking methods and/or materials to allow long-term storage of vertebrate cells under fieldable environmental conditions (see performance metrics below) that require minimal operating and preparatory steps prior to use.

PHASE I: Provide proof of concept demonstration of methods and/or materials for long-term storage of vertebrate cells with minimal operating and preparatory steps and environmental requirements. The concept will be original or will represent significant advances or extensions of existing approaches. Design and performance metrics for the proof of concept are given below. Note that due to the performance requirements cryogenic storage is not an acceptable solution.
1) The method and/or material must sustain cells for a minimum of 3 months with greater than 80% viability.
2) The method and/or material must require minimal temperature or environmental control during storage. An ideal method/material will sustain cells under ambient conditions with storage temperatures up to 40°C. Acceptable methods/materials may require controlled storage temperatures down to 4°C. Methods/materials requiring lower storage temperatures are not acceptable. Preference will be given to methods/materials capable of cell storage under ambient conditions.
3) The method must not require substantial user interaction to maintain cell viability. For example, solutions requiring frequent media or reagent changes or additions are not acceptable.
4) The method and/or material must maintain the physiological functioning of the cells.
5) Cells must be ready to use after storage in 3 hours or less with minimal preparatory or operational steps; shorter times are favored.
6) The method and/or material must be applicable to and effective for a broad range of cell types, including fish, amphibian, avian, reptilian, and mammalian. No method/material must be developed that specifically precludes the potential use of human cell lines.
7) The method and/or material must be transferrable to a glass or fused silica microfluidic chip OR allow facile loading of reanimated cells onto a glass or fused silica microfluidic chip with minimal operational steps.
Note that many of the criteria above apply only to the conditions required for storage/maintenance and not to initial preparation of the cells for storage/maintenance.

PHASE II: Expand on the Phase I proof of concept work to demonstrate extended cell viability and functioning for 6 months with greater than 90% viability and be ready to use in 60 minutes or less with minimal operational steps under the performance parameters described in Phase I. Demonstrate that the method is applicable to a variety of cell types including fish, amphibian, avian, reptilian, and mammalian. Additionally, the material and/or method must either be contained on a glass or fused silica microfluidic chip OR allow facile loading of reanimated cells onto a glass or fused silica microfluidic chip with minimal operational steps. The total weight of components necessary for cell sustainment, including protective case, consumables, and any necessary hardware should be less than 2 lbs. Total volume, including protective case and any consumables should be less than 1.0 ft(3) – note that this requirement applies only to cell storage/sustainment and not to initial cell preparation for storage. Smaller and lighter solutions are favored. Demonstrate that the method is viable under environmental conditions encountered in field testing. Phase II deliverables include equipment and materials for independent evaluation and testing.

PHASE III: Evaluate the ability of the material/method to preserve cells used in cell-based sensor constructs during field testing. The material/method will be used with the SafePort water analysis system as well as other systems incorporating cell-based sensors(6). Methods to preserve cells for cell-based sensing have potential applications in a wide variety of areas including drug toxicity screening in pharmaceutical studies, toxicity screening of municipal and military water supplies, and studies of environmental toxicity. A well-formulated marketing strategy will be critical for success in these commercial applications.

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KEYWORDS: Cell, microfluidic, toxicity sensor, cell preservation, water, environmental contaminants

A12-091 TITLE: Field-portable Quantitative Test for Chlorinated Organic Compounds in Water

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop a field portable analysis capable of detection and quantitation of chlorinated organic solvents in environmental water samples.

DESCRIPTION: As part of a research program to develop field-portable sensors for water contaminants and toxicants, the US Army Engineer Research and Development Center (ERDC) is seeking novel methods for rapid quantitation of chlorinated organic solvents in environmental waters. Chlorinated organic solvents, such as trichloroethylene (TCE), dichloromethane (methylene chloride), tetrachloroethylene (perchloroethylene, PERC), and trichloroethane are employed as industrial solvents in both military and civilian applications and have proven to be persistent environmental contaminants. While the military has largely phased out use of these compounds, detection of their presence in contaminated ground water is an ongoing concern due to known toxic and carcinogenic effects associated with exposure (1, 2). Current methods primarily involve the use of gas chromatographic/mass spectrometric (GC/MS) methods (3, 4). While field-portable GC/MS instrumentation is available, the associated logistical burden is cumbersome and not ideal for rapid sensing in the field. We are seeking innovative research and development to provide hardware and methodology for quantitation of chlorinated organic compounds in environmental water samples with rapid analysis times and minimal sample processing steps.

PHASE I: Provide proof of concept demonstration for quantitation of chlorinated organic solvents in water. Design and performance metrics for the proof of concept are given below. The concept will be original or will represent significant advances or extensions of existing approaches. Note that due to the performance metrics, gas chromatography (GC) based solutions are not acceptable. The proof of concept will demonstrate the technical feasibility of all key elements required for successful execution of the proposed method.
1) The method should provide quantitation of chlorinated solvents in environmental water samples with limits of detection less than 5 ppb.

2) The method should require minimal processing steps and require less than 30 minutes from water sample collection to results.
3) The method must be transitionable to a glass microfluidic chip-based design.
4) All hardware and consumables must have a shelf life of at least 6 months with minimal temperature or environmental controls.
5) The solution must be transitionable to a handheld, battery-powered device.
Preference will be given to technologies that provide quantitative analysis of individual compounds in a mixture with the highest priority given to selective and quantitative measurement of trichloroethylene (TCE).

PHASE II: Expand on the Phase I proof of concept work to construct and demonstrate operation of a prototype chlorinated organic solvent quantitation system. The system, including protective case, hardware, and consumables must be less than 2 pounds and must occupy a volume less than 1.0 ft3. Demonstration will include determination of limits of detection, sensitivity, selectivity for particular compounds, characterization of interferant effects, and response time using simulated environmental samples. Phase II activities should also demonstrate device feasibility under field testing conditions. Phase II deliverables also include two devices for independent evaluation and testing.

PHASE III: Evaluate the ability of the device to quantify chlorinated organic compounds in field studies. Field tests will involve testing at Army and USACE sites. This device will be incorporated into the SafePort™ hand-held water analysis system. Military uses include detection and quantitation of chlorinated organic compounds on military lands and ranges and monitoring of cleanup activities. Civilian uses include monitoring of municipal water supplies, environmental compliance studies, and environmental monitoring of industrial process or waste streams. A well-formulated marketing strategy will be critical for success in these commercial applications.

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KEYWORDS: Chlorinated organic solvents, trichloroethylene, quantitation, water, field-portable, detectors, sensors

A12-092 TITLE: <u>Environment and Conflict: Developing a Framework for Vulnerability Assessment.</u>

TECHNOLOGY AREAS: Battlespace

OBJECTIVE: To develop a framework that understands and synthesizes the relationship between the natural environment, local populations, and the corresponding impact upon operations in areas of conflict.

DESCRIPTION: Environmental security and human security are inextricably linked. However, less understood is the impact that environmental security can play in creating conflict or providing stability within a community. Secondly, the lack of a synthesized framework to understand and assess impacts of this relationship means that they are not fully incorporated into military doctrine or planning paradigm. By seeking to fulfill this void, this SBIR's objective is to systemically document the impact of environmental security upon local populations and the role that military operations can play in sustaining and mitigating potential conflict.

As the US Army is increasingly involved in military operations located in areas where the natural environment is a contributing factor to the conflict, it becomes important to understand what quantifies the environment and qualifies how it contributes to the surrounding conflict. Therefore, the environment has significant potential in either positively or negatively affecting military operations. For example, a degraded natural environment can introduce stress into an area of operations and in conjunction with other factors, either initiate conflict or exacerbate existing conflict. Additionally, US Army operations can either directly or indirectly cause an environment to be degraded, thereby introducing undesirable 2nd and 3rd order effects as a result. To understand how military operations affect the natural environment and local populations, and conversely how the natural environment and local populations affect military operations will require a systemic perspective that looks at the military operations, the natural environment, and the local population all holistically together.

Given the changing security landscape, it is imperative to understand the nuances that structure the relationship between environmental security and human security. Although it is one that has been generally understood, sometimes even anticipated and expected, the connection between environment as a catalyst for conflict or cooperation is one that has yet to be tangibly proven. To what degree can human security be linked to the environment? It is evident that there is an overwhelming need for the military to assist positively relationship given the potential for more successful military operations.

