NAVY
11.3 Small Business Innovation Research (SBIR)
Proposal Submission Instructions

The responsibility for the implementation, administration and management of the Navy SBIR Program is with the Office of Naval Research (ONR). The Director of the Navy SBIR Program is Mr. John Williams, john.williams6@navy.mil For program and administrative questions, please contact the Program Managers listed in Table 1; **do not** contact them for technical questions. For technical questions about the topic, contact the Topic Authors listed under each topic from **28 July 2011 through 28 August 2011.** Beginning **29 August 2011**, the SITIS system (http://www.dodsbir.net/Sitis/Default.asp) listed in Section 1.5, c of the DoD Program Solicitation must be used for any technical inquiry.

TABLE 1: NAVY SYSCOM SBIR PROGRAM MANAGERS

Topic Numbers	Point of Contact	Activity	Email
N113-171 thru N113-174	Mr. Paul Lambert	MARCOR	sbir.admin@usmc.mil
N113-175 thru N113-181	Mr. Dean Putnam	NAVSEA	dean.r.putnam@navy.mil

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

PHASE I GUIDELINES

Follow the instructions in the DoD Program Solicitation at **www.dodsbir.net/solicitation** for program requirements and proposal submission. Cost estimates for travel to the sponsoring Syscom's facility for one day of meetings are recommended for all proposals and required for proposals submitted to MARCOR and NAVSEA. For NAVSEA proposals, a recommended proposal template can be found at http://www.navysbir.com/navsea. The Navy encourages proposers to include, within the 25 page limit, an option which furthers the effort and will bridge the funding gap between Phase I and the Phase II start. Phase I options are typically exercised upon the decision to fund the Phase II. **The base amount of the phase I should not exceed $80,000 and six months; the phase I option should not exceed $70,000 and six months.**

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

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

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

PHASE I SUMMARY REPORT

All awardees must submit a non-proprietary summary of their final report (without any proprietary or data rights markings) through the Navy SBIR website. Submit the summary at: **http://www.onr.navy.mil/sbir**, click on "Submission", and then click on "Submit a Phase I or II Summary Report". A template is provided for you to complete. This summary, once approved, may be publicly accessible via the Navy's Search Database.

PHASE II GUIDELINES

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

The Navy will invite, evaluate, and select Phase II proposals using the evaluation criteria in Section 4.3 of the DoD Program Solicitation in descending order of importance with technical merit being most important, followed by qualifications and commercialization potential of equal importance. Due to limited funding, the Navy reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded. The Navy does NOT participate in the FAST Track program.

The Navy SBIR Program structures Phase II contracts in a way that allows for increased funding levels based on the project's transition potential. This is called the Phase II.5 and is accomplished through either multiple options that may range from $250,000 to $1,000,000 each, substantial expansions to the existing contract, or a second Phase II award. For existing Phase II contracts, the goals of Phase II.5 can be attained through contract expansions, some of which may exceed the $1,000,000 recommended limits for Phase II awards.

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

The Navy typically awards a cost plus fixed fee contract for Phase II.

PHASE II ENHANCEMENT

The Navy has adopted a Phase II Enhancement Plan to encourage transition of Navy SBIR funded technology to the Fleet. Since Phase III awards are permitted during Phase II work, some Navy Syscoms may match on a one-to-four ratio, SBIR funds to funds that the company obtains from an acquisition program, usually up to $250,000. The SBIR enhancement funds may only be provided to the existing Phase II contract. For more information, please contact the Syscom SBIR Program Manager.

PHASE III

A Phase III SBIR award is any work that derives from, extends or logically concludes effort(s) performed under prior SBIR funding agreements, but is funded by sources other than the SBIR Program. Thus, any contract or grant where the technology is the same as, derived from, or evolved from a Phase I or a Phase II SBIR/STTR contract and awarded to the company which was awarded the Phase I/II SBIR is a Phase III SBIR contract. This covers any contract/grant issued as a follow-on Phase III SBIR award or any contract/grant award issued as a result of a competitive process where the awardee was an SBIR firm that developed the technology as a result of a Phase I or Phase II SBIR. The Navy **will** give SBIR Phase III status to any award that falls within the above-mentioned description, which includes according SBIR

Data Rights to any noncommercial technical data and/or noncommercial computer software delivered in Phase III that was developed under SBIR Phase I/II effort(s). The government's prime contractors and/or their subcontractors shall follow the same guidelines as above and ensure that companies operating on behalf of the Navy protect rights of the SBIR company.

ADDITIONAL NOTES

Because of the short timeframe associated with Phase I of the SBIR process, the Navy does not recommend the submission of Phase I proposals that require the use of Human Subjects, Animal Testing, or Recombinant DNA. For example, the ability to obtain Institutional Review Board (IRB) approval for proposals that involve human subjects can take 6-12 months, and that lengthy process can be at odds with the Phase I time to award goals. Before Navy makes any award that involves an IRB or similar approval requirement, the proposer must demonstrate compliance with relevant regulatory approval requirements that pertain to proposals involving human, animal, or recombinant DNA protocols. It will not impact our evaluation, but requiring IRB approval may delay the start time of the Phase I award and if approvals are not obtained within six months of notification of selection, the award may be terminated. If you are proposing human, animal, and recombinant DNA use under a Phase I or Phase II proposal, you should view the requirements at **http://www.onr.navy.mil/About-ONR/compliance-protections/Research-Protections.aspx**. This website provides guidance and notes approvals that may be required before contract/work can begin.

Proposals submitted with Federal Government organizations (including the Naval Academy, Naval Post Graduate School, or any other military academy) as subcontractors will be subject to approval by the Small Business Administration (SBA) after selection and prior to award.

PHASE I PROPOSAL SUBMISSION CHECKLIST:

The following criteria must be met or your proposal will be REJECTED.

____1. Include a header with company name, proposal number and topic number to each page of your technical proposal.

____2. Include tasks to be completed during the option period and include the costs in the cost proposal.

____3. Break out subcontractor, material and travel costs in detail. Use the "Explanatory Material Field" in the DoD cost proposal worksheet for this information, if necessary.

____**4. The base effort does not exceed $80,000 and six months and the option does not exceed $70,000 and six months. The costs for the base and option are clearly separate, and identified on the Proposal Cover Sheet, in the cost proposal, and in the work plan section of the proposal.**

____5. Upload your technical proposal and the DoD Proposal Cover Sheet, the DoD Company Commercialization Report, and Cost Proposal electronically through the DoD submission site by 6:00 am ET, 28 September 2011.

____6. After uploading your file on the DoD submission site, review it to ensure that it appears correctly. Contact the DoD Help Desk immediately with any problems.

