NAVY
14.1 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 **20 November through 19 December 2013.** Beginning **20 December**, the SITIS system (http://www.dodsbir.net/Sitis/Default.asp) listed in Section 4.15.d 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
N141-001 thru N141-002	Ms. Elizabeth Madden	MARCOR	sbir.admin@usmc.mil
N141-003 thru N141-021	Ms. Donna Moore	NAVAIR	navair.sbir@navy.mil
N141-022 thru N141-056	Mr. Dean Putnam	NAVSEA	dean.r.putnam@navy.mil
N141-057	Mr. Chris Coleman	NSMA	chris.coleman@navy.mil
N141-058 thru N141-078	Ms. Lore Anne Ponirakis	ONR	loreanne.ponirakis@navy.mil
N141-079	Ms. Elizabeth Altmann	SPAWAR	elizabeth.altmann@navy.mil
N141-080 thru N141-082	Mr. Mark Hrbacek	SSP	Mark.Hrbacek@ssp.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.navysbir.com. Additional information pertaining to the Department of the Navy's mission can be obtained by viewing the website at http://www.navy.mil.

PHASE I GUIDELINES

Follow the instructions in the DoD Program Solicitation at www.dodsbir.net/solicitation for program requirements and proposal submission. It is highly recommended that you follow the Navy proposal template located at http://www.navysbir.com/submission.htm as a guide for structuring your proposal. Cost estimates for travel to the sponsoring SYSCOM's facility for one day of meetings are recommended for all proposals.

Technical Volumes that exceed the 20 page limit will be reviewed only to the last word on the 20th page. Information beyond the 20th page will not be reviewed or considered in evaluating the Offeror's proposal. To the extent that mandatory technical content is not contained in the first 20 pages of the proposal, the evaluator may deem the proposal as non-responsive and score it accordingly.

The Navy requires proposers to include, within the **20-**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.**

PHASE I PROPOSAL SUBMISSION CHECKLIST:

The following criteria <u>must be met</u> or your proposal will be REJECTED.

____1. Include a header with company name, proposal number and topic number on each page of your Technical Volume.

____2. Include tasks to be completed during the option period in the 20 page technical volume and include the costs as a separate section in the Cost Volume. The costs for the base and option are clearly separate, and identified on the Proposal Cover Sheet, in the Cost Volume, and in the work plan section of the proposal.

____3. BREAK OUT SUBCONTRACTOR, MATERIAL AND TRAVEL COSTS IN DETAIL. Use the "Explanatory Material Field" in the DoD Cost Volume worksheet for this information.

____4. If Discretionary Technical Assistance (DTA) is proposed, add information required to support DTA in the "Explanatory Material Field" in the DoD Cost Volume worksheet.

____**5. The base effort should not exceed $80,000 and have a period of performance of six months and the option should not exceed $70,000 and have a period of performance of six months. If proposing direct DTA, a total of up to $5,000 may be added to the Base and Option periods combined.**

____6. Upload your Technical Volume and the DoD Proposal Cover Sheet, the DoD Company Commercialization Report, and Cost Volume electronically through the DoD submission site by 6:00 am ET, 22 January 2014.

____7. 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.

The Navy will evaluate and select Phase I proposals using the evaluation criteria in Section 6.0 of the DoD Program Solicitation 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.

Protests of Phase I and II selections and awards shall be directed to the cognizant Contracting Officer for the Navy Topic Number. Contracting Officer contact information may be obtained from the Navy SYSCOM SBIR Program Manager listed in Table 1.

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.

In accordance with section 4.10 of the DoD Instructions, your request for a debrief must be made within 30 days of non-award notification.

CONTRACT DELIVERABLES

Contract Deliverables (CDRLs), typically progress reports, final reports, and initial Phase II proposals should be uploaded to https://www.navysbirprogram.com/navydeliverables/ as required by the contract.

PHASE II GUIDELINES

All Phase I awardees will be allowed to submit an **initial** Phase II proposal for evaluation and selection. The Phase I Final Report and Phase II Initial Proposal will be used to evaluate the offeror's potential to progress to a workable prototype in Phase II and transition technology in Phase III. The details on the due date, content, and submission requirements of the initial Phase II proposal will be provided by the awarding SYSCOM either in the Phase I award or by subsequent notification. **All SBIR/STTR Phase II awards made on topics from solicitations prior to FY13 will be conducted in accordance with the procedures specified in those solicitations (for all Department of Navy topics this means by invitation only).**

Section 4(b)(1)(ii) of the SBIR Policy Directive permits the Department of Defense and by extension the Department of the Navy (DoN), during fiscal years 2012 through 2017, to issue a Phase II award to a small business concern that did not receive a Phase I award for that R/R&D. The DoN will **NOT** be exercising this authority for Phase II awards. **In order for any small business firm to receive a Phase II award, the firm must be a recipient of a Phase I award under that topic.**

The Navy will evaluate, and select Phase II proposals using the evaluation criteria in Section 8.0 of the DoD Program Solicitation 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 typically awards a cost plus fixed fee contract for Phase II. The Phase II contracts can be structured in a way that allows for increased funding levels based on the project's transition potential. This is called the Phase II.5 or Subsequent Phase II 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. Each SYSCOM has specific guidance for Phase II.5 which can found at http://www.navysbir.com/phaseII5andcpp.htm

DISCRETIONARY TECHNICAL ASSISTANCE – The SBIR Policy Directive section 9(b), allows the DoN to provide discretionary technical assistance to its awardees to assist in minimizing the technical risks associated with SBIR projects and commercializing products and processes. Firms may request, in their application for Phase I and Phase II proposals, to contract these services themselves in an amount not to exceed $5,000 per year. This amount is in addition to the award amount for the Phase I or Phase II project.

Approval of direct funding for this discretionary technical assistance will be approved by the DON SBIR office if the firm's proposal clearly identifies the need for assistance (purpose and objective of required assistance), provides details on the provider of the assistance (name and point of contact for performer) and why they are uniquely skilled to carry out this work (specific experience in providing the assistance proposed), and the cost of the required assistance (costs and hours proposed or other details on arrangement). This information must be included in the firm's cost proposal specifically identified as "Discretionary Technical Assistance" and is not subject to any profit or fee by the requesting (SBIR/STTR) firm. In addition, the provider of the discretionary technical assistance may not be the requesting firm, an affiliate of the requesting firm, an investor of the requesting firm, or a subcontractor or consultant of the requesting firm otherwise required as part of the paid portion of the research effort (e.g. research partner). Failure to include the required information in your proposal will result in your request for discretionary technical assistance being disapproved. Exceeding proposal limits identified for Phase I ($150,000) without including the required identification of Discretionary Technical Assistance will result in your proposal being REJECTED without evaluation.

If the firm requests discretionary technical assistance in a Phase II proposal, they will be eliminated from participating in Navy Transition Assistance Program (TAP) and Navy Opportunity Forum or any other assistance the Navy provides directly to firms.

Phase I awardees that propose more than $150,000 in total funding (Base, Option and discretionary technical assistance) cannot receive a purchase order. The need to issue a Firm Fixed Price (FFP) contract may result in contract delays if the SYSCOM normally issues Phase I awards as purchase orders.

All Phase II awardees not receiving funds for discretionary technical assistance in their award must attend a one-day Transition Assistance Program (TAP) meeting during the second year of the Phase II. 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.

PHASE III - A Phase III SBIR award is any work that derives from, extends or completes 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 the rights of the SBIR company.

AWARD AND FUNDING LIMITATIONS – In accordance with SBIR Policy Directive section 4(b)(5), there is a limit of one sequential Phase II award per firm per topic. Additionally in accordance with SBIR Policy Directive section 7(i)(1), each award may not exceed the award guidelines (currently $150,000 for Phase I and $1 million for Phase II) by more than 50% (SBIR/STTR program funds only) without a specific waiver granted by the SBA.

TOPIC AWARD BY OTHER THAN THE SPONSORING AGENCY – Due to specific limitations on the amount of funding and number of awards that may be awarded to a particular firm per topic using SBIR/STTR program funds (see above), Head of Agency Determinations are now required before a different agency may make an award using another agency's topic. This limitation does not apply to Phase III funding. Please contact your original sponsoring agency before submitting a Phase II proposal to an agency other than the one who sponsored the original topic. (For DoN awardees, this includes other SYSCOMs.)

TRANSFER BETWEEN SBIR AND STTR PROGRAMS – Section 4(b)(1)(i) of the SBIR Policy Directive provide that, at the agency's discretion, projects awarded a Phase I under a solicitation for SBIR may transition in Phase II to STTR and vice versa. A firm wishing to transfer from one program to another must contact their designated technical monitor to discuss the reasons for the request and the agency's ability to support the request. The transition may be proposed prior to award or during the performance of the Phase II effort. Agency disapproval of a request to change programs shall not be grounds for granting relief from any contractual performance requirement. All approved transitions between programs must be noted in the Phase II award or award modification signed by the contracting officer that indicates the removal or addition of the research institution and the revised percentage of work requirements.

ADDITIONAL NOTES

Due to 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/en/About-ONR/compliance-protections/Research-Protections/Human-Subject-Research.aspx. This website provides guidance and notes approvals that may be required before contract/work can begin.