In attempting to deal with these types of problems, the US Army has been increasingly looking at how to view the complex operational environment from a systemic perspective - especially when it comes to COIN (counterinsurgency) operations. PAM 525-5-500 discusses the "wicked problem" and the need to look at the battle-space from a systemic perspective. Numerous articles in Military Review and Parameters have cited the same need, especially in articles pertaining to the Army's new concepts on operational design. Operational design is reflected formally in new US Army doctrine - specifically FM's 3-0 and 5-0.

However, while the general need for a systemic approach has been described in these documents, the difficulty comes in how to actually executing the approach into practice - especially when capturing and modeling the social, environmental, and conflict systems. Given that the natural environment has the potential to: 1) contribute to conflict; 2) finance and sustain conflict; 3) undermine peace-making, it is necessary to thoroughly understand how the environment operates in initiating and transforming conflict. This SBIR will also consider how environmental remediation has the potential to sustain effective local governance.

PHASE I: The contractor will need to create a notional framework that captures and incorporates conceptually both the significant entities and significant relationships of elements from all three systems: the social, environmental, and conflict systems. During this phase, a framework will be developed that will provide a comprehensive capability for capturing and assessing the inter-related roles that social, environmental, and conflict systems have on each other in a dynamic setting across time and space. We know that it is not desirable or practical to build a complicated social/environmental/conflict system from scratch. The goal is to provide a framework with a practical number of significant entities and relationships that would allow a tactical commander to understand and explain his system and then effect change. Ideally, we want a tool that will allow a commander to create and model his own environment so that he can develop COAs and do "what if" scenarios. Finally, the contractor must demonstrate some basic capability to build a portion of the proposed framework with software developed under this contract.

PHASE II: Using the framework derived from Phase I, the contractor will complete system design. The contractor will develop the framework as defined in Phase I as a prototype software system. The prototype system will further develop and enhance the capabilities developed in Phase I. The software must minimally allow the commander to visualize and understand the indicators of the natural environment, the social factors and conflict. The SBIR will analyze the continuum between conflict and cooperation and the role that the environment plays within it.

PHASE III: Using methods derived from Phase I and Phase II, a deployable vulnerability assessment will be the final outcome. The vulnerability assessment tool will be able to diagram vulnerability based upon set metrics and indicators. This should be demonstrated within a variety of diverse case-studies. The system tool will incorporate both quantitative and qualitative methodologies and attempt to bridge the gap between measuring direct and indirect correlations and causalities between the environment, local populations and conflict. Potential users of this technology beyond the Army include: State Department, USAID, NGOs, World Bank etc.

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KEYWORDS: Environment, conflict, stability, counterinsurgency

A12-093 TITLE: System for Application of Biopolymer for Revegetation of Soil

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop technology for application of biopolymer (non-petroleum-based compound) for rapid revegetation and soil improvement on active training lands for improved usage and surface water quality, and reduced dust emissions.

DESCRIPTION: Military training activities often result in environmental degradation due to creation of heavily disturbed soil areas. These heavily disturbed areas include, but are not limited to, dirt road beds, vehicular training areas, tank trails, training areas for earth moving engineering systems, terrain subject to wildfires, artillery impact areas, helipads and dirt landing areas for aircraft. These areas are currently a challenge in that they are resistant to revegetation efforts. These sites are also susceptible to sediment loss through water erosion and the generation of dust through wind erosion. The traditional revegetation process requires fertilization and application of a moisture retention agent, currently a petroleum-derived polymer. Dust reduction on dirt roads currently requires application of either water retentive and/or a petroleum product. Surface applied fertilization provides temporary vegetative growth and often leads to nutrient transport to surface waters, eutrophication of those waters and regulatory scrutiny. The petrochemical products most often used as soil additives are known to leach carcinogenic monomers and their use is often regulated by environmental entities. The technical challenges that research and development efforts should address are:
1. Specific soil mass loadings based on plant and soil type
2. Biopolymer application methods for optimal performance
3. Delivery techniques including wet or dry introduction of biopolymer to soil or seed coatings amended with the R.T biopolymer.
4. Selection of seed mixtures coordinated with biopolymer for specific climates and land use parameters.

This solicitation will address EO 13514, which encourages the use of sustainable practices on all DoD installations and promotes conservation and protection of the water resources of the nation through storm water management and erosion control. In addition, this innovative research will support recommendations set out in AR 200-3 (modified 2000) and PWTB 200-3-30 (2004), “Current Technologies for Erosion Control on Army Training Lands.” Innovative techniques for reduction of both water and wind-driven erosion of soil falls under several Federal laws and regulations including the Clean Air Act (1990), Clean Water Act (1972, 1990), Soil and Water Conservation Act (1977), and NEPA (1970). It is expected that successful Small Business Innovative Research will contribute to revisions of the Army’s BMP Technical Bulletin 200-3-30.

PHASE I: Design an optimized system and techniques through the development of soil mass loading rates for biopolymer based on climate, soil type and native plant species commonly used for re-vegetation activities of eroded or otherwise degraded soils. These application rates should be high enough to reduce sediment transport in runoff water and fugitive dust emissions across a range of climate and use conditions but low enough to keep the biopolymer commercially competitive with petroleum-based soil stabilization products. Develop preliminary (proof-of-concept) data for innovative methods of biopolymer/seed delivery based on climate, soil type and land use that may include, but are not limited to, hydroseeding, seed coatings for aerial delivery, as well as wet and dry application methods. The success criteria for the concept of biopolymer for erosion control and re-vegetation of degraded lands are:

• Decreased sediment transport in runoff water
• Decrease in fugitive dust emissions
• Rapid establishment of planted species compared to controls as measured by above ground biomass and soil coverage
• Increased rate of germination for seeds in the biopolymer-treated soil versus seeds in an untreated control soil
• Increased drought tolerance for seeds in the biopolymer-treated soil versus seeds in an untreated control soil
• Increased root mass for plants in the biopolymer-treated soil versus plants in an untreated control soil

PHASE II: Based on the results of the preliminary testing and the application design schemes (Phase I), perform a pilot-scale test for application and evaluation of biopolymer for rapid re-vegetation of heavily disturbed soils in areas where soil disturbances are contributing to loss of topsoil, excessive fugitive dust emissions, and/or reduced habitat or soil viability. The success criteria for the pilot-scale evaluation are:

• 75% reduction of total suspended solids in runoff water from the biopolymer-treated area versus an untreated control area
• 50% reduction of fugitive dust emissions from the biopolymer-treated area versus an untreated control area
• 50% increase in viable habitat for indigenous species versus a control area
• Increase in soil quality indicators such as soil nitrogen content as a result of the growth of multiple crops of nitrogen fixating legumes, organic carbon, soilorganic matter.

A technical report will be provided that documents the optimized system and techniques for the application of a biopolymer formulation for the revegetation of disturbed soil areas, preliminary data for application of the biopolymer using candidate climate specific plant species commonly used for revegetation, design schemes for field application, and results of preliminary laboratory tests that address the Phase I and Phase II success criteria.

PHASE III: Develop a commercial system for application of the biopolymer to areas of heavily disturbed soil that can be used throughout the Army and DoD. Based on the results of Phases I and II, perform one or more field demonstrations on an active or closed U.S. Army facility using the commercial system for biopolymer application. Other commercial applications could be found in the construction or agriculture industries.

• Completion of multiple soil amendment procedures in varied climates and soil types representing a range of Army facilities.
• Publication of guidance documents detailing specific approaches for the use of biopolymer soil additives for revegetation of disturbed soils
• Design and commercialization of a biopolymer production system for efficient production of biopolymer soil amendments
• Design, production and commercialization of specialized soil amendment systems for efficient introduction of biopolymer for re-vegetation.