NAVY SBIR 11.3 Topic Index

NAVY SBIR 11.3 Topic Descriptions

N113-171 TITLE: Long Range Laser Induced Plasma

TECHNOLOGY AREAS: Sensors, Weapons

ACQUISITION PROGRAM: Joint Non-Lethal Weapons Program; (ACAT IV)

OBJECTIVE: Non-lethal weaponization of ultra-short pulse (pico-femtosecond) laser systems to produce laser induced plasma detonation (LIPD) in air or on material targets in close proximity to targeted humans. Current LIPD systems are capable of producing some optical out-put and a buzzing sound. We are interested in out-puts, comparable to existing flashbang systems. This capability is intended to produce non-lethal effects on human targets. Systems intended for use against material targets cannot be used in non-lethal scenarios and vice versa.

DESCRIPTION: The creation of plasma with a laser beam is utilized in technologies such as laser induced plasma spectroscopy and surface physics ultra-short pulse (pico-femtosecond) lasers. Similar technology could be potentially utilized in the non-lethal weapons sector to create a visual and auditory deterrent at a given range by ionizing air or ablating a solid target. Options are sought to design an above the state of the art non-lethal weapons system capable of creating laser plasma bursts while keeping the optical system resilient and portable by military means (personnel or small vehicle). Recent laser material development can be utilized in the design of the non-lethal system which should radiate at wavelengths greater than 1.4 microns to ensure retinal safety from inadvertent ocular exposure, with as small of a form factor as possible to create apparently continuous plasma. Goals for visual cues or temporary visual impairment include bright flashes and a bright light spray as a result of plasma bursts. Auditory cues should be the result of an extremely irritating buzz to be achieved through highly repeated plasma production at multiple plasma bursts per second and may be modulated to convey coherent, audible messages.

PHASE I: Analytically demonstrate that a laser system is capable of using retina-safe lasers to produce plasma with non-lethal effects at a range of hundreds of meters.

PHASE II: Develop and demonstrate a brassboard system capable of plasma production beyond 100 m.

PHASE III: Develop a system prototype that is portable by military means (personnel or small vehicle).

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology could be used by any branch of the military or by civilian forces as a visual and/or auditory cue as a deterrent at an extended range to deny, move, or suppress personnel with the possibility of physical cues in the form of shockwaves or heat.

REFERENCES:
1. Gordon, D.F. (2003). Streamerless guided electric discharges triggered by femtosecond laser filaments. Physics of Plasma, 10, 4530-4538.

2. Morgan, C.G. (1974). Laser-induced breakdown of gases. Reports on Progress in Physics, 38, 621-665.

3. Vaill, J.R., Tidman, D.E., Wilkerson, T.D., Koopman, D.W. (1970). Propagation of high-voltage streamers along laser-induced ionization trails. Applied Physics Letters, 17 (1), 20-22.

4. Vogel, A. & Venugopalan, V. (2003). Mechanism of pulsed laser ablation of biological tissue. Chemical Reviews,103, 577-644.

KEYWORDS: laser; plasma; ionization; visual obscurant; auditory deterrent; non-lethal weapon

N113-172 TITLE: Innovative tie down

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: None

OBJECTIVE: Design and demonstrate an innovative tie-down that enables loading more vehicles on amphibious ships, without modifying the ships or the vehicles.

DESCRIPTION: System that meets heavy weather requirements for securing existing vehicles to existing ship decks while reducing broken stow (target broken stow is 20%). Solution must be a product that is lightweight, easily handled, low maintenance and compatible with a salt-water environment. (Broken stow is the ratio of unusable deck space on (due to cargo tie-down configuration, or etc) to total deck space. Broken stow represents lost opportunity to carry additional vehicles, impacting our warfighters. Broken stow is affected by lashing/tie-down requirements, configuration and lashing material used.)

Tie-down standards (number of tie-down provisions and G-force criteria) for vehicles and equipment are outlined in Military Standard 209K. A tie-down configuration that meets heavy weather requirement results in a broken stow of approximately 70%. 70% broken stow reduces the equipment a MEU can transport too much to be effective.

Instead, a typical current tie-down configuration utilizes 4 tie-downs from vehicle to the deck; each is 2-4 ft long, 90 degrees (from the longitudinal axis) and 30-60 degrees (from the vertical axis). Utilizing this configuration results in a broken stow factor of approximately 35%, but it does not meet heavy weather requirements. Typical lashing material is chains with strength ranging from 15,000 lbs to 70,000 lbs. The chains are heavy (weighing up to 90 lbs each), cumbersome and labor intensive.

One approach would be to develop a restraint that can run from attachment points on the deck under the vehicle to the vehicle attachment points. The challenge with such an approach is to design something that can be employed by a service member in the limited space under a military vehicle.

Proposers cannot modify the ship or vehicle designs. The solution must take into account the size and weight of the equipment being restrained.

PHASE I: Research needs to identify possible technologies for cargo restraints onboard amphibious shipping which can meet the below reference criteria (heavy weather).

PHASE II: Develop and demonstrate a prototype system in a realistic environment. Conduct testing to prove feasibility over extended operating conditions. The Marine Corps will provide vehicle(s) and test resources.

PHASE III: This system could be used in a broad range of military and civilian applications where mobile loads have to be secured for transportation. Examples include rail movement and commercial shipboard movement of wheeled heavy vehicles.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This system could be used in a broad range of military and civilian applications where mobile loads have to be secured for transportation. Examples include rail movement and commercial shipboard movement of wheeled heavy vehicles.

REFERENCES:

1. MIL-STD 209K Interface Standard for Lifting and Tiedown Provisions
http://seabasing.nsrp.org/projects/icmh.html

2. SBIR Tie Down Representative Load List, uploaded in SITIS 8/2/11.

3. Representative example of locations and tiedown patterns on an amphibious ship. (Uploaded in SITIS 7/17/11.)

KEYWORDS: tie-down; amphibious; ships; cargo

N113-173 TITLE: Desktop Software for First Order Approximations of the Effects of Blast and Ballistic Impact on Vehicles

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

ACQUISITION PROGRAM: PM Advanced Amphibious Assault, ACAT I

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is "ITAR Restricted". The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the "Permanent Resident Card", or are designated as "Protected Individuals" as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

DESCRIPTION: The Marine Corps has numerous tracked and wheeled vehicles designed to operate over harsh off-road terrain, oceans and riverine environments. Generally the design of a vehicle is subject to competing requirements: 1) mobility, 2) combat effectiveness and carrying capacity, and 3) survivability. All vehicles undergo tests to determine specification compliance and survivability using direct and indirect fire weapons, explosive charges, IED's etc. Current trends in vehicle survivability are directed towards a base armor with modular appliqué systems available for increased protection geared towards specific threats. With the myriad of configurations of materials available it is desired that desktop software be developed for the evaluation of vehicles subjected to explosions and ballistic impact. Currently several organizations such as DARPA, ARL and NSWC are working on software development. However this work is for hydrocode (finite element) applications such as CTH, LS-DYNA and ANSYS. Current state of the art finite element software require days to weeks to develop a model and require a minimum of an hour to complete one configuration (very simple model). This is the drawback to using finite element models for initial screening of designs. This software is to be used as a design tool able to execute multiple iterations i.e. armor configurations on a desktop or laptop computer and should include the acceleration effects to the vehicle in a short time period compared to 6 finite element analyses. It is envisioned that this application would utilize a spreadsheet as its basic operating system. The first-order design tool is to screen designs solutions so that more detailed finite element analyses can be limited to the most promising designs.. In all cases the software will permit iteration on input parameters.