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NAVY SBIR 14.1 Topic Descriptions

N141-001 TITLE: Alternative Energy Sources for Heating Rations

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PM Combat Support Systems (CSS), PdM Combat Support Equipment (CSE)

OBJECTIVE: Develop an alternative method to heat rations for echelon sized units while stationary, on the move and at outlying or remote feeding sites to negate the dependence on fossil fuel technology.

DESCRIPTION: The mission of Field Feeding is clearly stated in the Marine Corps Reference Publication 4-11.8A, Marine Corps Field Feeding Program and it reads “The Marine Corps Field Feeding Program supports the Marine Air-Ground Task Force in an expeditionary environment through flexibility in feeding methods - furnishing the capability to provide Marines the right meal, at the right place, at the right time” (Ref 1-2). This is especially significant with the recent article from the CNO and CMC that articulates that the Navy Marine Corps team will develop integrated operating concepts for our forces, field them with compatible equipment, and then deploy them in innovative force packages. Currently, the Marine Corps has systems that provide 250+ meals per sitting to lower echelon sized units. The Tray Ration Heating System (TRHS) and Enhanced Tray Ration Heating System (E-TRHS) accomplish this reduced mission, but both require the use of fossil fuel as well as a power source in order to accomplish the heating of rations (Ref. 3). The current fuel requirement to operate the ration heating systems for 59 hours is 30 gallons of diesel. By eliminating the fuel component, the same 30 gallons could potentially provide 420 miles for unit mobility or could save $156 for every 59 hours of ration heating operations per company sized unit deployed or conducting field training. Ultimately, eliminating the fuel component contributes to the overall reduction of combat resupply missions and decreasing the risk of Marines being wounded or killed while conducting these missions. The potential benefits of reducing resupply missions was evident from the Logistics Casualties Study from 24 March 2010 to 30 June 2010 for Marines conducting combat logistic patrol missions in Iraq. For a period of 3 months, there were 100 resupply missions per month with 2 Marines wounded in action per month from Improvised Explosive Device (IED) attacks.

This topic seeks to develop innovative approaches in the application of alternative energy sources (chemical, thermal, solar, etc.) capable of heating food rations (140-180°F), [Unitized Group Rations (UGR) A, B and Heat & Serve (H&S)], within the same time constraints as the TRHS and E-TRHS (Ref. 4-5). This effort alone is essential in eliminating the requirement to use fossil fuel which ultimately equates to fewer combat logistic patrols and mitigates the chances of Marines being wounded or killed while conducting resupply missions. There are existing technologies, such as solar cookers, that can accomplish the heating of rations using alternative methods; however, they only provide heating on a small order of 200 or less meals and not for multiple sittings. In order to replace the fossil fuel for fired burners and electrical heating systems, the technology must be able to demonstrate its effectiveness on a much larger scale, such as heating 250+ meals twice a day. The new technology shall have the capability to be transported, mounted and operational while on the move in all tactical cargo vehicles with minimum modification to the vehicle. The new technology shall operate in all climates and environments that may be encountered such as arctic, desert, jungle, and coastal. There shall be no operational degradation when ambient temperatures are between 125°F and -25°F. It must operate in all humidity levels up to 100 percent. It must be resistant to the effects of salt/water spray, and extreme sand and dust conditions to the extent outlined in MIL-STD-810G (Ref. 1, 2, 6). Small businesses should be mindful that the performance of any proposed technology solutions should match or exceed the current ration heating systems and that life-cycle costs should be maintained at the same level or lower as compared to the current systems.

PHASE I: The small business will develop concepts for an improved method to heat rations that meets the requirements described above. The small business will demonstrate the feasibility of the concepts in meeting Marine Corps needs and will establish that the concepts can be developed into a useful product for the Marine Corps. Feasibility will be established by material testing and analytical modeling, as appropriate. The small business will also provide a Phase II development plan with performance goals, key technical milestones, and a technical risk reduction strategy.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a scaled prototype evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II development plan and the Marine Corps requirements for heating rations. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Marine Corps requirements. The company will prepare a Phase III development plan to transition the technology to Marine Corps use.

PHASE III: If Phase II is successful, the small business will be expected to support the Marine Corps in transitioning the technology for Marine Corps use. The small business will develop a plan to determine the effectiveness of the new method for heating rations in an operationally relevant environment. The small business will support the Marine Corps for test and validation to certify and qualify the system for Marine Corps use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The potential for commercial application is limited to organizations that heat previously prepared rations. U.S. Marine Corps Bases and Stations are linked to state and local disaster response organizations and this technology would benefit them in supporting displaced personnel in a larger scale natural disaster relief role.

REFERENCES:
1. Marine Corps Reference Publication 4-11.8A, Marine Corps Field Feeding Program http://www.scribd.com/doc/13590063/MCRP-4118A-Marine-Corps-Field-Feeding-Program

2. Girard, C. E. Informational Brief to R&DA. Food Service & Subsistence Program [Brief]. Headquarters, U.S. Marine Corps, Washington, DC. http://militaryfood.org/powerpoint/S11_SessionX_USMCUpdates_CGirard.pdf

3. Tray Ration Heating System (TRHS) and Enhanced Tray Ration Heating System (E-TRHS); http://nsrdec.natick.army.mil/media/fact/food/TRHS.htm

4. R. D. L. Smith, M. S. Prevot, R. D. Fagan, Z. Zhang, P. A. Sedach, M. K. J. Siu, S. Trudel, C. P. Berlinguette. Photochemical Route for Accessing Amorphous Metal Oxide Materials for Water Oxidation Catalysis. Science, 5 April, 2013; DOI: 10.1126/science.1233638. http://www.sciencemag.org/content/340/6128/60.abstract

5. V. Ramanathan and K. Balakrishan, “Reduction of Air Pollution and Global Warming by Cooking with Renewable Sources”, A Controlled and Practical Experiment in Rural India White Paper, University of California, San Diego, March 5, 2007 http://www.Ramanathan.ucsd.edu/files/SurayWhitePaper.pdf

6. MIL-STD-810G, DEPARTMENT OF DEFENSE TEST METHOD STANDARD: ENVIRONMENTAL ENGINEERING CONSIDERATIONS AND LABORATORY TESTS; http://www.everyspec.com/MIL-STD/MIL-STD-0800-0899/MIL-STD-810G_12306/

KEYWORDS: renewable energy; alternative energy; heating rations; field feeding; heating system; fossil fuel

N141-002 TITLE: Reduced Hazard Antenna

TECHNOLOGY AREAS: Electronics

ACQUISITION PROGRAM: PMM MAGTF Command, Control and Communications (MC3)

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: Marine Corps Systems Command seeks innovative approaches to provide equivalent or better radiation pattern and omnidirectional gain as existing handheld or manpack radio antennas, while providing high voltage protection to reduce the risk of electrical shocks from low overhead wires for dismounted radio.

DESCRIPTION: Marine Corps Systems Command (MARCORSYSCOM) provides radio and antenna material solutions to the Marine Corps. In an operational environment, dismounted Marines can encounter low-hanging wires such as unregulated power distribution lines which present the potential for an electric shock hazard. These lines can be unpredictable in height and voltage. Dismounted Marines operate handheld or manpack radios with long whip (6 to 10 ft.) or blade antennas (3 to 4 ft) (Ref 1 and 2). The configurations allow for the possibility of an electrical shock hazard should direct contact be made with a power line. While whip antennas exhibit good size and weight characteristics for the performance they provide, they pose an electrocution risk in these types of environments due to their length and all metal construction. Intermediate length blade antennas are more manageable, but are also not designed for the electrical safety of the operator. The development of technology solutions for this type of environment creates several challenges. Electrical antennas (monopoles) need to be in upright position to perform well and display the appropriate omni-directional pattern. However, doing this increases visual cueing to the enemy. An operator in "prone" position (under fire) could also experience substantial degradation in antenna performance due to reflections off of the ground plane. While higher amplification could facilitate the use of a shorter antenna height, this could in turn negatively impact the available portable battery power carried by each warfighter as higher amplification would require more available power. Wearable antenna solutions (e.g. solution that wraps around the individual) are available; however, it could potentially pose Hazards of Electromagnetic Radiation to Personnel (HERP) concerns. These solutions also are limited by the use of one frequency band and typically have insufficient power for communications. Loop antennas provide a means to reduce the height significantly, but with a cross-looped design (such as an eggbeater), it becomes impractical for an individual to use. Presently, a temporary solution has been deployed but this solution is a simple antenna sheathing that is considered a temporary work around and not integrated with the antenna. There are no robust viable technology solutions for this ongoing need in the application cited.

MARCORSYSCOM is looking for innovative approaches to reduce the risk to the operator by providing high-voltage protection to 20KV RMS (35KV RMS objective) while providing equivalent of better radiation pattern and omnidirectional gain, regardless of the position of the operator, as well as a solution that is difficult for the enemy to visually detect. The desired solution would be the development of an antenna that would be able to provide protection to the operator from electrocution, while 1) not being readily observable by the enemy, 2) utilized the same or less power 3) maintain the existing or improve performance, all without any permanent modifications to the current Marine Corps systems. Other potential (but less desirable) technology solutions may include, but are not limited to, manpack system redesign to incorporate effective isolating and/or grounding features including; the addition of blocking capacitors at optimum locations in antennas; use of antennas with less quantity of conductive material and/or better insulation/coatings of antennas; methods of insulation of radio housing from antenna and/or shielding of personnel from radio housing; providing a potential alternate shielded path to ground.