REFERENCES:

1. AERTA CN-5-02-04: Managing Cumulative Impacts on Installation Lands

2. Executive Order EO 13514

3. AR 200-3 (modified 2000)

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KEYWORDS: KEYWORDS: Biopolymer, revegetation, sustainable range, water erosion, wind erosion, erosion control

A12-094 TITLE: Downscaling Techniques for Ground State Information

TECHNOLOGY AREAS: Battlespace

OBJECTIVE: Define and develop scaling algorithms to support rapid computation and identification of Army scale soil strength

DESCRIPTION: The computation of high resolution near surface profiles of soil moisture is critical to determining soil strength for Army scale mobility predictions, DoD target acquisition and identification, and flood mapping. There is a significant technology gap between the ability to compute high resolution soil moisture maps in austere environments due resolution limits in remote sensing and weather modeling technologies (weather scale). New methods are needed to bridge the gap between the limits of available coupled weather and land surface modeling science with target and mobility scale resolutions required by Army. This topic addresses a specific goal of developing mathematical modeling method designed to bridge the gap between weather scale and Army scale.

PHASE I: This proposed SBIR seeks to define downscaling and up scaling algorithms and related available software and hardware to support rapid identification of areas of low surface soil strength and related soil moisture. The study is expected to support mobility predictions, buried explosive detection, improved flood models, and other related terrestrial engineering studies. The downscaling algorithms will support current data sources for soil moisture at the global scale as generated at resolutions of 25 kilometers or less as distributed by the Land Information System (LIS) generated by the Air Force Weather Agency (AFWA). Currently the LIS fails to define the localized extremes in soil moisture variability occurring due to elevation changes, vegetation, soil type, or other related factors. Local weather stations provide only point data requiring upscaling of information to define soil moisture outside the local area. The investigator will address innovative techniques to support in downscaling and up scaling soil moisture data.

The required deliverables in Phase I will include bi weekly progress reports, a prototype algorithm supporting input of low resolution soil moisture along with correlated attributes (as defined in this study) with outputs of high-resolution moisture data, and supporting ground truth documents of the down scaling and up scaling programs. The small business will produce a conceptual design and breadboard supporting the development and demonstration of a prototype program to downscale moisture data derived from existing LIS AFWA supplied data sets, elevation data, soils data, and any other data sources determined as highly correlated to changes in soil moisture. Obtaining soil moisture grids at 1 to 25 kilometer resolution, the small business will define soil moisture variations at scales of the existing elevation grids of 100 meters or less. The resulting algorithms should be sufficiently portable enough to allow integration into a Geographic Information System (GIS) or Open Geospatial Consortium (OGC) compliant mapping system.

Simple interpolation algorithms are limited due to the complex nature of multiple hydrologic processes affecting the soil moisture. Conversion of this soil moisture to standard units such as rating cone index, to support maneuver predictions would be part of the research effort. The research will provide algorithms which produce high resolution soil strength and/or soil moisture maps at minimum resolutions of 100 meters. The product would identify calibration sources and define the expected error in the predictions for risk assessment. This phase will demonstrate the feasibility of producing a demonstration of downscaling of soil moisture data within the US and Afghanistan, and will outline the demonstration success criteria by the generation of a first generation downscaling/up scaling tool box. The study will include reviews of innovative methods to validate the new high resolution maps of soil moisture.

PHASE II: The contractor will develop, demonstrate, and validate the down scaling and up scaling algorithms created in phase I with sites in the US and at least one site overseas. Required phase II deliverables will include source code and program which takes as input low resolution global soil moisture data and related information from AirForce Weather Agency and process this data using correlated terrain data such as elevation to resolutions of 100 meters or less. The soil moisture data should be exhibited in terms of volumetric and gravimetric data using the most current soils information for the region. The data for the top 10 centimeters should show good correlations with ground truth collected in the regions. The deliverables will include sample data supporting the downscaling technique for a region no less than 40 kilometers by 40 kilometers in the US and a least one site overseas. The program is expected to be a toolbox within ArcGIS which takes as input the data source required to generate the high resolution data grid.

The contractor will also develop, demonstrate, and validate a up scaling algorithm as a component of a GIS or OGC-compliant web mapping service which takes as input a one or more weather stations and generates the a grid of soil moisture at the resolution of 100 meters or less within a region of 40 km by 40 km.

The contractor shall demonstrate the accuracy of both the downscaling and upscaling techniques using a jackknife statistical approach. The correlation between the predictions will be supplied as an additional attribute in the shape file created from the ArcGIS toolbox.

During Phase II the contractor will have biweekly telecoms with the government POC and provide a report each quarter detailing progress. Updated versions of the program will be provided to the government at the end of the study along with source code and documentation.

PHASE III: Numerous industries within the U.S. see impacts from high soil moisture or weakened soils, including logging, construction, and agriculture. The ability to compute high resolution soil strength would benefit each commercial sector. Inversely, the ability to compute high resolution soil moisture states for agriculture, better identifying areas of excessively moist or dry soils at small field-scale resolutions, could lead to better improved irrigation and fertilization efficiencies.

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5. Army Regulation 10-87, Organization and Functions: Army Commands, Army Service Component Commands, and Direct Reporting Units, HQ Department of the Army, Washington, D.C., 4-September-2007

6. Moore, D. W. (April 1989). "The Influence of Soil Surface Conditions on the Traction of Wheeled and Tracked Military Vehicles," Technical Report GL-89-6, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

KEYWORDS: Soil Strength, soil moisture, downscaling, weather, target acquisition, maneuver support, Land Information System, remote sensing

A12-095 TITLE: Improved Solar Shade (ISS) with Enhanced Durability and Performance

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: To research and develop a modular, ruggedized, Improved Solar Shade (ISS) material and deployment system.

DESCRIPTION: Solar shading has been demonstrated to be the most cost effective approach to reduce fuel consumption for climate control in expeditionary shelters. These relatively simple, low cost shades have a very high Return on Investment (ROI). Current solar shade systems lack in durability as they have typically only lasted through about one (1) year of use. [10] This design life is severely less than the shelters, supplies, and equipment that the shade would protect and cover. The strike and erect process of solar shades after they have been used for an extended period of time often result in fabric tearing in the degraded material.

Data collection through Net Zero+ Joint Concept Technology Demonstration identified solar shading as one of the most significant energy saving solutions for expeditionary shelters in warm climates, offering a dramatic ROI. [12] Providing greater than 70% solar block capability and an air gap (convective cooling) between the shade and the covered object greatly lowers the effects of solar heating. With shading:

- Shelters demand significantly less energy to maintain a constant cool temperature
- Environmental Control Units (ECU) function more efficiently
- Fuel and water bladder material lifespan can increase.
- Supplies and other equipment remain cool and pose less of a hazard.

A new solar shade system is desired that is designed to shade objects with various forms to reduce visual signature and lessen volume of the packaged system. This is best facilitated by employing modules or kits, for example, using a large initial "starter kit" to cover a 32 foot long TEMPER-Air Supported shelter with available add-ons for shading vestibules, ECUs, or annexing kits. Starter kits could also vary in size based on the shelter, equipment, or supplies being covered.

The following are the technical requirements for the shading material:

Characteristics	**Requirement**	**Test Method**
Fabric Weight (oz/yd^2)	$\leq$ 10	ASTM D 3776
Breaking Strength (lbs.)		
Warp	200	ASTM D 5034
Fill	200	
Tear Strength (lbs.)		
Warp	20	ASTM D 1424
Fill	17	
Flame Resistance		
Initial-		
After Flame:		
Warp (seconds)	2	
Fill (seconds)	2	ASTM D 6413
		NFPA 701
After Glow:		
Warp (seconds)	3	
Fill (seconds)	3	
Melt Drip:	0	
Fill (inches)	0	
Burst Strength (lbs.)	175	ASTM D 3787
Opacity (of visible light)	T: 70%, O: 90%	ASTM D 5780/5781
Air Permeability (CFM/ft^2)	Minimum of 900	ASTM D 737
Gloss		
60^{o} specular gloss	2%	ASTM D 523

85^{o} specular gloss	2%	
Reliability (months)	48 (active) 90 (stored)	No degradation of mission performance after exposure to temperature extremes, weathering, UV, mildew or POL. MIL-STD-810 FED-STD-191, method 5804 AATCC, Method 159 (UV) ASTM G 21 (mildew)
Toxicity	Nontoxic	Nontoxic to the skin or eyes
Color	Tan (686A) Or Green (383)	FED-STD-595

PHASE I: Develop a new, more ruggedized solar shade material that can withstand a higher degree of environmental effects (primarily UV, high wind loads) and achieve a longer useable lifespan than the first generation. The total life span for the new solar shade will be four (4) years. The objective is to accomplish this increased durability while maintaining or improving upon the shading ability and its energy saving effects. Measuring the improved shading will consist of opacity thru the shade; a standard test shown in the chart above. [2] The improved durability will include a longer life span, less tearing in the fabric and less degradation in the material. Measuring the durability of the solar shade will consist of strength testing, the weathering of the material, and air permeability tests; these tests are all referenced in the above chart. [2] The fabric weight must be less than 10 oz/yd, as shown in the chart. [2] The package volume should be no greater than the current solar shade system (NSN 5410-01-519-7185); the system as a whole should be optimized for both weight and packing volume. For reference purposes, a 50 foot by 50 foot solar shade system weighs 220 pounds and should be optimized for packing volume. Deliverables for Phase I would include samples of all of the improved fabric/material considered for shading, environmental, and durability testing. Only one fabric/material solution is required, but multiple are acceptable for Phase I. Sample sizes for each of the prototype materials should be no less than fifteen (15) continuous yards for testing and evaluation of the prototype material. In addition to an improved material, an improved system for assembly and system deployment is also desired. The second Phase I deliverable will be to provide multiple concepts and/or models for an ISS deployment system.