The desired capabilities are as follows:
1. Estimate V50 and Vxx (V0, V90, V100, etc.) and penetration depth of irregular fragments, projectiles and Fragment Simulating Projectiles (FSP) into various materials used in armor constructions.
2. Estimate crater dimensions from charge weight and depth of burial or estimate charge weight and depth of burst from crater dimensions.
3. Estimate pressure and impulse time histories for both free air and hemispherical surface bursts.
4. Compute blast forces over a 2-D shape, produce side-on and reflected pressure and impulse histories. Produce 3-D plots and animations of the blast.
5. Estimate exterior ballistics data using 3-degree-of-freedom calculations for irregular fragments, projectiles and FSPs in order to produce plots of the output.
6. Estimate plate deflection for homogeneous metals, the likelihood of plate fracture, and the response of a virtual accelerometer placed anywhere on the structure due to blast. Produce plots and animations of the response.

PHASE I: The contractor shall conduct research and develop software for evaluation of vehicles subjected to explosions and ballistic impacts for use in evaluating the vehicles performance. The contractor shall create a software design with either a single (preferred) or separate applications to generate first order performance characteristics. The contractor shall conduct a Kick-off and a Final Review meeting at the Program Office in Woodbridge, VA. Monthly reports are required.

PHASE II: The contractor shall verify and validate the software using existing unclassified ballistic test data to specified performance levels. The contractor shall provide prototype software for evaluation. The contractor shall conduct a Kick-off, 3 Semi-Annual Reviews and a Final Review meeting at the Program Office in Woodbridge, VA. Monthly reports are required.

PHASE III: Transition technology into production via sales to the US Army and US Marine Corps.

Private Sector Use of Technology: Successful development and characterization of ballistic evaluation software has direct application to a wide variety of requirements for use in development and evaluation of various military and commercial vehicles. This technology is directly applicable to all combat vehicle development and test and the evaluation of protection requirements of body armor.

REFERENCES:
1. MIL-STD-662F V50, Ballistic Test for Armor;
https://assist.daps.dla.mil/quicksearch/basic_profile.cfm?ident_number=35877

2. TR-HFM-090, Test Methodology for Protection of Vehicle Occupants against Anti-Vehicular Landmine Effects;
http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=ADA473218

3. AEP-55 Vol. 2 Ed. 1, Procedures for Evaluating the Protection Level of Logistic and Light Armoured Vehicles Volume 2 for Mine Threat;
http://www.dodsbir.com/Sitis/view_pdf.asp?id=N111_002%20REF%209%20AEP55%20Vol2%20Ed1%20Procedures.pdf

4. AEP-55 Vol. 1 Ed. 1, Procedures for Evaluating the Protection Level of Logistic and Light Armoured Vehicles Volume 1; http://englands1.com/ballistics/AEP-55.pdf

5. ITOP 4-2-508 Vehicle Vulnerability Tests Using Mines;
https://assist.daps.dla.mil/quicksearch/basic_profile.cfm?ident_number=276301

KEYWORDS: Materials; Software; Test; Survivability.

N113-174 TITLE: Encapsulation and Delivery of Non-Lethal Malodorant in a 40mm-munition or Hand-thrown Grenade

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: Joint Non-Lethal Weapons Program; (ACAT IV)

OBJECTIVE: To develop a non-lethal malodorant weapon which can be dispersed from a 40mm delivered munition (fired from standard 40mm launcher) or a hand-thrown munition. Malodorous payloads must be effective at repelling humans, while being maintained at concentrations that do not trigger trigeminal nerve activation. Above the concentration threshold of trigeminal nerve activation, chemicals must be classified as Riot Control Agents per the Chemical Weapons Convention.

DESCRIPTION: The Department of Defense (DoD) has developed and tested a malodorant payload, potentially capable of repelling humans at concentrations that do not cause trigeminal nerve activation. Previous attempts to seal this payload into a tactical form-factor, such as a hand-thrown grenade or 40mm-muntion have not been successful as the chemical composition is highly volatile. A malodorant weapon could therefore be created by two means: 1) Developing a sealing or encapsulation technique capable of preventing leaks of the government developed malodorous payload 2) Developing a new malodorous payload.

PHASE I: If a new payload is proposed, develop and submit IRB protocols for two sequential experiments. The first will use a lateralization test to determine the threshold at which trigeminal nerve activation occurs. The second will determine the effectiveness at repelling human subjects from an area at concentrations below the established threshold. Perform these two tests.

If it is proposed to use the government developed malodorous payload, develop and submit an IRB protocol to determine the effectiveness at repelling human subjects from an area at concentrations below the established threshold. Perform this test.

Using the results of these tests, determine the feasibility of using malodorants to remove individuals from enclosed spaces. Estimate the number of munitions required t0 generate effective concentrations in an enclosed 5m x 5m x 3m space.

PHASE II: Develop and demonstrate an initial prototype of a malodorant munition that does not leak payload despite the shock expected from transportation and handling in military environments. Show concentration measurements as a function of time and area/volume denied.

PHASE III: Develop and test a mature prototype in a relevant military environment. Demonstrate effectiveness against highly and lightly motivated personnel.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology could be used by any branch of the military or by civilian forces to deny, move, or suppress personnel.

REFERENCES:
1. Dalton, P. (2006). Evaluation of Psychological vs. Physiological Effects of Malodorants. Malodorants: Psychological vs. Physiological Effects.

2. United Nations Treaty Collection. Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction.

KEYWORDS: malodorant; non-lethal weapon; encapsulation; sealing techniques

N113-175 TITLE: Optical Perception System for Situational Awareness and Contact Detection for Unmanned Surface Vessels

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PMS 406 Unmanned Influence Sweep System Program of Record - ACAT III

OBJECTIVE: To develop an optical perception system for unmanned surface vessels (USVs) to support the lookout function as defined by COMDTINST M16672.2D, “Navigation Rules” Rule 5.

Transition Path: Littoral Combat Ship (LCS) Mine Warfare Mission Package: Unmanned Influence Sweep System (UISS) and other Navy USVs under PEO LMW PMS420 Unmanned Maritime Systems Program Office

DESRIPTION: The Unmanned Surface Vehicle (USV) at the heart of the UISS is required to follow Navigation Rule 5: “Every vessel shall at all times maintain a proper look-out by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision.” Since the vessel is unmanned, the lookout function must be supported by a perception system consisting of sensors and processing that provide situational appraisal to a remote operator of the USV and to an onboard automated command and control system.