For maximum range and reliability, the dismounted Marine requires the antenna to be light and flexible (Ref 3 and 4). A collapsible design is not required but would be helpful for storage and transportation. The antennas/solutions of most interest are for use with handheld and manpack tactical radios in the High Frequency (HF), lower Very High Frequency (VHF) bands (2 to 88 MHz), and 33-88mhz Single Channel Ground and Airborne Radio System (SINCGARS) . The following handheld and manpack tactical radios use those above mentioned bands: AN/PRC-150, AN/PRC-117F, AN/PRC-117G and AN/PRC-152 (Ref 3 and 4). The radios use N Type and threaded Neill–Concelman (TNC) antenna connectors. Concepts proposed must not negatively impact or damage the high voltage wires encountered and must pass a high voltage performance test. Proposers should be prepared to discuss the level of protection their technology solution(s) provides, the technology used to achieve a proposed level of protection, and any applicable antenna/solution performance information. Proposers should employ open architecture designs principles as much as is practicable. Preference will be given to solutions that do not cause permanent modifications to the current Marine Corps systems.

PHASE I: The company will develop concepts for an improved antenna meeting the requirements described above. The company will demonstrate the feasibility of the concepts in meeting Marine Corps needs and will establish the concepts can be developed into a useful product for the Marine Corps. Feasibility will be established by material testing and analytical modeling, as appropriate. The small business will provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a scaled prototype evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II development plan and the Marine Corps requirements for the antenna. System performance will be demonstrated through prototype evaluation and modeling over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design meeting Marine Corps requirements. The company will prepare a Phase III development plan to transition the technology to Marine Corps use.

PHASE III: If Phase II is successful, the company will be expected to support the Marine Corps in transitioning the technology for Marine Corps use. The company will develop an antenna for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Marine Corps for test and validation to certify and qualify the system for Marine Corps use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Municipalities, law enforcement, and first responders also use radios sharing the same radio bands. A reduced size antenna with superior range and performance would also be attractive to these applications. Such applications could be both applied to both handheld or vehicle mounted applications.

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KEYWORDS: antenna; tactical radio; AN/PRC-150; AN/PRC-117F; AN/PRC-117G; AN/PRC-152

N141-003 TITLE: Innovative Signal Processing Techniques for Mitigation of Wind Turbine Farm Interference in Airborne Radar Systems

TECHNOLOGY AREAS: Air Platform, Electronics, Battlespace

ACQUISITION PROGRAM: PMA 265

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: Develop innovative signal processing techniques for the mitigation of adverse effects on airborne radar systems resulting from the interference caused by the large radar cross section of a wind turbine combined with the Doppler frequency shift produced by its rotating blades which impacts the ability of a radar system to differentiate a wind turbine from an aircraft.

DESCRIPTION: There is growing public and private sector interest in generating electrical power using wind energy both within the United States and abroad. Systems that harness wind energy are largely comprised of installations of multiple wind turbines with rotating blades reaching to heights of 500 feet. The quantity, height and rotation of wind turbines present technical challenges to the effectiveness of airborne radar systems. Wind turbine farms located within line of sight of an airborne radar system have the potential to degrade the ability of that radar to perform its intended function. The magnitude of the impact will depend upon the quantity, size, structural properties and location of the wind turbines. The physical size of the wind turbine blades results in a substantial radar cross section (RCS) target, irrespective of whether the blades are viewed face on or edge on by the radar. The tip velocities for wind turbine blades fall within a speed range applicable to aircraft and in fact the broadly spread variable Doppler signature of the reflected signal from the wind turbine can often exceed that produced by an aircraft. Consequently, the turbine blades will appear on a radar system as a moving target of significant size if they are within the radar line of sight. Responses cannot be inhibited using normal moving target indicator (MTI) based techniques since they are generated by a moving structure of long airfoils resulting in an extremely complex spectrum of Doppler returns.

Wind turbines in close proximity to military training, testing, and development sites and ranges can adversely impact the ability to test airborne radar systems and train Navy aviators in the proper operation of airborne radar systems. Since airborne radar systems are required to work independently, some of the traditional mitigation techniques used in a ground based scenario such as gap filling, wind turbine structural regulation, radio frequency (RF) signature reduction, and environmental techniques cannot be employed. In order to ensure that airborne radar systems can continue to function properly in an environment where wind turbine farm activity will continue to proliferate there is a need to develop an innovative signal processing technique within the radar system to mitigate the problems caused by wind farms.

PHASE I: Identify and define the RF signature from wind turbines in various configurations. Perform modeling and simulation of the RF returns from wind turbine farms, and investigate signal processing techniques for mitigation of wind turbine farm effects.

PHASE II: Develop, test, and demonstrate signal processing algorithms for mitigation of wind turbine farm effects with simulated wind turbine farm data, and several sets of radar data.

PHASE III: Complete testing of the wind turbine farm mitigation signal processing algorithm and transition the technology to appropriate platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: There is a high potential for private sector use of algorithms developed under this topic. Primary
candidates for dual use of wind turbine farm mitigation technology are air traffic control and weather radar systems that must contend with the issue of interference resulting from the presence of wind turbines.

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http://www.defense.gov/pubs/pdfs/WindFarmReport.pdf

KEYWORDS: Radar, signal processing, wind turbines, clutter, RF, RCS target

N141-004 TITLE: Fully Integrated Low Size, Weight, and Power (SWaP) and Cost Magnetometers for Air and In-Water Anti-Submarine Warfare (ASW)

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PMA 290

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OBJECTIVE: Develop a low Size, Weight and Power (SWaP) and low cost total field scalar magnetometer with all control electronics fully integrated within the sensor package. The magnetometer is targeted for use in Unmanned Aerial Vehicles (UAVs), Unmanned Undersea Vehicles (UUVs), buoys, in-water arrays, Unmanned Ground Vehicles (UGV), as well as manned platforms.

DESCRIPTION: Recent work to reduce the SWaP and cost of magnetometers under SBIRs and commercial company Independent Research and Development (IR&D) funding has resulted in a vast improvement over the current production military and commercial systems, but still falls short of the optimum level for UAVs and in-water arrays and other remote sensor applications.

All current atomic scalar magnetometers consist of a sensor head (or physics package) that senses the magnetic field and a control circuit module located some distance away to drive the sensor and convert the analog sensor signals to useable digital data. The separation between the sensor head and control module is required so the electro-magnetic effects of the circuit card(s) will not interfere with the measurements of the sensor and create additional noise. While a significant amount of work has been focused on improved performance of the sensor head, the control module has been neglected and is still a design with separate analog, digital, and discrete components. The control module is also the major source of power consumption for the overall system. This configuration is not optimal for the Navy's current interests in unmanned systems, where size, power, and available volume are at a premium or other noise sources exist. For example, in a UAV or rotary wing platform there are many inherent noise sources such as motors, servos and avionics that can add noise to the magnetic measurements and thus reduce the effectiveness of the magnetometer. One possible solution for noise mitigation, borrowed from helicopter Magnetic Anomaly Detection (MAD) systems, is to tow the sensor in a non-magnetic tow body far enough away from the aircraft so that it no longer interferes with the sensor measurements. Current systems have multiple wires and transmit analog signals between the sensor and electronics which requires a fairly large cable and additionally the analog signals are susceptible to electromagnetic interference (EMI) noise. A fully integrated magnetometer would reduce the size and weight in such a tow cable by putting the control electronics in the towed body and also reduce the power required. Also, in remote sensor applications, this separation requires larger sensor packages to be developed which creates additional complications when deploying the systems.

Low SWaP and cost expendable magnetometers are desired for the High Altitude Anti-Submarine Warfare (HAASW) mission, geomagnetic noise reduction, in-water detection, and land-based target detection such as buried weapons caches and improvised explosive devices (IEDs). Proposed solutions should provide innovative design concepts for a total field scalar magnetometer able to operate in all Earth's field orientations and magnitudes. Scalar in this usage defines a magnetometer that produces a total field magnetic measurement that is insensitive to motion of the sensor in the Earth's magnetic field, except for the atomic physics phenomena related to heading error. A vector magnetometer that only measures the magnetic field along a sensitive axis, or combinations of multiple vector magnetometers are not acceptable for this effort and will not be considered for this application. Vector magnetometer(s) in a moving platform cannot attain the noise level of a true scalar magnetometer due to motion induced measurement errors.