PHASE II: Phase II should consist of optimizing the shade material developed in Phase I for manufacturing large quantities and continuing to develop the ISS deployment system. The objectives will include developing “starter kit” systems that are form fitting to the shelter to reduce system volume and weight. The second objective will be to continue to develop multiple “add-on kit” designs. By the end of Phase II, the ISS material and system should comply with all the characteristics/metrics described in this solicitation. The deliverables will be five (5) full ISS system “starter kits” for 32 foot long TEMPER-Air Supported shelters, two (2) vestibule “modules,” and one (1) annexing “module” for testing and evaluation purposes. The ability of the starter kit to integrate with each module type will also be evaluated. These kits will include the new ISS fabric/material and all hardware required for deployment. The cost goal for the ISS system should be roughly the same as the current systems, ~$1/square foot, or less.

PHASE III: Phase III should include a manufacturing plan for full scale production and supply for this technology as part of a commercialization strategy. As discussed in this solicitation, shading is the most efficient way to reduce the energy demand caused by solar heat load. The return on investment (ROI) on solar shades is very high in comparison to other technical solutions. A more durable ISS could benefit all the US armed forces branches that deploy temporary structures in addition to benefiting any commercial or industrial temporary structures under high solar heat load. This technology could be used to reduce energy costs in both Contingency and established bases as solar covers over shelters and can also reduce heat load in open environment areas for stored equipment and maintenance facilities. The solar shading fabric technology has commercial and residential applications that include skylight covers, patio covers, awning applications, event shading, and shading systems for parking lots.

REFERENCES:
[1] Solar Shade System Purchase Description (5-18, 2004)

[2] ASTM D 523, D 737, D 1424, D 3776, D 3787, D 5034, D 5780, D 5781, D 6413,

[3] ASTM G 21

[4] NFPA 701

[5] MIL-STD-810

[6] FED-STD-191

[7] FED-STD-595

[8] AATCC Method 159

[9] Solar System Fact Sheet

[10] Journal of Photochemistry and Photobiology, B: Biology 46 (1998) 96–103, Effects of increased solar ultraviolet radiation on materials, A.L. Andrady, S.H. Hamid, X. Hu, A. Torikai

[11] DoD Power, Energy & Propulsion 2011, Green Solutions for Shelter Systems, Marty Kauchak,

[12]Net Zero Plus Joint Capability Technology Demonstration Energy Saving Technologies for Expeditionary Structures Report (Draft)

[13] Air Force Civil Engineer vol.18/3, 2010, Energy Initiatives Expeditionary, Rod Fisher, Richard Peck, Maj Paul Sand

KEYWORDS: Shading material, Solar Shades, Solar Shade System

A12-096 TITLE: Anthropometric Casualty Estimation Methodologies

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Define, develop and demonstrate anthropometric casualty estimation methodologies for analyzing personal protective equipment fit and form taking into account individual body shape differences impact on Soldier protection

DESCRIPTION: Soldier force protection is a major Army challenge to ensure the highest degree of Soldier survivability across the spectrum of Army operations. Soldier body armor is designed to provide individual ballistic and blast protection to improve the Soldier survivability when facing small arms fire, artillery, and secondary fragmentation from explosions (e.g. improvised explosive devices, IEDs). Body armor, and other wearable protective equipment, fit individual body shapes differently and the variation in coverage leads to variation in Soldier protection and survivability. For example, the Army's Interceptor body armor uses four rigid plates that can stop most lethal bullets; however the wide ranges of body types results in variations in fit that can impact protection. The Army has a need for improved tools to assess the effectiveness of material solutions to provide Soldier protection while taking into account the variation in individual protective equipment fit.

Key metrics are to take into account most individual body shape variations in the design of Soldier protective equipment as well as to identify critical fit and form issues and their associated impacts. The Army has invested heavily in an anthropometric survey and the collection of accurate three dimensional (3D) data of active duty Soldiers to enable development of better anthropometric models to assist in Soldier clothing and equipment design. New and innovative anthropometric-based casualty estimation methodologies are needed that can leverage and utilize these 3D data sets to design improved protective systems that better fit the range of body types to optimize Soldier protection while maintaining combat effectiveness.

PHASE I: Research and develop an innovative approach to advance the design of anthropometric casualty estimation methodologies capable of addressing individual body shape differences for the design of Soldier protective equipment. The approach must start with a needs assessment to identify potential design alternatives and assess their capability to support, develop, extend and integrate into existing capabilities. Assumptions, limitations, barriers and bounds of design alternatives shall also be assessed and presented. Proposed methodologies will enable the quantifying of the impact of body size/shape variation on the fit and form of Soldier protective equipment on Soldier survivability. The design must also provide a clear explanation of how the proposed concept can be extended in more detail and how any potential concept shortfalls can be achieved in a SBIR Phase II effort (this task will not be accepted as a Phase I option task). A proof-of- concept of the soundness, feasibility and validity of the proposed advanced design approach concept will be performed. The concept must clearly demonstrate a linkage between high level and low level elements and express the critical need for their inclusion. The Phase I process and results will be captured in a final report identifying the recommended design approach, process, assessment, details and rationale for recommendation.

PHASE II: Define and refine a functional prototype of anthropometric casualty estimation methodologies designed in Phase I. Demonstrate how the prototype system supports a practical implementation for conducting anthropometric based casualty assessment on standard anthropometric data sets to represent individual body shape variation for Soldier protection and PPE design. Conduct verification and validation (V&V) studies to establish that the model properly represents the body fit variation data (i.e. scan, survey data, etc) to support casualty assessment. Document the design, development, resulting Phase II products, process and demonstrations of the proposed concept to include a listing and explanation of assumptions, traceability, barriers and bounds associated with the modeling approach.

PHASE III: The initial use for this technology will be to allow design of improved protective systems that fit the range of body types to optimize Soldier protection. The SBIR results could also support various commercial applications. Examples of potential applications range from local and state government first responders and disaster preparedness organizations, logistics planning and forecasting, police planning and mission rehearsal, and the software gaming industry.

The SBIR results could support various commercial applications by extending the concept and prototype developed in Phase I and II for commercial and military use, such as demonstrating the use of the tool in early Soldier protective equipment design or selection processes. Multiple commercial applications exist for this SBIR technology to include commercial protective equipment design and manufacturing, and even use in sports applications, such as protective equipment against sports injuries in football, car racing, hockey, and extreme sports.

REFERENCES:
1. The Integrated Casualty Estimation Methodology (ICEM) Analyst Manual, ICEM version 1.0, Dec 2003.

2. ANSUR II information at http://nsrdec.natick.army.mil/media/print/Army_ANSURII_Trifold2.pdf and http://nsrdec.natick.army.mil/ansurII/

KEYWORDS: Anthropometry, casualty estimation, force protection, body armor, personal protective equipment.

A12-097 TITLE: Non-invasive Detection System for Assessment of Oxidative Status

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: To develop a portable detection system to assess oxidative status of the Warfighter using non-invasive techniques and to determine the effects of micro nutrient interventions.