The current capability for providing the lookout function onboard the USV consists of a camera system, a radar and microphone. These provide only a rudimentary situational awareness without sufficient data to enable appropriate action based on a full appraisal of the situation and the risk of collision. The focus of this topic is to develop an innovative optical sensor and processor subsystem for the total perception processing system. The optical subsystem will provide a continuous 360 degree field of view, process the raw data and provide the contact attributes as an output to an operator or an onboard autonomous control system to support obstacle/collision avoidance in accordance with Navigation Rule 5. Current state of the art optical perception systems do not meet the goals of USV operational needs with respect to the Navigation Rules. The Navy has reviewed and used a variety of optical technologies and strategies to provide USVs with optical situational awareness (SA) and contact detection (CD), but to date these approaches lack the ability to satisfactorily capture images and process the digital data, and fail to meet requirements with respect to performance (stabilization, coverage, range, obstacle detection) and environment (shock, water intrusion, green water impact).

These existing technologies, furthermore, are not suitable for supporting even basic USV operation by a remote operator. Existing technology simply overloads the operator with information. A human onboard a craft can quickly rotate to get a 360 degree appraisal of the environment and is self stabilizing. An operator behind a remote console controlling a pan-tilt-zoom camera or switching between multiple fixed camera views, as is required by current technology, is an extremely ineffective and fatiguing approach. The processor subsystem should collect all data from the sensor and process the data into a useable output format. Output types would include streaming video, still pictures of contacts of interest and contact attribute data.

Contacts may include all sizes of power and sailing vessels, buoys and other navigation markers, structures on land including light houses and floating, semi-submerged debris (log to ISO container). Attributes may include contact size, height to length ratio, range, bearing and speed/direction. The objective is to provide the contact attributes a person would need to make a full appraisal of the situation and of the risk of collision.

The processor shall have the capability to detect navigation lights and day shapes on other vessels (Navigation Rules, Part C) from the raw sensor data and provide their attributes. The processor shall also have the capability to detect and provide attributes of navigation aids such as color, lights and shapes.

Environmental effects must be taken into account in developing the optical subsystem. These include water intrusion/impacts and craft motions. State of the art systems not been operated in higher sea states and thus have not addressed such issues as motions, shock, vibration, water spray and water impact. The optical subsystem must be capable of both performing and surviving in the intended environment.

The subsystem must be able to receive communications directing it, for example, to zoom in on an image or replay a captured sequence. This communication could come from a remote human operator or an onboard autonomous control system, both of which will be receiving inputs from the radar and audio sensor subsystems. Such communications will allow the optical subsystem to “focus” both the optical sensor as well as processing power on an indicated area. This would be similar to a human operator who hears something coming from a particular direction and focuses in that direction. Further development and integration into a complete perception processing system could occur under Phase III, but it is only the intent of this topic to define such interfaces.

Reference 1, slide 14, provides a picture of the USV and its principal hardware including the current navigation sensors. The desired camera subsystem should have a field of view (FOV) that provides 360 degrees in the horizontal plane and be able to view contacts on the water surface from within 10 yards (man in the water and larger) of the vessel to the horizon (12m long by 3m high and larger) during operation, which includes significant vessel motions (e.g., incurred during sea state 3 operations) and operations in all visibility conditions (day, night, rain, snow, fog, etc.). The processor shall have the capability to detect a contact on the water or shore from the raw sensor data, and provide contact attributes. Maximum detection range for navigation aids, such as buoys, and other vessels is two nautical miles and minimum detection range is 10 yards. Determination of specific requirements for resolution will be the responsibility of the proposer and shall be based on the processors’ requirements to perform contact detection as defined below. The camera subsystem would typically be mounted on an arch approx 10’ off the water, and is subject to sea spray, direct sunlight and occasional green water impacts.

This SBIR topic is not soliciting the development of computer hardware technology as part of the perception processing system. Ruggedized computing systems exist on the market. Environmental requirements can be met by either using a ruggedized computer able to directly handle the environment or by repackaging the system (shock mounts, cooling, etc.). However, novel optical processing techniques and technologies shall be used to minimize the required processing power and footprint. Hardware selection shall address environmental issues. The processor would normally be installed below decks, in a relatively sheltered compartment not directly exposed to the elements.

PHASE I: Complete preliminary design for the proposed optical sub-system. The design should include details on system hardware and software architecture and should specify key system components and their expected performance. Provide convincing evidence of the feasibility of the system design to meet the objectives of the topic. Perform bench top experimentation where applicable to demonstrate concepts.

PHASE II: Develop detailed hardware and software design for the optical sub-system. Fabricate and test a prototype. In a laboratory environment demonstrate that the prototype meets the performance goals established in Phase I. Verify final prototype operation in a representative environment and provide results. Develop a cost benefit analysis and a Phase III installation, testing, and validation plan.

PHASE III: Construct a full-scale prototype and install on board a selected combatant craft. Conduct extended shipboard testing. Support transition and integration of the subsystem into a full system, including radar and audio subsystems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology developed under this topic will be applicable to any Unmanned Surface Vehicle of similar size and outfitting as the UISS USV. As radar has greatly helped the maritime industry with regards to safe navigation, optical perception systems can also enhance safe navigation of manned and unmanned craft alike.

REFERENCES:
1. D. Ashton. Unmanned Maritime Systems Overview. Presentation to The Maritime Alliance Conference. 17 November 2010. [Google: “Nov 17, 2010 ... Unmanned Maritime Systems Overview. Presented to: The Maritime Alliance Conference. Presented by: CAPT Duane Ashton,.”]

2. ONLINE COMDTINST M16672.2D, NAVIGATION RULES (International-Inland). http://www.navcen.uscg.gov/?pageName=navRulesContent

3. NAVIGATION RULES FREQUENTLY ASKED QUESTIONS. Question 12. http://www.navcen.uscg.gov/?pageName=navRulesFAQ

4. S. Calfee and N. C. Rowe. An Expert System and Tutor for Maritime Navigation Rules. http://faculty.nps.edu/ncrowe/oldstudents/ccrt02b.htm

5. See SITIS under this topic number for Additional Guidance for Compact Autonomous Perception Processing System for Situational Awareness and Contact Detection Unmanned Surface Vessels.