SWaP and cost goals are driven by intended small platform applications, which in many cases are expendable systems. The cost objective should be less than $5,000 in small quantities with a goal of less than $2,000 in volume production (100 - 500 units/year). Proposed designs should be small. The target volume threshold is equal to or less than 400 cm3 with an objective of equal to or less than 100 cm3 for the complete magnetometer. Also low-power (< 5 Watt total threshold, <1 Watt objective), and low-weight (< 2 lb. total) are required. The primary use is in airborne applications. The noise floor threshold of the magnetometer should be equal to or less than 10 pT/rt Hz from 0.015 to 100 Hz with a objective of equal to or less than 2 pT/rt Hz from 0.015 to 20 Hz and a raw heading error of < 300 pT (threshold) and compensated heading error <10 pT (objective). The secondary use is in-water applications which require 0.001 to 20 Hz bandwidth at the same noise levels. The threshold is the airborne frequency band and the objective is the in-water band. External master control units or processors for noise compensation or MAD detection algorithms need not be included in the SWaP requirements.

The external interface to the magnetometer must be at the minimum power and digital data. The power input can be assumed to be low voltage regulated DC or battery power but not necessarily clean voltage on the power line input to the magnetometer, meaning power conditioning will be required at the magnetometer. In order to measure the sensor noise level in the field and compensate for common environmental noise, the accepted procedure is to take measurements from two relatively close magnetometers and coherently subtract the total field measurement. This technique requires, at the minimum, to know the latency of the measurement and the timing must be consistent in order to synchronize the data streams between the two sensors. The bi-directional digital data interface can be any commercial standard, but the data packet transmission must be deterministic. Non-standard digital interfaces or power other than DC will be considered if it brings additional capability to the design such as reduced wire count or shown to reduce noise effects. The power and digital data must traverse 25 Meters (Threshold, 100 Meters Objective) of cable to the master control unit or processor. Additional inputs or outputs such as a 1 Pulse per Second (1-PPS) or shared frequency standard input or synchronization outputs are desirable but left up to the designer. Additionally, in order to reduce the inherent magnetic noise effects of the platform, additional sensors are usually used to include 3-axis vector magnetometers, 3-axis accelerometers, GPS inputs and other analog sensors. It is highly desirable to include 24 bit analog to digital converters in the design to accommodate these external sensors. The computer intensive computations such as heading error correction, noise suppression, and MAD algorithms need not be done in the magnetometer and can be done in an external master control unit or processor.

PHASE I: Design and develop an innovative concept for a low SWaP and cost fully integrated compact magnetometer that can achieve the described size, weight, power, performance, and cost requirements. Demonstrate the feasibility of the design relevant to the design requirements

PHASE II: From the Phase I design, fabricate two fully integrated compact magnetometer laboratory prototypes. Demonstrate the specified noise floor in a laboratory and field environment within the above-specified parameters.

PHASE III: Transition the compact magnetometer for use in appropriate platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Miniature high-performance magnetometers will find application in UAVs for geologic applications including mineral and petroleum exploration. Also a fully integrated magnetometer has applications in the medical imaging field.

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KEYWORDS: Magnetic Anomaly Detection; Magnetometers; Airborne ASW; Unmanned Air Vehicles (UAVs); Vertical Takeoff UAVs (VTUAV); Improvised Explosive Devices (IEDs)

N141-005 TITLE: <u>Ruggedized Narrow-Linewidth 1550nm Laser</u>

TECHNOLOGY AREAS: Air Platform, Electronics

ACQUISITION PROGRAM: JSF-MS

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OBJECTIVE: Develop and package a high-power, low noise, narrow-linewidth laser for Radio Frequency (RF) photonic link applications on air platforms.

DESCRIPTION: New military communications, sensing and surveillance systems require ever-faster real-time acquisition and transmission of electronic signals to achieve continuous sensing of electromagnetic spectrum. For the development and utilization of such systems, RF photonic-based solutions that provide ultra-wide bandwidths, low power operation, immunity to interference and survival under high input signals are essential. As wider portions of the electromagnetic spectrum are accessed and utilized, wider operational bandwidths are needed. High-power, low-noise, narrow-linewidth fiber coupled lasers hybridly integrated with wideband electro-optic modulators will benefit a wide range of RF/photonic link air platform applications. There have been a number of low-linewidth external cavity semiconductor laser and fiber based devices introduced into the marketplace. In particular, semiconductor active region based devices demonstrated show promise for integrated technologies to meet the performance required. However, at this point, the size, weight and price of available lasers are still high, and performance is still worse than solid state lasers.

One practical method to cut cost and reduce the size, weight and power (SWaP) of the next generation RF/analog laser sources would be through inexpensive, wafer-scale semiconductor laser technology coupled with hybrid package integration, but other proposed solutions will be considered. Current narrow linewidth laser cost is dominated by the labor and piece part costs associated with designing, procuring and assembling lasers. A wafer-scale laser fabrication technology combined low-cost hybrid integration of external optics and control circuitry could significantly reduce packaged narrow-linewidth procurement and package assembly costs. The laser sources must have an ultra-narrow linewidth of <1 kHz, wavelengths in the range of 1545 to 1560 nm, and output powers greater than 100 mW. Their relative intensity noise (RIN) spectrum must be -175 dBc/Hz from 500 MHz to 40 GHz, -155 dBc/Hz from 100 – 500 MHz, and -110 dBc/Hz at frequencies below 100 MHz. The laser sources are required to be fiber-coupled with a polarization maintaining fiber which produces a polarization extinction ratio of greater than 20 dB. A ruggedized package is required that has a package height less than or equal to 5 mm, a package volume of approximately 2.5 cubic centimeters, or less than 100 cubic centimeters if the laser drive electronics are integrated within the package. The packaged laser device must perform over a temperature range of -40 to 100 degrees Celsius, and maintain hermeticity and optical alignment upon exposure air platform vibration, thermal shock, mechanical shock, and temperature cycling environments.

PHASE I: Design and analyze a new approach for narrow-linewidth 1550 nm RF/photonic laser sources. Demonstrate laser source via a supporting proof of principle bench top experiment showing path to meeting Phase II goals.

PHASE II: Optimize laser source design from Phase I. Test prototype laser source to meet laser source design specifications (linewidth, polarization maintaining fiber coupled output power, relative intensity noise) in an air platform representative operational environment. Test prototype laser in an RF photonic link over temperature with the objective performance levels reached. Characterize the packaged device over the full –40 to +100 degrees Celsius ambient temperature range and air platform vibration and mechanical shock spectrum. If necessary, perform root cause analysis and remediate packaged laser failures. Deliver packaged laser prototypes on evaluation boards.

PHASE III: Perform extensive laser reliability testing and packaged laser source reliability and durability testing. Transition the demonstrated laser source technology to radar systems, electronic warfare systems, and communication systems on Naval Aviation platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology would find application in commercial systems such as fiber optic networks and telecommunications.

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KEYWORDS: Laser, RF Photonics, Ultra-Wideband, Narrow-Linewidth, Semiconductor, Packaging

N141-006 TITLE: Distributed Synthetic Environment Correlation Assessment Architecture and Metrics

TECHNOLOGY AREAS: Air Platform, Human Systems

ACQUISITION PROGRAM: PMA 205

OBJECTIVE: Develop an innovative and extensible distributed synthetic environment correlation assessment architecture that can verify correlation between flight simulator visual and sensor databases.

DESCRIPTION: Naval/Marine Corps flight simulators are often run in isolation; however, there are growing requirements for distributed networked simulation such as those included in the Aviation Distributed Virtual Training Environment (ADVTE). Communication, processing models and synthetic environments are some of the simulation components that are affected by distributed system interoperability [1] [2] [3]. Interoperability of distributed systems is achieved only when the perception of the same events and models by different systems is similar, thus enabling the linked war fighters to work together and achieve a common goal. Working together is dependent on the consistency between the synthetic environments, yet today aircraft simulators rely on manual inspection and limited testing to determine if the simulated environments are a match between networked simulators.

Correlation assessments between terrain databases and interoperability of simulation models have been investigated over the years [1] [2] [3]. However, at this point in time no clear solution exists for the automated assessment of correlation errors between large synthetic environments and in particular for the runtime formats used by the Naval/Marine Corps flight simulators. The current approaches bypass or minimize correlation assessments between synthetic environments and include techniques such as the generation of runtime from the same source data in real time [4] and dedicated facilities which generate static representations of the different environments based on a fix set of simulators [3]. The former real time regeneration technique requires co-located simulators and large network bandwidth whereas the latter technique requires dedicated terrain database generation facilities that result in large production and integration times as well as large budget. A gap exists in the automated assessments of correlation errors between large synthetic environments as far as it relates to visual and sensor simulation for Naval/Marine Corps flight simulators. Considerations on architecture, data collection, runtime, read and write operations and parameter prioritization will enable a robust and flexible solution that can be expanded to include other tests and formats.

Correlation errors occur between different simulation systems when environmental representation features are rendered differently between simulation applications [4]. Although some metrics and tools have been proposed in the past [2] [4], an automated, and even semi-automated, process for determining the degree of correlation between heterogeneous human in the loop simulators in a distributed environment still does not exist. As a result, programs must spend many months determining the degree of similarity between simulators and its impact on a successful networked exercise. This analysis may have to be repeated if new simulation platforms are added, and if the training scenario or location changes.