DESCRIPTION: Strenuous physical exertion induced Reactive Oxygen/Nitrogen Species (RONS) production in the muscle has been correlated with degradation of muscle force output, fatigue and muscle soreness in animal and human models[1]. RONS are generated during normal metabolic function and have important roles in cell signaling. However, when production of RONS in the body exceeds the body's innate ability to neutralize them, oxidative stress occurs, compromising physiological function due to cellular damage[2,3]. RONS can induce cellular damage by oxidizing lipids, proteins, and DNA[4]. Oxidative stress, defined as oxidative damage to cells and tissues caused by unregulated RONS production, contributes to degradation of physical performance and can occur due to environmental and physiological stressors, traumatic injury and physical exhaustion[5]. Moreover, oxidative stress is known to play a role in muscle atrophy6 which is commonly experienced during Warfighter recovery from injury. Oxidative stress stimulates the endogenous antioxidant defense systems, and when intrinsic mechanisms are depleted, oxidative stress may be mitigated by exogenous antioxidants found in foods to maintain cellular homeostasis[7,8,9]. Recent studies show that low-level RONS production that occur during exercise/training contribute to beneficial muscle adaptations by inducing up-regulation of antioxidant enzymes[2]. Excessive consumption of dietary/supplemental antioxidants has been shown in animal and human models to negatively impact muscle adaptation to exercise and aerobic performance, by blunting RONS production and up-regulation of antioxidant defenses[10]. Hence, it is important to maintain beneficial levels of RONS, so as not to compromise Warfighter adaptation to initial military training (IMT), and reduce combat effectiveness.

A non-invasive detection system is required to assess/discern the changes between baseline oxidative status and oxidative states involved in muscle adaptation or cellular damage in the context of the effects of dietary interventions and physical performance in healthy and recovering Warfighters. Detection system performance goals include adequate sensitivity, precision and accuracy to determine the influence of dietary intervention on oxidative status biomarkers. A systemic measurement is critical for accurate assessment of overall status. Various biomarkers exist for measuring oxidative status, however, the degree to which they are altered may depend on the physical challenge. Therefore the detection system should also demonstrate effectiveness over a range of physical challenges (e.g., IMT, field training) faced by the Warfighter. Successful quantification of changes in oxidative status that stimulate muscle adaptation and cause cellular damage would enable researchers to recommend nutritional strategies.

A non-invasive assessment tool will significantly reduce the overall cost and time needed to sample invasive fluids (e.g., blood), which is generally difficult and not suitable during field research. Proof of beneficial effects of bioactive nutrients on oxidative stress and Warfighter performance has been elusive largely due to technological limitations in measuring blood biomarkers[11, 12]. As a result, the evidence is minimal regarding the mechanisms by which environmental stressors and common physical challenges faced by the Warfighter promote oxidative stress and degrade performance. The proposed research tool would facilitate the establishment of accurate baseline oxidative status measurements, to examine effects of dietary interventions and how it relates to Warfighter performance[10]. This system will benefit future research designed to understand the relationship between oxidative status, nutrition and Warfighter performance.

PHASE I: Initiate design concepts for a non-invasive detection system with a small footprint <100 lb and <4 ft[3]. System must be robust (conducive for field research) and designed to operate in extreme temperature (32oF to 120oF) and humidity (20 to 100%) ranges. Conduct feasibility studies utilizing proof of principle. Submit a report describing the science supporting the systemic oxidative status detection system and any proof of concept data. Address any technical barriers.

PHASE II: Develop an innovative non-invasive detection system for measuring oxidative status. Design and conduct tests to demonstrate device capabilities. Suggestions for test design follows. Trials should be based on a resting condition and at least 2 typical physical activities (i.e., mandatory morning physical training, field training scenario) performed by the Warfighter. Test detection system by establishing oxidative status at resting baseline and compare to oxidative status during and after a strenuous physical activity [(i.e. maximal graded aerobic exercise performance test on a treadmill, (VO2 Max test)] between placebo vs. antioxidant supplement. Measure at least two previously validated blood biomarkers of oxidative stress to determine cellular damage and verify that changes in oxidative status have exceeded the buffering capacity of intrinsic antioxidant defense systems. Using the data established for the cellular damage study, determine the % change in oxidative status that is associated with training adaptations and performance decrements, also comparing placebo vs. an antioxidant supplement group and account for dietary and physiological variation. Then test detection system in a relevant (field simulated) scenario evaluating the effect of dietary intervention (fruit and vegetable extract or powder) on oxidative status. Time will be built in for proper submission, of all necessary human use protocols, and approval through Institutional Research Board (IRB) and Human Use Research Committee (HURC) in collaboration with USARIEM. Submit monthly progress reports. At the end of Phase II deliver prototype [6] and a final report. The report must include system and study design protocols and data, appropriate documentation such as protocols for operation, instruction manuals, such as sensitivity limitations, test throughput, training, materials required, lifecycle, routine maintenance and disposal requirements.

PHASE III: Conduct a field test demonstrating the technology in a Warfighter relevant environment including operation, sensitivity limitations, training, lifecycle, routine maintenance and disposal requirements. Phase III will include DoD/CFD evaluation of detection system. Dual use partners will be identified to co-evaluate device. Possible dual-use may exist; other researchers may use for a similar purpose to assess dietary intervention effects on the oxidative state or to assess oxidative state under certain test conditions; for use in clinical setting to supplement other diagnostic tests; for use by USARIEM and other medical professionals to monitor those most at risk and provide nutritional intervention; or possibly for use in training Warfighters/high performance athletes and for other trainers. Potential interest from DARPA collaborator expressed at 'Point of Use Nutritional Diagnostic Devices Workshop' (15 Nov 2010).

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13) Powers, S.K., Smuder, A.J., Kavazis, A.N., and Hudson, M.B. Experimental Guidelines for Studies Designed to Investigate the Impact of Antioxidant Supplementation on Exercise Performance. International Journal of Sport Nutrition and Exercise Metabolism, 2010, 20, 2-14.

14) Point of Use Nutritional Diagnostic Devices Workshop held by DARPA, November 2010. Final Agenda only. (Uploaded in SITIS 6/5/2012.)

KEYWORDS: Oxidative stress/status, antioxidant, performance, rapid non-invasive assessment

A12-098 TITLE: Multi-functional Integrated Drive System Sensor(MIDSS) for Rotorcraft

TECHNOLOGY AREAS: Electronics

ACQUISITION PROGRAM: PEO Aviation

OBJECTIVE: The objective of this SBIR is to develop a Multi-functional Integrated Drive System Sensor (MIDSS) capable of measuring multiple parameters critical to the operation and health of a rotorcraft drive train.

DESCRIPTION: This effort will develop a MIDSS capable of measuring strain, vibration, torque and temperature at multiple locations. The ability to provide complete measurement capability for an entire gearbox or set of shafts is desired. The MIDSS measurements should be of sufficient accuracy and sampling rates for monitoring of normal drive-train function, detecting and quantifying over-speed or over-torque conditions, and use in calculation of advanced drive train health indicators. The MIDSS needs to be capable of interface to cockpit displays as well as being fed to on-board monitoring systems. The effort should address the sensor requirements such as accuracy and resolution, networking or multiplexing capacity, reliability and fault tolerance. Oil debris or quality sensors would be difficult to incorporate within the system and are not required as part of the effort.

Other desired attributes to consider for Phase III are (1) impact per Mil-Std 810F, Method 516.5; (2) vibration requirements of Mil-Std 810F, Method 514.5; (3) acceleration per Mil-Std 810F, Method 513.5; (4) altitude per Mil-Std 810F, Method 500.4; (5) rain per Mil-Std 810F, Method 506.4; (6) fungus per Mil-Std 810F, Method 508.5; (7) humidity per Mil-Std 810F, Method 507.4; (8) salt spry/fog per Mil-Std 810F, Method 509.4; (9) sand/dust per Mil-Std 810F, Method 510.4; (10) fluid susceptibility per Mil-Std 810F, Method 504; and (11) electromagnetic interference (EMI) per Mil-Std 461E as modified by ADS-37A-PRF Table 1.