KEYWORDS: camera, sensor, unmanned, USV, optical, perception

N113-176 TITLE: Multi-Target High Probability of Kill Weapons Engagement

TECHNOLOGY AREAS: Information Systems, Sensors, Weapons

ACQUISITION PROGRAM: Undersea Defensive Warfare Systems Program Office (PMS 415). ACAT III

RESTRICTION ON PERFORMANCE BY FOREIGN CITIZENS (i.e., those holding non-U.S. Passports): This topic is “ITAR Restricted”. The information and materials provided pursuant to or resulting from this topic are restricted under the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 - 130, which control the export of defense-related material and services, including the export of sensitive technical data. Foreign Citizens may perform work under an award resulting from this topic only if they hold the “Permanent Resident Card”, or are designated as “Protected Individuals” as defined by 8 U.S.C. 1324b(a)(3). If a proposal for this topic contains participation by a foreign citizen who is not in one of the above two categories, the proposal will be rejected.

OBJECTIVE: The objective of this SBIR is to optimize fire control through innovative research and development in machine cognitive decision theory to develop a fire control decision engine that addresses the complexities associated with the simultaneous engagement of multiple concurrent hostile torpedoes while addressing the uncertainty dimensions and associated constraints.

DESCRIPTION: The Torpedo Warning System is a man-in-the-loop system that couples active and passive sonar components with a fire control decision engine to engage incoming torpedoes with CATs. The man-in-the-loop role is to apply situation awareness using a clear and simple information display to validate automated torpedo alerts and to make decisions concerning launch of CATs and ship's evasive maneuvers. The actual fire control guidance to optimize CAT effectiveness is automated. Current program-of-record fire control solutions are built upon an explicit enumeration of inputs and behaviors where system designers attempt to anticipate all possible behaviors of the system. This solution provides a base capability that is repeatable and auditable, but not robust in the entire solution space.

Recent academic developments in the area of adaptive machine learning have not been applied in this arena. This SBIR seeks research only in the application of Adaptive Learning techniques to the TWS multi-target problem. Machine learning systems adaptively improve with exposure to the problem space. Evolutionary algorithms, genetic programs, classical neural networks, spiking nets, and learning classifier systems seem suitable to address this problem. This topic does not seek development of all the technologies mentioned above but does seek the application of one or more of these implicit techniques to the Torpedo Warning System (TWS) problem that is measurably superior to the program-of-record approach. Small businesses will utilize modeled or simulated data based upon publicly available information to develop the Adaptive Learning approach through phase II. Given that learning systems provide limited auditability, the proposed solution must prove to be deterministic in the sense that, once deployed, the behavior in a given set of circumstances must always be the same (repeatable).

PHASE I: Develop criteria concepts to discriminate amongst modern machine learning approaches with applicability to Torpedo Warning System (TWS). Provide recommended approach/design for prototype system with Phase II program plan.

PHASE II: Develop prototype machine learning system based upon results of Phase I, using simulated data. Develop Metrics and assess relative performance of learning system against explicit enumerated system.

PHASE III: Provide development of a scalable system with interfaces to Torpedo Warning System (TWS) and implement the recommended system developed under Phase II. Evaluate and demonstrate the system's ability to augment the Torpedo Warning System (TWS).

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Advances in machine cognitive decision theory are applicable to automation efforts going on in commercial rail industry, automobile automation programs, robotics industry, as well as the commercial power industry.

REFERENCES:
1. Marsland, Stephen (2009), Machine Learning: An Algorithmic Perspective. Chapman & Hall/Crc Machine Learning & Pattern Recognition

2. Bishop, Christopher (2007), Pattern Recognition and Machine Learning. Springer, Corr. 2nd printing edition

3. Winkler, Joab; Lawrence, Neil; Niranjan, Mahesan (Eds.) (2004), Deterministic and Statistical Methods in Machine Learning. Springer Lecture Notes in Artificial Intelligence

KEYWORDS: Machine Learning; Cognitive Decision Making; Human-Machine-Interface; Defensive Warfare Systems; Visualization; Rapid Response

N113-177 TITLE: <u>Battery Management, Monitoring and Diagnostic Device for Navy Energy Storage Modules</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles, Electronics

ACQUISITION PROGRAM: PMS 320, Electric Ships Office

OBJECTIVE: Develop a battery energy, storage management/electrical safety device to ensure correct operation, prevention of abusive conditions and storage system condition awareness pertaining to large rechargeable energy storage systems.

DESCRIPTION: Energy storage is an enabler for a growing number of applications onboard Navy platforms to enhance functionality and fuel savings. In certain situations, an energy storage device may serve as the primary power source for operations, in other applications the device might be required to monitor a distributed network of devices of various types which must collectively work together in order to meet specific power requirements. Current battery management systems are disparate in nature, resident within the battery itself and typically only perform minimal operational monitoring (voltage and temperature cut-outs) of energy storage devices for the purpose of preventing abusive conditions. Regardless of application, safety and the individual as well as collective condition awareness of the energy storage devices which comprise an overall system are key areas of technology need for which there is no currently available solution. Independent of host platform and application, the management and monitoring of future energy storage systems will need to be able to diagnosis and prognosis battery health, identify and report anomalies associated with battery degradation, and ultimately have the capability to provide forewarning of a potential casualty event.

This topic seeks to explore innovative approaches to the development of a Battery Management System (BMS) device which would allow ships force the ability to control critical parameters associated with thresholds of abusive or otherwise hazardous or non-optimal conditions in energy storage architectures up to 1000 VDC minimum. Proposed concept(s) should employ open architecture design principles to enable the ability to be tuned to a variety of secondary battery chemistries, device types (including the batteries, energy storage capacitors, hybrid devices, etc. from different manufacturers and of different sub-varieties (not associated with any one type or manufacturer)) and architectures to provide awareness of the operational characteristics of the system on a cell-by-cell basis. A key technical challenge will be in the ability to develop sophisticated algorithm(s) that will permit the integration of relevant operational and physical data, which can be obtained from both normal use and enhanced monitoring, while being able to determine changes in performance and forecast degradation and pending failures within the energy storage system or a singular cell. Additional inputs for consideration could be, but are not limited to, current probe monitoring of the battery string, gas/smoke sensor signals, and outputs to control contactors, switches, relays, warning lights, etc. Proposed concepts must be adaptable and applied in a simple and straightforward manner such that any number of end-users can utilize the system with minimal learning curve. In addition, proposers should be mindful of the goal of a flexible design to allow for application on future battery designs and naval applications with interface, input-output and processing capability while allowing for enable local monitoring and control as well as connectivity and communications with the various shipboard controls and reporting systems. Upon completion of Phase II proposed concepts should address the ability to pass Navy standard electrical safety device certification tests (in accordance with ref. 1 & 2, NAVSEAINST9310, S9310-AQ-SAF-010 Section 2.3.7.2.5, and modified as needed for all implemented cutout parameters, e.g. voltage, temperature, etc.).

PHASE I: Demonstrate the feasibility of the innovative approaches to the development of a Battery Management System (BMS) device which would allow ships force the ability to control critical parameters associated with thresholds of abusive or otherwise hazardous or non-optimal conditions in energy storage architectures up to 1000 VDC minimum. As applicable, demonstrate the effectiveness of the solution with modeling and simulation and engineering analysis. Establish performance goals and provide a Phase II developmental approach and schedule that contains discrete milestones for product development.