Ideally, the distributed synthetic environment correlation assessment architecture for aviation platforms should be flexible and expandable so that it can perform comparisons between different formats, versions of the same databases, and the original geospatial source data. The correlation assessment should put particular emphasis on aircraft mission areas of interest such as airports, landing zones, confined area landings, low-level terrain flight areas, and ranges. The correlational assessment should be automated and consider environment components of designated areas of interest that affect mission performance, such as avenues of approach, key landmarks, feature densities and texture densities. Furthermore, the architecture should allow for the addition of new runtime and source formats, as well as new tests and analysis plug-in modules by third party developers. The results of the correlation analysis should be displayed in a graphical way that allows for easy understanding of the correlation differences and the impacts on distributed training.

The correlation assessment component of the architecture should include parameters that consider visual and sensor simulation. Different weights should be used to account for the importance of virtual simulation domain, visual cues in different platforms, and training missions. The prototype should determine the degree of similarity between simulators for the simulation of sensors to include visual, radar, infrared, night vision devices, and others by geospatial location regions. The prototype should accommodate the different models which are used in simulations which include: rendering models, animations, sensor models, mobility models, damage assessment models, and explosions.

The prototype should consider metrics such as terrain elevation, culture existence, feature size and attributes, surface materials and composition, and line of sight. Evaluation between two or more representations should be based on a criterion that considers the most important parameters. Criteria for correlational score should consider constraints such as domain, platform, and training mission and weigh them accordingly. Furthermore, the proposed prototype should consider how standards, such as the Common Image Generator Interface (CIGI) and High Level Architecture (HLA), could be leveraged to collect data. The prototype concept should describe how runtime read/write and test Application Programming Interface (API) will be developed to allow access to proprietary runtime format data and enable flexible testing modules that can be developed by third parties.

The prototype should consider source dataset formats such as NAVAIR Portable Source Initiative (NPSI), Marine Corps ADVTE virtual simulations aviation platforms, and constructive simulations formats, such as Joint Semi-Automated Forces (JSAF)/Tactical Environment (TEn) Compact Terrain Database (CTDB) v8.

PHASE I: Investigate, further define, propose, design and demonstrate the feasibility of an extensible distributed synthetic environment correlation assessment architecture for aviation platforms that incorporates the various criteria and source dataset formats described above, including: a set of correlation metrics and weighing schema, a strategy for acquiring synthetic environment data to support the correlation metrics, and an API that supports the proposed collection of environment data. Propose a strategy or plan for the determination of acceptable values for correlation and how this correlation level maps or translate to an interoperability assessment.

PHASE II: Develop, demonstrate and validate a prototype system using selected flight simulation facilities and trainers. Include test techniques for the validation of the metrics.

PHASE III: Transition and apply the new technologies developed into standalone products/services, as enhancements to existing training systems, and appropriate military and commercial flight training simulators.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The innovation would enhance the energy efficiency and reliability of all simulation based training systems for civilian, law enforcement, and emergency response communities. Systems of systems, or distributed application, which combine a variety of different environment representations can benefit from interoperability and synthetic environment correlation.

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KEYWORDS: Interoperability; synthetic environment; terrain database; virtual, constructive; distributed

N141-007 TITLE: Automated Warhead Characterization

TECHNOLOGY AREAS: Air Platform, Ground/Sea Vehicles, Weapons

ACQUISITION PROGRAM: PMA 201

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OBJECTIVE: Develop an innovative and efficient low-cost means of measuring full-hemisphere, open-air, warhead fragment mass, geometry, and velocity information during munitions explosions.

DESCRIPTION: The present method of warhead characterization is costly, labor intensive, and produces only a piece of the required data. A warhead is placed in the center of an arena test bed consisting of blast-pressure gages and fragment catch bundles. Fragment catch bundles (composed of fiber materials, e.g. Celotex) are placed just above ground level and arc around the warhead at a large radius. While this large radius ensures bundle survival during blast-pressure impingement, bundles occupy only a small slice of the hemisphere. As such, only a fraction of the fragments are captured for inclusion in the subsequent warhead characterization analysis. Weeks of tedious and error-prone labor are necessary to locate, recover, weigh, and describe the geometry of each fragment entering the bundles. Many small fragments are not recovered and few if any individual fragments are mapped to their specific velocities. In order to complete the dataset for user consumption, analysts subject raw warhead test data to a series of assumptions including averaging and rotations to produce an approximation of the true warhead’s fragment mass and velocity field. Individual fragment masses or geometries remain uncoupled from their velocities and many of the smaller fragments are not included in the data collection.

All warhead characterizations and data reduction methods are conservatively-skewed to help ensure target kills. As such, true munitions lethalities are higher than their arena test scores. The differential presents a problem when accounting for collateral effects. Munitions must be selected to destroy a target and do no additional harm. Corrective measures, such as re-characterizing munitions are prohibitively time consuming, expensive, and potentially technically problematic.

An innovative combined sensor and software technology is needed whereby sensors can assess object movement within large hemispherical volumes (15 to 300 feet in diameter) at sufficient resolution to detect solid-masses (0.5 gram to 100 kilogram) traveling at high-velocities (5 to 9000 feet per second) with particles (numbering up to 30,000) originating near the center of the hemispherical test space and moving within that volume. The interrogation system must be suitable for open-air outdoor testing and sufficiently robust to handle blast overpressures ranging from 1,000 pound-force per square inch (psi) near the center of the hemispherical test space to 1 psi near the fringes. The proposed interrogation system must be insensitive to blast-flash obscuration, capable of mapping individual fragment masses to their respective velocities, and capable of estimating each fragment's geometry. If the system lies within the lethal radius of the warhead, the system must be able to reliably operate in a high-shock environment. Proposed research and development (R&D) solutions are allowed complete flexibility with respect to sensor interrogation methods and data processing/archival methods. The focus is on developing a suitable and efficient interrogation system. The measurement method should be capable of characterizing warhead fragmentation over a full-hemisphere.

PHASE I: Develop and demonstrate feasibility of an interrogation method to complete warhead characterization.

PHASE II: Further develop the concept from Phase I and perform bench level testing to prove the concept worthy of full-scale pursuit.

PHASE III: Finalize testing and transition the technology to the appropriate platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial applications involve tracking and identifying micro- and macro-devices and objects in real time. Various entities could benefit from the technologies developed through this SBIR including the Motion Picture Industry, Chemical Manufacturing, the Oil and Gas Industry or any other organization that utilizes high pressure vessels and is concerned about accurate characterization of flying debris or fragments from industrial accidents.

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KEYWORDS: munitions, warhead characterization, fragments, automated system, velocity mapping, tracking of flying debris

N141-008 TITLE: Power scaling of blue lasers with high peak-power and repetition rate for detection of underwater objects

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PMA 264

OBJECTIVE: Develop a scalable high peak-power laser solution consisting of either a single laser or multiple beam-combined blue lasers for use as a transmitter source for detection of underwater objects from an aircraft.

DESCRIPTION: There is a need for a high peak-power blue laser system solution to be operated in pulsed mode with high repetition rate for detection of underwater objects from an aircraft at an altitude of not more than 1000 ft. It should be rugged, compact, and light enough to be used in Naval aircraft, both fixed and rotary wing platforms. The current State Of the Art (SOA) which includes Optical Para-Metric Oscillators (OPOs), wave length doubling of titanium sapphire (TiSa) based lasers, doubling and tripling of other laser hosts, and blue laser diodes, do not currently support the performance, size and weight objectives needed. Many commercially available lasers and near term developmental lasers meet a few of the required characteristics but none can meet every performance criteria. It is paramount that the blue laser solution meets or exceeds the design objectives in order to be effective for detection of undersea objects. Blue laser is required due to the ability of the blue wavelength to penetrate the ocean to significant depths compared to all other wavelengths. It is therefore the goal of this program to seek the development of a power scalable blue laser system solution that will meet the size, weight, performance and reliability requirements below while considering component costs for future production of the system. The proposer should consider this development as the innovative advancement and combination of blue laser and supporting technologies towards the goals stated below rather than a new effort to discover as yet unknown or untested blue laser concepts.

The performance objectives of the laser solution are:
1. High repetition rate (Threshold: 1 kilo hertz)
2. High peak power (Threshold: 10W average, Objective: 15W average; Threshold: 10 milli-joule, Objective:15milli-joules per pulse with pulse width no more than 20 nanoseconds)
3. Blue wavelength (Ideal wavelength is to match a Fraunhofer line in the blue (460 - 490 nano meters) but a laser with suitable power and repetition rate in that range would be acceptable
4. Line width of less than or equal to 0.1 nano-meter
5. Wall plug efficiency of greater than 5%
6. Laser beam quality M-squared less than 3.
7. Light weight. (Total weight including the laser head, cooling system, power supply, and control system) Threshold: less than 100 pounds, Objective: less than 60 pounds.
8. Small volume. (Total volume for the cooling system, power supply, control system and laser head) Threshold: less than 3 cubic feet, Objective: less than 2 cubic feet.
9. Ability to be ruggedized and packaged to withstand the shock, vibration, pressure, temperature, humidity, electrical power conditions, etc. encountered in a system built for airborne use.
10. Reliability: Mean time between equipment failure—300 operating hours.
11. Full Rate Production Cost: Threshold < $50,000; Objective <$15,000 (based on 1000 units)

Because of Size, Weight and Power (SWaP), ruggedization requirements and restricted use of hazardous material in airborne applications, argon ion lasers, chemical lasers, and dye lasers are unacceptable. Furthermore, systems using cryogenic cooling will also be discounted.