PHASE I: Phase I of the effort will prove the feasibility of the proposed technology approach. Phase I will develop the technology sufficiently to prove the ability to integrate the required measurement capabilities and implement a MIDSS. The effort should address the monitoring requirements for a representative drive system component. The technical viability of the various sensors, as well as any associated digitization and multiplexing should be demonstrated at a bench test level. The source of data needed for the selected drive system component as well as any performance, usage or diagnostics models should be addressed. An aircraft level architecture and a roadmap for implementation should be defined under this phase. The architecture must address integration with existing aircraft Health and Usage Monitoring Systems (HUMS).

PHASE II: Phase II will develop the Phase I technology into a fully functional prototype. The MIDSS will be tested to assess the accuracy of the measurement capabilities as well as an aircraft level architecture. Individual sensor testing will be conducted along with the ability to combine multiple sensor locations covering the entire aircraft drive system.

PHASE III: The technology is applicable to both military and commercial rotary wing aircraft (qualified to military standards listed in description) to monitor components and performance in real time. This technology will be used on high value and flight safety critical drive system components. The MIDSS will alert the user to component(s) stressed beyond their intended boundaries. The reduction of the wire weight and number of sensors will prove to be very beneficial. As this technology matures it can be transitioned to non-aircraft applications such as gearboxes used in the wind energy industry.

REFERENCES:
1. MIL-STD-810F, DOD Test Method Standard for Environmental Engineering Considerations and Laboratory Tests, 1 January 2000.

2. MIL-STD-461E, DOD Interface Standard Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment, 20 August 1999.

3. ADS-37A-PRF, Electromagnetic Environmental Effects (E3) Performance and Verification Requirements, 28 May 1996.

4. ADS-79A-HDBK, Aeronautical Design Standard Handbook for Condition Based Maintenance Systems for US Army Aircraft Systems, 17 December 2009

KEYWORDS: Rotary Wing, Drive Systems, fiber optic, micro-electro-mechanical systems (MEMS), Health and Usage Monitoring Systems (HUMS)

A12-099 TITLE: Air-to-Air Targeting Algorithms for Turreted Gun Systems

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PEO Aviation

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 air-to-air targeting algorithms for a turreted gun systems such as found on AH-64D helicopter (Reference 1) that could use impact, proximity and airburst fused rounds. The application of this technology applies to helicopters, ground vehicles and ships. This system will increase accuracy against air targets and ground targets, thereby reducing collateral damage and increasing survivability.

DESCRIPTION: This effort will focus on the development of air-to-air targeting algorithms for a turreted gun systems such as found on the AH-64D helicopter (Reference 1) that could use impact, proximity and airburst fused rounds. The application of this technology applies to other helicopters, ground vehicles and ships. (References 2,3,4) Critical technical measures to be demonstrated include system accuracy against air targets that is equivalent to current ground targets engagements.

Continuing development of airborne threats has increased risk for military rotorcraft. Development of air to air targeting algorithms for a stabilized turreted gun systems has not kept pace with technology and improvements are needed to be effective against aerial systems. Military helicopters use machine guns as offensive and defensive weapons against air and ground targets. Some guns are mounted on remotely operated turrets aimed by the pilot using head / eye trackers (AH-64, AH-1, soon MV- 22), some are mounted on swiveling pintles and are aimed manually by crew members (door / window guns on UH-60, MV-22, UH-1, CH-53). All have challenges in targeting airborne targets where the target is moving rapidly in three directions. Aircraft state, recoil, round ballistics, winds, target state estimators, tracking system, targeting sensor accuracy, GPS location, laser ranging, pointing accuracies, turret errors, target speed and target maneuverability all contribute to error in targeting solution. New air to air targeting algorithm approaches need to account for all these errors to increase the accuracy against airborne targets.

Turreted guns provide great operational flexibility by allowing off-axis shots in virtually any direction, but they have limitations on accuracy for maneuvering airborne targets. The standard of performance for aerial gunnery from an AH-64D is to achieve at least one hit out of 30 shots fired at a wheeled vehicle between 800 – 1200m distant (Reference 5).

Given the performance demonstrated in references 6 and 7, it is reasonable to think that improvements in air-to-air accuracy could be equivalent to current air-to-ground targets engagements. Given the vast reduction in potential for collateral damage, the system will pay for itself after 2 or 3 instances of the pilot using the gun rather than an expensive air-to-air missile.

PHASE I: The Contractor will determine the feasibility of developing air-to-air targeting algorithms for a turreted gun systems such as found on AH-64D helicopter (Reference 1) that could use impact, proximity and airburst fused rounds. The Phase I effort will take into account time based information and associated errors related to aircraft state, aircraft location error, sensor error, target location error, laser range error, winds to target, ballistic table for round, round fragmentation shape, intelligence of target type, target tracking error, gun pointing error, gun dynamics, GPS and INS error on aircraft, GPS and INS error on gun, millimeter wave radar data and error, sensor and gun motor delays, recoil, target state estimators, tracking system, targeting sensor accuracy, GPS location, pointing accuracies, turret errors, target speed and target maneuverability (Ground and Air). The Phase I effort approach to software development will be in a modular approach (Plug and Play) for parameters identified above and allow for variance in time based information and associated errors. The software approach and architecture should be compatible with the Joint Multi-Role (JMR) system (Reference 8 and 9). Successful algorithm designs shall achieve air-to-air accuracy equivalent to current air-to-ground targets engagements with graceful degradation if the above parameters change or become inaccurate.

PHASE II: The contractor shall demonstrate the performance in a high fidelity simulation (preferably hardware-in-the-loop) and ground-based tests of firing accuracy from a moving ground platform (vehicle or motion-base) shall be done at a minimum. At the end of Phase II the live fire performance of the system shall be demonstrated to the Government. Technology Readiness Level, TRL 6 - System/subsystem model or prototype demonstration in a relevant environment

PHASE III: This technology addresses two of the DoD's fundamental operational requirements; to perform airborne missions against airborne threats, and to minimize collateral damage. It will benefit helicopters, ground vehicles and ships. The technology can be used by both civilian and military sectors to improve tracking of objects with multiple inputs and increase the accuracy to the tracking. Police, Coast Guard and Border Patrol could use the technology to track persons or objects of interest.

REFERENCES:
1) AH-64D Apache Helicopter, http://en.wikipedia.org/wiki/Boeing_AH-64_Apache

2) M230 Chain Gun is a 30 mm, single-barrel automatic cannon, http://en.wikipedia.org/wiki/M230_Chain_Gun

3) LW25mm Bushmaster Cannon - ATK, www.atk.com/Products/.../LW25mm%20Bushmaster%20Cannon.pdf

4) Air Bursting Ammunition Technology, www.dtic.mil/ndia/2003fuze/hiebel.pdf

5) FM 1-140, Appendix B, Tables VIII,
http://www.globalsecurity.org/military/library/policy/army/fm/1-140/AB.HTM , superceded by FM 3- 04.140

6) The Inertial Reticle Technology (IRT) Applied to a .50 Cal. M2 Heavy-Barrel Machine Gun Firing from a High-Mobility Multipurpose Wheeled Vehicle (HMMWV), Timothy L. Brosseau et al,
http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA377015&Location=U2&doc=GetTRDoc.pdf

7) Autonomous Rotorcraft Sniper System, http://www.sdl.usu.edu/programs/arss

8) Aviation S&T to Support Aircraft Survivability Aviation S&T to Support Aircraft Survivability,
http://65.18.194.107/~admin1/images/pdf/Presentations/ASE/2010/ASPF10-WALL.pdf

9) Future Airborne Capability Environment (FACE™) Consortium, http://www.opengroup.org/face/

KEYWORDS: guns, helicopter, air-to-air, fire control, targeting, algorithms, airburst, Unmanned Aircraft Systems (UAS), tracking

A12-100 TITLE: <u>3 kW Lightweight Efficient Generator</u>

TECHNOLOGY AREAS: Air Platform, Ground/Sea Vehicles, Human Systems

ACQUISITION PROGRAM: PEO Command, Control and Communications Tactical

OBJECTIVE: The objective of this project is to design, develop, and demonstrate an advanced small, lightweight man portable multi-fueled 3,000 W power unit. A key tenet of this power unit is that it should take advantage of recent advances in small lightweight high speed internal combustion engines which include but are not limited to unmanned aerial vehicles (UAV) engines.