PHASE II: Develop, fabricate and demonstrate a prototype as identified in Phase I. In a laboratory environment, demonstrate that the prototype meets the performance goals established in Phase I. Conduct performance integration and risk assessments. Develop a cost benefit analysis and cost estimate for a naval shipboard unit. Provide a Phase III installation, testing and validation plan.

PHASE III: Working with the Navy and applicable Industry partners, demonstrate application with an energy storage module to be implemented within shipboard and/or land-based test site to support fuel saving or other applications. This initial testing will then support transition into numerous energy storage applications. This effort will provide detail drawings and specifications, including documentation for manipulation of management operations and detailed explanation of the operation of the device software. The Proposer will perform Electrical Safety Device evaluation in accordance with reference 2 for the module as defined.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commonality within battery management system interfaces, communications and architectures will enable standards to be set which can effect applications associated with smart grid, vehicle applications, renewable, etc., particularly when implemented in large storage systems.

REFERENCES:
1) NAVSEA Instruction 9310.1B Subject: Naval Lithium Battery Safety Program
www.navsea.navy.mil/NAVINST/09310-001B.pdf

2) Technical Manual S9310-AQ-SAF-010 for Batteries, Navy Lithium Safety Program Responsibilities and Procedures
http://www.marcorsyscom.usmc.mil/sites/pmeps/DOCUMENTS/BatteryPolicy/Battery%20Policy%20-%20S9310%20manual%20-%2019%20Aug%2004.pdf

3) Lukic, S.M.; Jian Cao; Bansal, R.C.; Rodriguez, F.; Emadi, A.; "Energy Storage Systems for Automotive Applications," Industrial Electronics, IEEE Transactions on, vol.55, no.6, pp.2258-2267, June 2008

4) Rudi Kaiser, Optimized battery-management system to improve storage lifetime in renewable energy systems, Journal of Power Sources, Volume 168, Issue 1, 10th European Lead Battery Conference - Selected Papers Presented at the 10th European Lead Battery Conference (10 ELBC) Athens, Greece, 26-29 September 2006, 25 May 2007

KEYWORDS: Energy Storage; Battery Management System; Monitoring; Diagnosis; Electrical Safety

N113-178 TITLE: <u>Investigate Alternate Sealant Materials for Countersunk Fasteners Head and Hole Cavities on Exterior of Submarines</u>

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMS 392 IN-SERVICE STRATEGIC AND ATTACK SUBMARINES AND NEW CONSTRUCTION.

OBJECTIVE: To develop a sealant, equivalent to the existing PR-944F polysulfide material, to fill and fair-in the fastener head and cavities on submarine exterior hulls in order to level the surface and protect the fasteners from seawater. The sealant must be significantly easier to remove than PR-944F without increasing installation and cure times.

DESCRIPTION: Countersunk fastener hole cavities (up to 5” diameter and up to 3” thick) on submarine exterior hulls are filled and faired with PR-944F polysulfide sealant to level the surface and protect fasteners from seawater. In order to remove the fasteners the polysulfide sealant, PR-944F, must first be removed. The removal of this sealant is very labor intensive and requires hand tools. For example, ship yards estimate that to remove the PR-944F polysulfide from submarine hulls takes 1251 man hours of labor to remove all PR-944F seam filler during a typical major availability.

An equivalent, alternate sealant that is easier to remove is sought to reduce the time and labor currently required for maintenance, thus reducing costs to the navy. The sealant must exhibit hydrolytic stability when immersed in seawater and exposed to pressure cycling; must be environmentally friendly; safe for workers to use; have no adverse impacts on fastener materials, epoxy paint, rubber, urethane, metallic and Glass Reinforced Plastic (GRP) substrates; and provide adequate adhesion to fastener materials, metallic/nonmetallic substrates, paint systems and hull coatings to remain affixed while at sea. It must exclude water under pressure from the surfaces it adheres to and have minimal compression/set under pressure. The application method must be feasible from a vertical, horizontal, or overhead location with minimal sags, runs, or drips without increasing installation and cure times beyond those currently existing for the PR-944F. Installation, storage, shipping environments and requirements must be no more stringent than those currently required for PR-944F. Sealant packaging costs and shelf life shall be equivalent or superior to those for the current system.

PHASE I: Develop and define a concept to identify an environmentally friendly, safe sealant that is easier to remove than the current PR-944F. Define concepts to show its capability to replace PR-944F on submarine hulls with equivalent capability to exclude water under pressure from the surfaces to which it is applied. Concepts must include test methodologies for measuring hydrolytic stability when immersed in seawater and exposed to pressure cycling with minimal compression/set. Conceptual materials must have no adverse impacts on fastener materials, epoxy paint, rubber, urethane, metallic and Glass Reinforced Plastic (GRP) substrates, and provide adequate adhesion to fastener materials, metallic/nonmetallic substrates, paint systems and hull coatings to remain affixed in an at-sea environment.

PHASE II. Demonstrate and validate the sealant identified from Phase I to replace PR-944F on representative submarine hull section or mock-up that incorporates the desired typical features of interest. This includes countersunk fastener hole cavities up to 5” diameter and up to 3” thick. Evaluate the sealant from Phase I to validate that it can be prepared and installed without increasing installation and cure times beyond those required by PR-944F. Verify installation environment requirements. The application method must be demonstrated to be feasible from a vertical, horizontal, or overhead location with minimal sags, runs, or drips. Ensure cured sealant does not shrink causing separation from edges or exposing substrate.

Removal methods shall be identified and employed to evaluate the ease of removal for the sealant. During removal of the selected material, it shall be demonstrated that there is no adverse impact on fastener materials, surrounding paint and hull coatings, as well as substrates.

The environmental requirements for material installation, storage and shipping will be determined and must be no more stringent than those currently required for PR-944F. MSDS and material data sheets for the material shall be generated and supplied. The required sealant kit packaging costs shall be determined and must be no more than the existing material costs. Determine and evaluate any receipt inspection and quality assurance testing necessary for the sealant from Phase I including periodicity and test procedures.

PHASE III: Evaluate and validate the sealant to ensure that it meets the prescribed properties through testing a representative fabricated submarine hull section with fastener cavities. A representative fabricated hull section should also be tested to evaluate the ease of removal of the sealant. The application method must be demonstrated to be feasible from a vertical, horizontal, or overhead location with minimal sags, runs, or drips, and the sealant must also be verified to be environmentally friendly and safe. Evaluate the sealant from Phase II to validate that it can be installed without increasing installation and cure times beyond those required by PR-944F. Verify installation environment requirements.