PHASE I: Determine and design a viable and robust laser system solution consisting of either a single laser or multiple beam-combined blue lasers which meets or exceeds the requirements specified. Identify technological and reliability challenges of the design approach, and propose viable risk mitigation strategies.

PHASE II: Design, fabricate, and deliver a laser system prototype based on the design from Phase I. Test and fully characterize the system prototype.

PHASE III: Finalize the design and fabricate a ruggedized laser system solution and assist to obtain certification for flight on a NAVAIR R&D aircraft.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: High power, pulsed lasers have applications in manufacturing and lithography. Oceanographic bathymetry systems for survey and exploration work would benefit greatly from this laser system solution.

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2. Weber, M. (2001). Handbook of Lasers. CRC

KEYWORDS: Airborne; High Power; Asw; blue laser; high repetition rate; Oceanography

N141-009 TITLE: Autonomous Environmental Sensor Performance Prediction Tool for Multi-Static Active and Passive Anti-Submarine Warfare (ASW) Systems

TECHNOLOGY AREAS: Sensors, Battlespace

ACQUISITION PROGRAM: PMA 264

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: Develop an autonomous Anti-Submarine Warfare (ASW) sensor performance prediction tool that utilizes measured and predicted ocean environmental data retrieved via a network interface.

DESCRIPTION: Air ASW sensor systems like the Multi-static Active Coherent "MAC" (SSQ-125) sonobuoy source and ADAR (SSQ-101A/B) receiver to provide coherent pulses and waveform flexibility like doppler-speed sensitive and frequency modulated (FM) clutter suppression. The number of operational settings for this system can be quite large requiring thousands of permutations to optimize a single sonobuoy search area. It can be difficult to determine exactly which settings provide the best optimal detection capability for any given operational area. To solve this problem, a Air ASW multi-static active and passive modeling and simulation tool needs to be developed to help operators determine the best operating performance for various ASW sensor systems.

The tool should model drifting ocean currents and calculate and characterize ocean environments for optimal use of naval ASW sensors and provide the best successful operational recommendation for naval ASW sensor use. The tool should reiterate automatically with a new set of parameters while trying to optimize the probability of detection, signal excess coverage, and detection range. The tool should be able to run multiple calculations and predictions for many locations, times of year, pattern variations, including sonobuoy spacing, source depths, receiver depths, and sonobuoy pulse definitions such as pulse length and pulse type. The tool should use the data autonomously to determine the optimized acoustic parameters for sonobuoy patterns in active and passive fields. The tool should be able to ingest in-situ measured data from the Air community, such as forecasted sound speed from bathymetry (BT) measurements, wind speed, drift, and ambient noise. These measured and predicted ocean environmental parameters should be retrieved via an interface that would be used to populate the performance prediction tool. Autonomous performance prediction should be provided by interfacing with the Naval Oceanographic Office environmental database to obtain sound speed profile overlay, ambient noise, shipping level, sonobuoy drift overlays, and other oceanographic environmental data. The performance prediction results including sonobuoy depth and spacing pattern recommendations, ping plan strategies, and pulse settings should be stored in a database management system for retrieval via web access. The most optimized deployable patterns in an area should be instantaneously provided via the database management system. The tool should learn from itself by analyzing newly predicted or measured data against previously modeled scenarios. If the input environmental data matches a previously modeled event for a given location and time of year, then the system should obtain the result from the data management system and not recalculate performance predictions that are known. Due to constant changes in weather patterns, temperatures, and ocean currents, historical data should be replaced with data that is reflective of the current or the Naval Oceanographic Office predicted environment. As new environmentally measured or forecasted data becomes available, the tool should automatically optimize sensor performance measurements for various operational areas. The tool should quickly maximize the probability of detection, signal excess, detection range, signal excess surface area map, and number of detection opportunities. The tool should produce recommendations for optimized sonobuoy pattern placement, sensor depth settings, detection range, signal excess and ping plans on an ongoing 24 hours 7 days a week basis. The tool should support multi-static active systems, narrowband passive prediction and detection range modeling, and run in batch mode and utilize parallel processing techniques. The tool should also be able to handle ocean currents and drifting of sonobuoy systems.

Users should be able to select the location (latitude/longitude), month, source depth, receiver depth, target/threat type, threat depth, ping rate, aircraft parameters, sonobuoy pattern geometery, and pulse definitions (Triple Hyperbolic

Frequency Modulation, Hyperbolic Frequency Modulation, Continuous Wave) to use for mission planning and derive a performance prediction estimate called probability of detection (PD). Users should also be able to add environmental overlays, such as in-situ sound speed measurements, the Naval Oceanographic Office predicted sound speed files, known as wavelets, should be integrated. By automating the acoustic modeling and simulation for Air ASW sensor performance and using current, relevant, and future-casted environmental data, the resulting performance predictions should be more reflective of the true environment and greatly increase the probability of success when ASW assets are deployed to detect, track, and localize adversarial threats.

PHASE I: Determine feasibility and design a concept for a multi-static active and passive modeling and simulation tool for ASW systems.

PHASE II: Develop, demonstrate and validate the concept that was designed in Phase I.

PHASE III: Complete testing and transition tool to the applicable platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The system could be used commercially to quickly model the ocean environment using sound speed and ambient noise measurements to enhance marine mammal mitigation and detection and tracking of fish.

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KEYWORDS: Simulation; Modeling; Asw; Sonobuoy; Acoustic Propagation; Acoustic Detection

N141-010 TITLE: Development of Analysis Techniques for Predicting Magnetic Anomaly Detection (MAD) Equipped UAV Performance in Naval Anti-Submarine Warfare Environment

TECHNOLOGY AREAS: Air Platform, Sensors, Battlespace

ACQUISITION PROGRAM: PMA 264

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: Develop a software simulation tool, or Tactical Decision Aid (TDA), for predicting the Probability of Detection (Pd) of a Magnetic Anomaly Detection (MAD) equipped Unmanned Aerial Vehicle (UAV) against current submarine threats factoring in the complexities of the MAD system performance, magnetic environmental noise, UAV performance, target parameters and Area of Uncertainty (AOU)

DESCRIPTION: MAD equipped UAVs are being developed to accomplish the detection, localization and track phases of the Anti-Submarine Warfare (ASW) mission. The MAD ASW mission currently relies on paper MAD Operational Effectiveness (MOE) charts which are prepared for selected areas throughout the world and display predicted environmental noise levels only. There is no other TDA available for the MAD mission which factors in the sensor performance, including environmental effects, or aircraft and target parameters to determine a Pd. Without such a tool, the ASW mission commander has no current analysis of the MAD UAV effectiveness and will have no basis to determine the success of finding the target, thus possibly wasting time and assets in the most critical part of the ASW mission.

An integrated tool is needed for predicting the effectiveness of the MAD UAV in detecting the target which factors in all the relevant parameters of the MAD system. The TDA should factor in UAV performance, background magnetic noise, target parameters and the initial AOU size.

The tool must include inputs for:
MAD system: Inputs for known or predicted MAD noise levels.
MAD environmental noise: Known or predicted geomagnetic background noise. Known (MOE Charts) or predicted geologic noise (World Magnetic Model (WMM)/International Geomagnetic Reference Field (IGRF)).
Target signatures: Known or modeled typical magnetic moments (Anderson Functions) of current submarine threats. Include both DC Dipole and Extremely Low Frequency (ELF) signatures.
Target parameters: Known or predicted speed, depth, maneuverability.
UAV parameters: Speed, endurance, maneuverability, altitude, etc.
AOU parameters: Initial AOU size, time late of last detection, target speed course and depth parameters.
Launch Platform parameters: Speed, Altitude, and Time late to AOU.

Once all these factors are accounted for, the tool should provide the ASW mission commander with Pd result so he can make the GO/NO-GO decision to launch the MAD UAV and also provide the optimal search tracks for the UAV to follow.

PHASE I: Design and develop a detailed software integration and implementation plan showing how the above parameters will be combined into a single simulation tool for predicting the probability of detection of a MAD UAV given certain initial parameters.

PHASE II: Develop and implement the tool and demonstrate its applicability to the ASW mission using modeled parameters.

PHASE III: Further develop and integrate the tool for appropriate aircraft and mission systems

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: With slight modifications to remove target signatures, the tool can be used as a mission planning tool for geologic surveys. NOAA has interest in a MAD UAV for wreck detection and mapping.

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KEYWORDS: MAD, Magnetic Anomaly Detection, UAV, MOE Charts, Environmental modeling, ASW

N141-011 TITLE: Advancements in Solid Ramjet Fuel Development

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PMA 259

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OBJECTIVE: Develop and demonstrate innovative Solid Fuel Ramjet (SFRJ) technologies based on novel high performance fuels.

DESCRIPTION: Air-breathing propulsion, in the form of Liquid Fuel Ramjet (LFRJ) or Solid Fuel Ramjet (SFRJ) systems, is a highly competitive solution to tactical systems requiring long range and/or high speeds. While significant development has occurred, including development of several operational systems using traditional LFRJ technology and ducted rocket systems, few resources have been devoted to SFRJ's despite the significant potential demonstrated in the programs that have been completed [5]. SFRJ systems have a clear advantage over rocket-based systems due to their inherent high specific impulse values which greatly improve the range and kinematic performance of the system.