DESCRIPTION: The implementation of this technology could address several operational capability gaps across the broad spectrum of small power sources. The current Tactical Quiet Generator at 326 pounds and approximately 20% efficiency is outmoded and represents old technology; and currently there are no fielded systems in the range of 3 kW which weigh less than 200 lbs, and can operate on JP-8 over the range of military environments. In addition, the increasing advance of digital equipment and soldier battery loads is increasing the demand for a lightweight power source for forward area/platoon level battery charging. Small hybrid/alternative energy systems are also seeing increased use with generators in the 3 kW range for assured power. Use of smaller generators would be more efficient than using larger sets at part-load conditions. Increased efficiency of the generator is needed at both full and part-load conditions. Multi-fuel operation is desired in order to take advantage of locally available fuels (diesel, JP-8, gasoline). In addition it is desired that the technology can meet all the requirements for forward deployed equipment and provide quality power over a wide range of environmental extremes.

PHASE I: Phase I will be a technical analysis and feasibility study to determine an analytical and engineering design approach to develop the 3 kW Lightweight Efficient Generator. The offeror will identify any challenges/technical barriers as well as the technical benefits to the engineering design approach for the 3 kW Lightweight Efficient Generator. This study will provide a detailed technical description of the engineering/design approach, expected technical value, and any assumptions. It should also include a plan for measuring, evaluating and demonstrating the technical value and performance of the proposed engineering/design approach.

PHASE II: The scope of the Phase II will be to develop and demonstrate a prototype of the phase I proposed 3 kW Lightweight Efficient Generator. This demonstration shall show that the proposed 3 kW Lightweight Efficient Generator designed prototype can meet expected performance capabilities in conditions representative of Army tactical operations. The power unit prototype design should be based on the evaluation, modification/upgrade, and integration of available engines and state of the art alternator, power electronics, fuel processing techniques, thermal management and composite materials for packaging. In addition the prototype fabricated should meet all the requirements for forward deployed equipment and provide the projected weight savings.

PHASE III: If the technology can meet all the requirements for forward deployed equipment and provide the projected weight savings, PM-MEP is willing to consider the potential addition of this item to our FY14-19 budget. The 3 kW system could fit directly into our planned Program of Record for Small Tactical Electric Power (STEP). During this phase, three or more prototypes for the 3 kW Lightweight Efficient Generator will be completed and delivered along with specification documentation and system drawings. In addition documentation that describes the underlying methodologies, approaches, assumptions, capabilities and limitations will be provided.

The end-state demonstrated prototypes being researched within this topic will have dual-use value in commercial and government application. Potential commercial market applications for this innovation include Homeland Defense, first-responders, and local and Federal government organizations. The vendor is responsible for marketing its demonstrated prototype capability for further development and maturation for potential Post-Phase II transition and integration opportunities including actual military Programs of Record and any dual-use applications to other government and industry business areas.

REFERENCES:
1. MIL-STD 461F for EMI

2. MIL-STD 810D for Environmental Testing

3. MIL-STD 1332B Definitions of Tactical, Prime, Precise, and Utility Terminology for Classification of the DoD Mobile Electric Power Engine Generator Set Family

4. Additional information from TPOC to clarify requirements for SBIR 12.2 topic A12-100. (Posted in SITIS 5/16/12.)

KEYWORDS: n/a

A12-101 TITLE: Nonlethal Warhead for Miniature Organic Precision Munitions

TECHNOLOGY AREAS: Weapons

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: The objective of this effort is to develop a non-lethal warhead for use on miniature organic precision munitions. Non-lethal is defined as a warhead which is not deadly to the target personnel but is incapacitating for a period of time. The new warhead must be modular in nature, self contained and interchangeable with the standard lethal warhead. This effort will require innovative research and advancements in non-lethal technologies which can be packaged within a very small volume and weight.

DESCRIPTION: The primary objective of this effort is to develop non-lethal warhead technologies for application to miniature organic precision munitions such as Lethal Miniature Aerial Munition System (LMAMS). LMAMS is a small, soldier-carried, soldier-launched loitering precision munitions system, organic at the small unit level. LMAMS will offer the soldier a portable, non-line-of-sight precision strike capability against individual stationary or moving individuals, ensuring high precision effect from covert positions, with a very low risk of collateral damage. LMAMS allows engagement of enemy personnel and soft targets in urban/complex environments without exposure to direct enemy fires. The U.S. Army expects the new weapon to weigh around 3 lbs (1.36 kg). The user will also carry the integrated operating console and communications unit, weighing an additional 3 pounds. The entire system could deploy and be ready to fire within 30 seconds. Once launched, the system should be capable to acquire a man-size target at the system's combat range, in less than 20 seconds, flying at an altitude of 100 meter above ground. If conditions for attack are not met, LMAMS will be able to loiter over the target for up to 30 minutes. For the terminal phase, LMAMS is designed to hit target within 3.28 ft (1 meter) radius, at maximum speed of 80 – 100 mph (35-44m/sec). This accuracy matches the warhead's effectiveness to kill or incapacitate personnel in the open or on soft skinned vehicles, within a two meter radius from the point of detonation. The current LMAMS payload includes a lethal warhead and associated fuzing and electronic safe and arm device (ESAD). The user has expressed a strong need for a non-lethal alternative warhead for these munitions.

The LMAMS is designed to provide the warfighter with a "magic bullet". It can rapidly provide a powerful, but expendable miniature flying Intelligence, Surveillance and Reconnaissance (ISR) package on a Beyond Line-of-Sight (BLOS) target within minutes. This miniature, remotely-piloted or autonomous platform can either glide or propel itself via quiet electric propulsion, providing real-time GPS coordinates and video for information gathering, targeting, or feature/object recognition. The vehicle's small size and quiet motor make it difficult to detect, recognize, and track even at very close range. The LMAMS is fully scalable and can be launched from a variety of air and ground platforms.

As a general guide line, the payload constraints for the non-lethal warhead are:

Size: Should fit into the volume: 1.6 x 2.3 x 1.7 inches.

Weight: Not to exceed 380 grams.

Cost: The non-lethal, modular warhead cost should not exceed $500 per unit for 500 units.

Fuzing Mechanism: Fuzing will be based on no more information than available to the lethal warhead. Fuzing may be based an existing LMAMS mechanism, the details of which will be provided, or on a new fuzing mechanism, if required by the design of the non-lethal alternative. If the existing fuzing mechanism is used, then only the warhead volume described above will be available. If a new fuzing mechanism is required, then the volume of the warhead above plus the volume of the fuzing mechanism defined below will be available for the non-lethal warhead and fuzing mechanism. The volume and weight of the fuzing mechanism are:

Volume: Should fit into the volume: 1.2 x 1.2 x 2.1 inches.

Weight: No not to exceed 96 grams.

Cost: Not to exceed $500 per unit for 500 units.

Non-lethal mechanisms to be considered may include but are not limited to: mechanical, such as rubber balls; acoustic; chemical; electrical; or dazzle.

The non-lethal warhead should be effective against a single individual or up to 5 individuals within a radius of 4.25 meters.

PHASE I: Research and develop non-lethal warhead mechanisms that can be configured within the given size and weight constraints. Determine and document the effectiveness of each of the potential approaches considered. Perform trade studies to select the most effective solution within the given constraints. The output of Phase I will be a preliminary non-lethal warhead and fuzing design with effectiveness predictions based on analysis and simulation. A report documenting the preliminary design and analysis will be delivered to the Government. Simulation codes will be documented and delivered.

PHASE II: Develop, demonstrate and document a breadboard design of the non-lethal warhead technology selected in Phase I. The output of Phase II will be a breadboard design which conforms to the LMAM interface. The non-lethal effectiveness of the Phase II breadboard will be demonstrated. The LMAMS interface conformity will be demonstrated. All findings and results will be documented in a report deliverable to the Government.

PHASE III: The final embodiment of the warhead developed in Phase II will be a flight hardened, modular device, which will be flight tested on either an LMAMS or other similar government furnished miniature organic precision munition. At this phase of development, which will result in a TRL level 5 design, warhead effectiveness and flight worthiness will be demonstrated. Potential commercial applications might include, but are not limited to: crowd control for local law enforcement; border protection for Homeland Security; or temporary incapacitation of non violent criminals for local SWAT teams and/or law enforcement. A final report documenting the Phase III designs, findings, and test reports will be delivered to the Government.