The environments and requirements for material installation, storage and shipping will be determined and must be no more stringent than those currently required for PR-944F Material Safety. Data Sheets for the material shall be generated and supplied. The required sealant kit packaging costs shall be determined and must be no more than the existing material costs. The shelf life for the sealant from Phase II shall be determined and shall be no less than 1-year (preference for over 2 years). Determine and evaluate any receipt inspection and quality assurance testing necessary for the sealant from Phase II including periodicity and test procedures.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Marine and architectural sealant.

REFERENCES:
1) MIL-DTL-24631/1C, http://www.nstcenter.com/milspecs.aspx?milspec=24631

2) NSN 8030-01-398-7578, http://8030.iso-group.com/NSN/8030-01-398-7578

3) Material Safety Data Sheet (MSDS) for PR-944F, http://www.chemcas.com/msds112/cas/2046/93983378.asp

KEYWORDS: sealant; PR-944 F; Materials; fastener; cavity; polysulfide

N113-179 TITLE: Automated Radio Frequency (RF) Spectrum Management for Wideband Electronic Warfare (EW) Systems

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PMS-450 Virginia Class (ACAT I)

OBJECTIVE: Modern electronic warfare systems typically operate over very wide bandwidths of up to 40GHz. The goal of next generation WB EW systems is to ensure 100% POI with high dynamic range in order to detect and classify signals of interest (SOI) in dense target environments while reducing size, weight, power (SWaP) and cost. In order to effectively perform in this manner and over these bandwidths, innovative end-to-end spectral processing and analysis improvements are needed from the antenna to the receiver. Current IFM, notch filtering, analog channelization, high speed scanning and automatic gain control technologies as well as digital signal processing techniques can help overcome certain aspects of this problem, but have their own shortcomings with respect to the overall system SWaP, cost and performance.

What is needed is an innovative WB (up to 40GHz) RF spectrum management architecture that can tolerate and dynamically adapt in response to large in-band interferers. This will improve the EW system's ability to effectively detect and classify SOIs in dense, interference dominated RF environments, such as those encountered in the littorals. In other words, an architecture is needed which continually attempts to maximize S/(N+I) over wide bandwidths, but does not significantly increase system SWaP and cost.

DESCRIPTION: Modern electronic warfare systems typically operate over very wide bandwidths of up to 40GHz. The goal of next generation WB EW systems is to ensure 100% POI with high dynamic range in order to detect and classify signals of interest (SOI) in dense target environments while reducing size, weight, power (SWaP) and cost. In order to effectively perform in this manner and over these bandwidths, innovative end-to-end spectral processing and analysis improvements are needed from the antenna to the receiver. Current IFM, notch filtering, analog channelization, high speed scanning and automatic gain control technologies as well as digital signal processing techniques can help overcome certain aspects of this problem, but have their own shortcomings with respect to the overall system SWaP, cost and performance.

What is needed is an innovative RF spectrum management architecture that can tolerate and dynamically adapt in response to large in-band interferers. This will improve the EW system's ability to effectively detect and classify SOIs in dense, interference dominated RF environments, such as those encountered in the littorals. In other words, an architecture is needed which continually attempts to maximize S/(N+I) over wide bandwidths, but does not significantly increase system SWaP and cost.

PHASE I: Develop an innovative and cost effective RF spectrum management architecture which provides 100% POI with a minimum of 70dB (80dB desired) of dynamic range over 18GHz (40GHz desired) and maximizes S/(N&I). Demonstrate the performance of the approach via simulation. Show how the architecture cost vs. performance scales as a function of instantaneous BW and total N+I power (assume both NB and WB interference).

PHASE II: Implement a scaled prototype of the proposed architecture based on the concept developed in Phase I over a subset of the overall required instantaneous BW. The prototype must provide a means to measure S/(N+I) when connected to an RF input with a BW greater than or equal to the prototype. If possible, a demonstration on a representative system (e.g., radar band EW system) in a laboratory environment is preferred.

PHASE III: The architecture will be transitioned to one or more Navy EW and airborne early warning programs, such as the AN/BLQ-10 or AN/SLQ-32. This improved architecture will be ideal for Virginia (VA) Block IV/V and Ohio Replacement Program (ORP) to realize the full potential of EW sensor improvements for these platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology developed here for EW sensors should be readily applicable to commercial and military communications systems, radar systems and Counter Radio Controlled IED detection systems.

REFERENCES:

1. D.C. Schleher, Electronic Warfare in the Information Age, Artech House, 2001.

2. D.L. Adamy, Introduction to Electronic Warfare Modeling and Simulation, SciTech Publishing, 2006.

3. A Sampling Based Approach to Wideband Interference cancellation, A.M. Haimovich, M.O. Berin, J.G. Teti Jr., IEEE Transactions on Aerospace and Electronic Systems, 1998

4. Reference is not available for public distribution at this time, and has been removed (8/9/11).

KEYWORDS: electronic warfare, interference cancellation, wide band systems, narrowband interference, filtering, automatic gain control

N113-180 TITLE: Line-Distributed Hoop Strain Sensor

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PMS397 OHIO-Replacement Program ACAT I

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OBJECTIVE: The objective of this task would be to research, develop, and demonstrate a strain gage (sensor) capable of measuring axisymmetric hoop strain of a large diameter shell. The sensor must be accurate over a broad frequency range, down to and including zero Hz.

DESCRIPTION: Large structures acted upon by external forces exhibit complex vibrations. A complex vibration pattern consists of a superposition of many simpler vibration patterns (modes), each of which has a characteristic wavelength. Often the impact on the overall health of a structure depends more heavily on the vibration of modes with long wavelengths. For cylindrical shells, hoop strain is a key indicator of structural health. The current method of estimating the hoop strain is to place a large number of point sensors (accelerometers) around the circumference of the structure and apply geometrical weighting to the sensor signals. Many sensors are needed to filter out the shorter wavelength vibration content that can dominate the signals of the individual sensors. Each point sensor requires a cable to provide electric power and to transmit the measured signal to a centralized signal processing unit. Thus, to extract the single measure of axisymmetric hoop strain can require a significant amount of hardware and signal processing.

This proposal is looking for an innovative and cost reducing method that can measure the required strain over a long line or large area. Such a sensor must operate with minimal signal processing and low electrical power. It must operate over a range of environmental conditions (temperature, humidity, noise, and vibration). It must be capable of installation, operation, and maintenance by trained personnel. It should provide a significant signal-to-noise (SNR) improvement over current technology. Such a technology could intrinsically eliminate the need for spatial filtering, thereby radically reducing the signal processing and cabling demands and greatly reducing installation, operational, and servicing cost.

PHASE I: Develop concepts for a field of distributed sensor technology and propose a candidate set of technologies to test and evaluate in Phase II. The contractor will develop distributed hoop strain sensor concepts to address the requirements mentioned above. Criteria for assessing the technology will include accuracy, latency, linearity, ease of calibration, durability, fragility, electrical power/voltage/current requirements, and electro-magnetic interference.