The use of high-speed air-breathing propulsion for tactical applications has a long history in the U.S. dating back to the Navaho, Bomarc, and Talos systems of the late 1950's and early '60's [1]. All variants of the Ramjet, e.g. SFRJ, Ducted Rocket, LFRJ, etc., allow significantly higher effective specific impulse (Isp > 1200 seconds in the case of LFRJ and SFRJ cycles) compared with rocket propelled systems and can also possess design simplicity and safety advantages. For this reason, a large number of strategic and target development programs utilizing air-breathing propulsion have been conducted over the last 40 years including the Advanced Low Volume Ramjet (ALVRJ), Advanced Strategic Air Launched Missile (ASALM), Advanced Common Intercept Missile Demonstrator (ACIMD), Variable Flow Ducted Rocket (VFDR) [1], and most recently, the Navy's GQM-163A "Coyote" Supersonic Sea-Skimming Target (SSST) ducted rocket target drone [2]. The Navy's Ram Air Rocket Engine (RARE) program conducted boron and magnesium loaded SFRJ flight tests at Mach 2.3 in 1955 with good success [3]. A SFRJ development program in the 1970's, culminated in a free-jet test at NASA-Lewis Research Center in 1980 [4]. Other Air Force programs in the 1980's demonstrated high combustion efficiencies and the efficacy of metal fuel additives such as magnesium and boron. Additionally, modern flyout analyses comparing a min-smoke solid propellant rocket system to a similarly sized HC/boron-fuelled SFRJ predicted a 5-fold increase in range using the SFRJ technology.

The SFRJ cycle is the same as the LFRJ cycle except that the fuel exists in solid form within the chamber and the stoichiometry of combustion is controlled by the regression rate of the fuel. The fuel is not a propellant in the solid rocket motor sense, but a pure fuel without the addition of oxidizer particles. A wide range of fuels can be used from polymers such as polymethyl methacrylate (PMMA) to long-chain alkanes or cross-linked rubbers such as Hydroxyl-terminated polybutadiene (HTPB). Because the fuel exists in the solid form, inclusion of solid additives (e.g., metal powders, strengthening additives, etc.) is relatively easy and can increase potential performance gains without sacrificing safety and handling characteristics.

SFRJ's offer some significant advantages including:

• Simple in design compared to a liquid-fueled rocket or LFRJ. There is no need for pumps, external tankage, injectors, or plumbing for fuel delivery.

• Higher fuel density in the solid phase for many pure hydrocarbons and even higher if performance additives (such as metals) are used.
• Easy inclusion of solid performance additives (such as boron, magnesium, or beryllium) which raise the heat of combustion, and/or the density and therefore the density impulse capability compared with liquid ramjets.
• Solid fuel can act as an ablative insulator, allowing higher sustained combustion chamber temperature levels (and hence specific thrust) with less complexity.
• Fuel is stored within the combustion chamber allowing for more efficient packaging and higher mass fractions than liquid ramjets.
• Can be stored as "wooden rounds" in the same fashion as traditional solid rocket motors with minimal logistical concerns associated with liquid fuels.
• Have potential for favorable Insensitive Munition (IM) properties due to the minimization of oxidizers within the solid fuel grain.

To further advance the state-of-the art in SFRJ technology, advanced fuel formulations with high regression rate, high specific impulse and density impulse capability need to be developed. The fuel formulations need to generate stable and efficient combustion with air. Methods of increasing fuel-regression rates should not be at the expense of fuel inertness. Fuel formulations should contain a volumetric heating value of >825 BTU/in3 and demonstrate a combustion efficiency >90%. Additionally, system level concepts must consider precepts outlined in referenced Military Standards [6] & [7].

PHASE I: Develop innovative fuel formulations and verify performance gains over existing solid rocket motor systems through system level calculations and testing. Demonstrate operational advantages of fuel formulations and develop a plan to transition fuels into flight-qualified system.

PHASE II: Design and develop a prototype system capable of generating positive thrust force under realistic operating conditions. Perform subscale tests to assess theoretical predictions, mechanical properties, and burn rates associated with selected propellant formulations. Conduct direct connect or free-jet tests using a prototype system in order to demonstrate the performance gains of the newly developed fuel formulations over a varying range of operating conditions.

PHASE III: Integrate the selected fuel formulations and motor geometry into a munitions system capable of being integrated into the Navy warfighter capability.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Advanced solid-fuel formulations developed for ducted rocket-ramjet applications can have a dual-use application in hybrid rocket motors. Commercial space flight is an emerging area that could benefit from such formulations.

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5. Fink, L.E. (1981). Chronological History of SFRJ Flight Tests. Engineering Technology Boeing Aerospace Company. Seattle, WA.

6. MIL-STD-810G, ENVIRONMENTAL ENGINEERING CONSIDERATIONS AND LABORATORY TESTS, 31 OCT 2008.

7. MIL-STD-2105D, HAZARD ASSESSMENT TESTS FOR NON-NUCLEAR MUNITIONS, 19 APR 2011.

KEYWORDS: Solid Fuel Ramjet; Sfrj; Fuels; Airbreathing Propulsion; Ramjet; Ducted Rocket

N141-012 TITLE: Method for the Detection of Voids Underneath Aluminum Matting - 2 (AM-2)

TECHNOLOGY AREAS: Materials/Processes, Sensors, Electronics

ACQUISITION PROGRAM: PMA 251

OBJECTIVE: Develop a non-invasive void detection method technology with the capability to detect voids underneath aluminum airfield matting (AM-2).

DESCRIPTION: The Expeditionary Airfield (EAF) is a shorebased, mobile air base, which permits deployment of landing force aircraft within effective range of ground forces. EAFs rely heavily on fully supported Aluminum Matting - 2 (AM-2) for safe and efficient operations. One significant concern is the formation and presence of voids underneath the AM-2 which introduce challenges and the potential for damaging effects to aircraft and crew. Filled with water or air, voids occur naturally when water flows through soil, pushing the soil down and out from under the airfield surface. This factor, combined with the impact of an aircraft landing on the AM-2 surface, can compromise the mat's ability to support normal airfield operations. If the foundation of the AM-2 is not fully supported, the mat can become damaged, potentially resulting in damage to the aircraft, equipment, and personnel. The current void detection technology used in the fleet uses a vehicle that is driven across the mat. Any mat movement as a result of the vehicle's weight is then measured for deflection and if the deflection is significant enough, the mat is removed and the subgrade is reworked. This technique can sometimes spot a void just under the mat; however, if the void is few feet below the mat's surface this method can be inadequate. The detection of voids underneath AM-2 is critical to the life of the mat, the aircraft and the safety of the warfighter.

In order for a void detection method of this nature to effectively detect voids underneath AM-2, the properties and specifications of AM-2 should be considered. These properties present a unique challenge in detecting sub-grade voids. Radar, ultrasound, and thermal imaging have been investigated unsuccessfully in the past. Ground penetrating radar was found to be inefficient due to its inability to penetrate AM-2's metallic structure. The AM-2 cellular structure results in a lot of deflection and "noise", making it difficult for the inspector to read and interpret the data.

A non-invasive, user-friendly void detection sensor is needed. The solution should be non-invasive to minimize airfield downtime and non-destructive as it should not disturb the sub grade. The void detection sensor must identify and locate voids six inches or greater in diameter and down to three feet below final grade. EAFs can have airfield runway dimensions of 96 feet wide by 4,000 feet long and greater, justifying the need for a method that can cover large swaths of airfield quickly and easily; if not remotely, without increasing operator workload. AM-2 is used in a wide variety of operational conditions, ranging from arctic zones, temperate zones, tropical and subtropical zones, semi-arid and arid zones warranting the need for a method that can be easily and effectively transported and operated in a plethora of climatic conditions. The technology would not only aid in ensuring the safety of the Warfighter, equipment, and aircraft, but it would also increase ease-of-use and provide cost reduction opportunities, as well as commercial applications. The ability to detect voids underneath metallic matting would also enable preventive maintenance, allowing problems to be addressed before they escalate and result in costly, damaging effects.

Made of 6061-T6 aluminum, AM-2 is cellular in structure with integral aluminum ribs. AM-2 features 13 cells, a top skin thickness of approximately 0.14 inches and a bottom skin thickness of approximately 0.125 inches, and AM-2 comes in two different sizes with overall dimensions measuring two feet by six feet by 1.5 inches and two feet by 12 feet by 1.5 inches. In addition, AM-2 is painted green and the top skin is covered with an epoxy-based nonskid material; a void detection method should take into account these properties as they could potentially affect the method's capabilities.

The AM-2 expanse can serve a variety of functions (e.g. airfield runways, taxiways, parking areas, and Vertical Takeoff and Landing (VTOL) pads), and are painted and marked differently, depending on intended function. Yellow paint, white paint and glass beads are just a few marking materials that a void detection method must be able to penetrate. In addition, the ideal method should also be able to penetrate rubber/tire buildup, Petroleum, Oils, and

Lubricants (POLs), deicing chemicals, and hydraulic fluid, as these materials can be present on AM-2. All of these different materials must be understood by the sensor and its data must be displayed in a clear and concise manner.