REFERENCES:
1. UAS News. (2011, January 1). Lethal Miniature Aerial Munition System (LMAMS) to be deployed soon? Retrieved November 16, 2011, from http://www.suasnews.com/2011/01/3260/lethal-miniature-aerial-munition-system-lmams-to-be-deployed-soon/

2. Defense Update. (2011, April 1). US Air Force to Develop Micro-UAV Killer Drones for the Special Operations Command. Retrieved November 16, 2011, from http://defense-update.com/products/l/31122010_lmams.html

KEYWORDS: Warhead, Non-lethal, Miniature, Modular, Precision, Munitions, Fuzing, Electronic, Safe, Arm.

A12-102 TITLE: Cordless Battery Charging

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: PEO Soldier

OBJECTIVE: To provide the dismounted Soldier with cordless battery charging capability while inside a vehicle.

DESCRIPTION: The Nett Warrior uses a battery to power various Soldier-worn components (e.g., computer, radio, display, etc.). It is estimated that 10 watts per Soldier (for a total of nine Soldiers) will be required to trickle charge the Nett Warrior battery while inside a vehicle (at a distance of two feet). Space limitations and the dynamic nature of the battlefield suggests that carrying extra batteries and chargers will adversely impact the Soldier's mobility and readiness while transported by a ground vehicle. A proximity charger will require no extra storage for batteries and should be smaller than regular battery chargers (no need for battery space/access); increasing the mobility of the Soldier by allowing him to keep his gear on while inside the vehicle. No cables would be required to connect to a battery charger.

PHASE I: This phase will investigate the feasibility of a cordless battery charging system that can be implemented in an Infantry Carrier. It will establish if the state of the art in wireless power transmission is mature enough and exhibits the necessary efficiencies to enable a cost effective implementation of the technology. The study will characterize the status of the proposed technology(ies) and present a business case of what is currently doable. The study will address the limitations of the proposed approach to enable the Government to determine whether to proceed with a development phase. The study will rely on use cases to establish military operational relevancy. The study will address size, weight, power and cost characteristics of the proposed solution, as a minimum.

PHASE II: The objective of this phase is to design and manufacture a prototype system that will be installed inside a Bradley Infantry Fighting Vehicle and will provide 10 watts each of cordless battery charging capacity to nine Nett Warriors. The system will consist of a vehicle mounted component and a Soldier-borne component. The specific design requirements will be provided by the Phase I results. The contractor will provide 2 vehicle kits and 12 Soldier-wearable kits.

PHASE III: The end state for this technology is to become the replacement for battery charging everywhere (e.g., garrison, vehicle, aircraft, etc.). This technology will replace cables and standardize on one interface, potentially being able to adjust power settings to charge different types of batteries. Eventually, it will be embedded in commercial electronic devices, eliminating the need for an adapter. This effort will support the Nett Warrior and Air Soldier System programs. Commercial applications are numerous; from cell phones to tablets to laptops, etc.

REFERENCES:
1. Power and Energy Strategy White Paper, prepared by Army Capabilities Integration Center - Research, Development and Engineering Command - Deputy Chief of Staff, G-4, US Army (1 April 2010)

KEYWORDS: cordless, wireless, battery, charging, power, Soldier, vehicle

A12-103 TITLE: <u>Downrange Crosswind Sensor for Small Arms Fire Control</u>

TECHNOLOGY AREAS: Electronics

ACQUISITION PROGRAM: PEO Soldier

OBJECTIVE: Develop a standalone, downrange crosswind sensor component capable of measuring the average crosswind velocity for distances of up to 800 m [(T)hreshold)], [1500 m (O)bjective] in order to increase first round hit probability.

DESCRIPTION: Accurate wind speed measurements are crucial to military operations, especially long range small arms engagements. Crosswind is one of three major sources of error responsible for reducing the probability of hit, P(h) of a shooter, and deflection caused by crosswind is the most dominant factor affecting the flight of a bullet. Moderate crosswind velocity as low as 5 m/s will deviate a bullet off-course by as much as 1 mil for long range firing (800 meters and above) requiring a second attempt, which provides the target with the opportunity to reach defilade and increases the sniper's own probability of detection.

Local changes in the refractive index of air caused by atmospheric turbulence are quantifiable by remote sensing techniques which allow measurements of the crosswind velocity. Both active and passive methods have been demonstrated and experimentally verified in the field, with crosswind measurements determined accurately with an error on the order of the standard deviation of reference measurements.

Snipers currently have the ability to measure wind at their present location with handheld anemometers. Additionally, snipers are trained to "read the wind" by observing the movements of blades of grass, swaying tree branches or mirage to estimate the wind mid range and at the target and then calculate an average wind speed. Such methods require a great deal of time practicing in order to master. Further, the practice of using swaying objects, such as swaying tree branches, lacks accuracy and often results in a “best guess” on windage correction. Fire control systems are currently under development that provide wind correction methods into a single fire control system, such as those by US-Israeli (FOCUS) and DARPA (One Shot) initiatives. There are currently no efforts to develop stand-alone wind sensing capability, which is capable of both independent operation and interfacing with the next generation of fire control systems.

The objective of this effort is to develop a downrange crosswind measurement system which is significantly miniaturized (relative to aforementioned current programs), is capable of independent operation, and has an open architecture to facilitate integration into future fire control systems should the need arise. Further, this effort opens the door to exploration of both active and passive wind sensing capabilities, whereas prior efforts have been focused all but exclusively on active solutions.

PHASE I: Identify a method, components and develop system architecture for a remote sensing device for downrange crosswind measurement in both day and night operation. Selected method shall be modeled and simulated to demonstrate improved crosswind velocity measurements over conventional methods at ranges of 800m (T) [1500m (O)], in crosswinds of 0 m/s to 20 m/s (gale force wind, per the Beaufort Scale), with a crosswind measurement error of no more than ± 1.5 m/s. Outlined performance shall be achieved in all ambient light conditions (day, night, dawn/dusk). A report shall be delivered documenting the research, modeling and components for a laboratory scale device. Active illumination methods must assess eye safety requirements. Expected maturity level at completion of Phase I is TRL 3.

PHASE II: Develop a proof of concept breadboard prototype to demonstrate the technologies and capabilities identified and explored in Phase I. Upon completion and demonstration of proof of concept device, further develop the system to reduce the size, weight and power (SWAP) of the crosswind sensor such that it weighs no more than 1.5 lbs (T) [1 lb (O)], does not occupy a volume larger than 0.7 L (T) [0.5 L (O)], and operates on common U.S. Army inventory batteries (T), [AA or CR123 batteries (O)]. Developed prototype analysis shall include average crosswind velocity measurements in a relevant environment compared to measurements made by conventional wind estimation methods, for example, sniper wind estimation techniques or hand held local wind speed sensors. Expected maturity level at completion of Phase II is TRL 5.

PHASE III: Upon successful completion of the research and development in Phase I and Phase II, the new system will be capable to be fielded as a clip-on or weapon mountable device (MIL-STD-1913, Picatinny Rail) and provide a known interface in order to be integrated into fire control systems under development. Dual use applications include use in wind energy generation, determining crosswind at airports, free space optical communications and monitoring the drift of chemical, biological and radioactive agents. Expected maturity level at completion of Phase III is TRL 7.

REFERENCES:
1. R. Von Wahlde & D. Metz, "Sniper Weapon Fire Control Error Budget Analysis", U.S. Army ARLTR-2065, August 1999.

2. J. Shapira & O. Porat, “Crosswind sensing from optical-turbulence-induced fluctuations measured by a video camera”, Applied Optics, Vol. 49, No. 28 p. 5236-5244, 2010.

3. J. Shapira, O. Porat, M. Livneh, Z. Wies, D. Heflinger, S. Fastig, Y. Glick and A. Engel, "Atmospheric cross-wind and turbulence measurements using turbulence-induced scintillations", Proc. SPIE 7684, 76841L (2010)

4. Y. Gur, E. Adamovski and M. Gringauz, “The effect of a variable crosswind on flat-fire trajectories- A unique measuring technique and compensation methodology”, 26th International Symposium on Ballistics (2011)

KEYWORDS: Optical Turbulence, Scintillation, Crosswind, Wind Sensing, Laser Radar, Fire Control, Exterior Ballistics