PHASE II: The contractor will expand upon the Phase I work to develop a representative prototype of selected sensor concepts. The prototypes will then be demonstrated and tested under a number of operating conditions (temperature, humidity, noise and vibration level) that the government will specify.

PHASE III: The contractor will support the government in field testing the distributed strain sensor. The contractor will acquire the capability to manufacture the distributed strain sensor and the capability to provide technical support to the government in installation, operation, and maintenance of the strain sensors.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The benefits from a distributed strain sensor in reducing installation and servicing cost can be adopted by the private sector for commercial purposes. Such applications include installation of distributed strain sensors on pressure tanks and in the aircraft industry.

REFERENCES:

1. Fibre optic sensors in civil engineering structures, R. C. Tennyson, T. Coroy, G. Duck, G. Manuelpillai, P. Mulvihill, David JF Cooper, PW E. Smith, A. A. Mufti, and S. J. Jalali, Can. J. Civ. Eng. 27(5): 880–889 (2000)

2. Localized long gage fiber optic strain sensors, N Y Fan et al 1998 Smart Mater. Struct. 7 257

3. Structural Health Monitoring: Current Status and Perspectives, Fu-Kuo Chang (editor), CRC Press, 1998, ISBN 1566766052, 9781566766050

KEYWORDS: Strain; prognostic; health; monitoring; sensors; gage

N113-181 TITLE: Advanced Medium-Voltage, High-Power Charging Converter for Pulsed Power Applications

TECHNOLOGY AREAS: Ground/Sea Vehicles, Electronics

ACQUISITION PROGRAM: PMS 320, Electric Ship Office

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OBJECTIVE: Develop an advanced, modular, scalable, converter charger for a 250 kilo-joule (KJ) capacitor for the Electromagnetic Railgun's (EMRG's) Pulsed Power System (PPS).

DESCRIPTION: The Navy is currently developing a Pulsed Power System (PPS) to power an Electromagnetic Railgun (EMRG). The PPS uses a capacitor bank as the source of the very high current (on the order of several mega-amps) required by the EMRG for operation. EMRG requirements necessitate the use of a high power density (>1MW/m3) DC/DC converter capable of high, repetition-rate charging of capacitor banks. This capacitor bank is comprised of 250 KJ capacitor “rep-rate” modules which must recharge from the ship’s power system in no more than several seconds (equating to an average power draw of greater than 40 KW per module, or a total of greater than 8 MW for a 50 MJ system) in order to achieve the desired EMRG repetition rate. Presently, the available state-of-the-art in commercial capacitor chargers is not optimal for the anticipated high repetition-rate EMRG application. They have insufficient power ratings, with a unit size of less than 35KW, which would require that a very large number of systems be operated in parallel. They have power density of <0.2MW/m3 as single units which becomes significantly worse as units are ganged together in cabinets. They are not configured for the projected DC voltage input that they will see in this application and would require external rectifiers, further reducing power density. They are not suitable for shipboard use and would need significant modifications to meet military standards for shock, vibration, EMI, and power quality. Lastly, the volume and interior space air conditioning limits of shipboard application dictate the use of liquid cooling. Commercial chargers are nearly exclusively air cooled, which imposes a significant volume penalty and results in heat being dissipated into the interior spaces of the ship, placing a large heat burden on the air conditioning system. These shortcomings necessitate the development of a capacitor charger capable of being used to meet the more robust requirements of the EMRG pulsed power system.

This topic seeks to explore innovative approach(es) to the development of an advanced, modular, converter charger for a 250 KJ capacitor. The proposed converter charger concept must be able to: draw power from a 700-900 VDC battery bank; provide sufficient power to charge the 250 KJ capacitor to 10 kVDC within several seconds; have a repetition rate of 6 charges/minute; have a peak-to-average power ratio of no more than 1.3 over the charge cycle. As necessary, the proposed concepts should incorporate liquid cooling and other technologies (such as but not limited to: advanced power electronic devices, novel topologies, etc) for reducing the overall system size (>1MW/m^3). This system should be designed so that the devices and topologies employed will be scalable during the Phase III to the voltage and power levels (10kV and 8MW) needed for a 50+ MJ capacitor bank with 1 MJ capacitor converter chargers that can be operated separately or ganged together without compromising volume.

PHASE I: Demonstrate the feasibility of an advanced, scalable, modular converter charger for a 250 KJ capacitor. As applicable, demonstrate the effectiveness of the solution with modeling and simulation and engineering analysis. Establish performance goals and provide a Phase II developmental approach and schedule that contains discrete milestones for product development.

PHASE II: Develop, demonstrate and fabricate a prototype as identified in Phase I. In a laboratory environment, demonstrate that the prototype meets the performance goals established in Phase I. Conduct performance, integration, and risk assessments. Develop a cost benefit analysis and cost estimate for a naval shipboard unit. Provide a Phase III installation, testing, and validation plan. Proposer should demonstrate that the proposed components and concepts would be scaleable up to full voltage and power levels of 50 MJ.

PHASE III: Working with the Navy and Industry, as applicable, design and construct a fully functional 250 KJ charger converter capable of being scaled to 1 MJ for future use in a 50+ MJ capacitor bank. The goal is to be able to utilize the proposed converter charger concept on the EMRG proof-of-concept demonstration and design efforts and, ultimately, in a system onboard a ship.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Technologies developed in this program are applicable utility and industrial applications requiring high density dc power conversion, especially those involving the charging of large banks of capacitors. Examples include fusion research facilities such as the National Ignition Facility (NIF) which use 100’s of megajoules of stored energy. Technologies would also be applicable to more general medium voltage power electronics applications such as High-Voltage DC transmission (HVDC) systems, medium-voltage motor drives, and systems designed to interface alternative energy supplies to the medium voltage distribution grid.

REFERENCES:
1. Gully, J. H., “Power Supply Technology for Electric Guns”, Magnetics, IEEE Transactions on, Volume: 27 Issue: 1, Jan 1991, Page(s): 329 -334.

2. Elwell, R.; Cherry, J.; Fagan, S.; Fish, S.; “Current And Voltage Controlled Capacitor Charging Schemes”, Magnetics, IEEE Transactions on, Volume: 31, Issue: 1, Jan 1995, Pages: 38 – 42.

3. Bernardes, J. S.; Sturmborg, M. F.; Jean, T. E., “Analysis of a Capacitor-Based Pulsed-Power System for Driving Long-Range EM Guns”, Magnetics, IEEE Transactions on, Volume: 39, Issue: 1, Jan. 2003 Pages: 486 - 490.

4. Grater, G.F.; Doyle, T.J.; “Propulsion Powered Electric Guns-A Comparison Of Power System Architectures”, Magnetics, IEEE Transactions on, Volume: 29, Issue: 1, Jan 1993 Pages: 963 – 968.

KEYWORDS: electromagnetic; capacitors; pulsed-power; converter; power electronics; EMRG