PHASE I: Develop a conceptual design for a void detection method that meets the requirements above. Prove the feasibility of such a device through analysis and/or lab demonstrations.

PHASE II: Finalize, build and demonstrate a prototype with the capability to detect voids underneath AM-2. Provide estimates for production cost.

PHASE III: Build production units for transition for EAF use. Provide logistics, including operational and maintenance manuals.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: In addition to benefits provided to the DoD, the application of a method that could detect voids underneath aluminum airfield mat would be particularly beneficial to the construction industry and municipal public works. A device of this nature would provide the ability to detect soil erosion underneath buildings, roads, or runways. By determining the condition of the infrastructure early on, maintenance work and preventive measures can be taken to ensure the integrity of the infrastructure; thereby reducing replacement costs and failure of the infrastructure.

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KEYWORDS: Expeditionary Airfield (Eaf); Mat; Void Detection; Void; method; AM-2

N141-013 TITLE: Ruggedized Wideband High Power Balanced Photodiode Receiver

TECHNOLOGY AREAS: Air Platform, Sensors, Electronics

ACQUISITION PROGRAM: JSF-MS

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OBJECTIVE: Develop and package high-power balanced photodiodes for wideband Radio Frequency (RF) photonics receiver applications.

DESCRIPTION: The need for compact ruggedized microwave photonic links arises in avionic platforms as photonics continues to provide unique solutions in a wide variety of military applications. The requirements for high dynamic range links have previously been demonstrated but a lack of packaged components able to withstand harsh environments persists. Photodiodes presently limit many multi-octave applications presenting a need for ruggedized high-power wideband photodiode receivers. Balanced photodiodes provide a number of advantages in high power link applications. Shot-noise limited performance at high optical power with advantages in link gain, spurious-free dynamic range and noise figure can be achieved through balanced detection. To achieve high-fidelity multi-octave performance, one proven technique uses balanced photodiodes to suppress photodiode even-order distortions.

The multi-octave dynamic range of a photonic link is typically quantified in terms of second-order and third-order output intercept points, OIP2 and OIP3, respectively. Balanced photodiodes offer the ability to suppress second-order distortion so that the link is third-order limited by modulator nonlinearities. High-power balanced photodiodes and packaging of these devices, providing balanced photodetector receivers for wideband RF photonic air platform applications is desired. Balanced photodiodes that operate at 1.3 micron and 1.55 micron require, per balanced pair, a 20 GHz bandwidth at 100 mA (50 mA per photodiode) and 40 GHz bandwidth at 50 mA (25 mA photodiode). The targeted OIP3 is 40 dBm at 20 GHz for 50 mA per photodiode with a minimum OIP3 of 30 dBm. The minimum required rejection for both common-mode noise and even-order distortion is 20 dB. An OIP2 of approximately 70 dBm is required to maintain a conventional Mach-Zehnder modulator link to be third-order limited for 1 MHz instantaneous bandwidth, which requires 50 dBm OIP2 per photodiode. Linearity specifications should be met across 20GHz bandwidth. The output power at 1-dB compression for the total packaged balanced photodetector receiver is required to be 14 dBm, such that the receiver does not degrade an intrinsic Mach-Zehnder compression at 100 mA. Low back reflection, single-mode fiber coupled surface-illuminated or edge-illuminated photodiode designs are encouraged. The efficiency should be high enough to keep power consumption low, with a target of 0.7 A/W effective DC responsivity referenced to the fiber inputs. The balanced photodiodes are required to be packaged providing balanced photodetector receivers with fiber pigtails and standard RF connector outputs such as 2.92 mm coaxial connectors. The packaged devices should maintain the RF bandwidth and linearity specifications discussed above. A balanced photodetector receiver package is required that has a package height less than or equal to 5 mm, a package volume of approximately 2.5 cubic centimeters. The packaged balanced photodetector receiver must operate over a temperature range of -40 to 100 degrees Celsius, and maintain hermeticity and optical alignment upon exposure to air platform vibration, thermal shock, mechanical shock, and temperature cycling environments.

PHASE I: Design and analyze a new approach for balanced photodiodes. Demonstrate feasibility of balanced photodiode response with a supporting proof of principle bench top experiment showing path to meeting Phase II goals. Design and analyze a balanced photodetector receiver package prototype.

PHASE II: Optimize the balanced photodiode and packaged photodetector receiver designs from Phase I. Build and test the balanced photodetector receiver to meet design specifications. The prototype should be able to be tested in an RF photonic link with the minimum performance levels reached. Characterize the packaged balanced photodetector receiver over the full -40 to 100 degree Celsius ambient temperature range and air platform thermal shock, vibration and mechanical shock spectrum. If necessary perform root cause analysis and remediate balanced photodiode and balanced photodetector receiver package failures. Deliver balanced photodetector receiver package prototypes on evaluation boards.

PHASE III: Perform extensive balanced photodiode and balanced photodetector receiver package reliability and durability testing. Transition the balanced photodetector receiver technology to radar systems, electronic warfare systems, and communication systems on appropriate platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology would find application in commercial systems such as fiber optic networks and telecommunications.

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KEYWORDS: Balanced Photodiode, Receiver, RF Photonics, Ultra-Wideband, High-Power, Packaging

N141-014 TITLE: Low Magnetic Signature Expendable Unmanned Aerial Vehicle (UAV) for Anti-Submarine Warfare (ASW)

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: PMA 264

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: Develop a low magnetic signature, expendable Tier 1 Unmanned Aerial Vehicle (UAV) that can be launched from a P-8A or similar military aircraft via the sonobuoy launch system from high altitude, with the capability to carry a sensitive scalar magnetometer for Anti-Submarine Warfare (ASW) Magnetic Anomaly Detection (MAD) with the requirement that the inherent UAV magnetic noise shall not limit the effectiveness of the MAD sensor.

DESCRIPTION: With the introduction of the P-8A Poseidon into the fleet, the ASW Concepts of Operations (CONOPS) is shifting from the low altitude search and track as was done by the P-3C to a High Altitude ASW (HAAWS) mission where the P-8A remains at altitude for the ASW mission from initial detection through the attack phase. As such, there is a need to localize and maintain track of the submerged submarine while the mission aircraft prepares to drop a weapon and provide updated targeting information to the weapon as it descends to the splash point. Previously, the precise localization was done by the P-3C use of an inboard MAD system which required the aircraft to fly at 300-500 foot altitude.

ONR and NAVAIR are developing the concept of a MAD equipped UAV that can be launched from aircraft at high altitude which would then autonomously localize and track the submerged submarine and continue tracking the target after weapon release for possible re-attack. There were previous developments of sono-launched UAVs, but neither was initially designed to be magnetically quiet. Preliminary magnetic profiling of these UAVs indicates that they will require major redesign in order for the MAD system to be effective, assuming the re-design is even doable and effective.

A UAV designed to be magnetically quiet from the beginning and still be capable of sono-launch from high altitude in the final version is desired. Innovative research and techniques are needed to quiet a small UAV that will have known magnetic interference sources such as motors, servos and avionics and minimally use any magnetic or conductive material in the fuselage, wings, controls, control surfaces, structural components, etc.

There has been very little if any development to integrate a magnetometer sensor in a UAV because of issues of magnetometer availability and the problem of reducing the inherent platform noise in such a small platform. The concept of a small MAD equipped UAV can only be realizable now with the advent of suitable low-cost Size, Weight and Power (SWaP) magnetometers currently in development. New high strength composite materials will be a benefit to the design of the structure, but there are many electro-magnetic interference issues will need to be dealt with.

Additionally since the MAD sensor is "blind" to the type of magnetic target it detects, a basic camera will be required in the prototype to distinguish a MAD contact as a surface or subsurface contact. The objective would be an EO/IR turret system in the final system which would provide additional capability to the warfighter.

The objectives of this development are:

UAV: Speed: 70 kts Air Speed (Threshold)
Endurance: 70 minutes (Threshold)
Packaging: LAU-126A Sonobuoy Launch Container (SLC) or equivalent
Launch Envelope: Full Sonobuoy production specification.
Weight: Max 39 lbs (includes SLC)
Autonomy: Threshold: Fly pre-programmed waypoint tracks and orbits. Objective: Transition to target tracking as cued by MAD system
MAD:
MAD in-air noise level: Threshold: 50 pT/rtHz in 0.015 to 10 Hz band. Objective: 10 pT/rt Hz in 0.015 to 10 Hz band.
Noise level verification: Threshold: This can be demonstrated by combining the ground based magnetic measurements from a "Rock and Roll table" with Roll, Pitch, Yaw (RPY) and translational motion flight characteristics obtained from one or more flights instrumented with IMU and GPS. Navy will assist in defining the standard test profile during the Phase II. Objective: Demonstrate in-flight performance with an integrated magnetometer system in a low environmental noise area.
Noise Compensation Processing: Threshold: Post processing of Rock & Roll table results projected onto in-flight RPY and buffet behavior to obtain the expected magnetic noise. (Include UAV inherent noise and noise due to UAV buffeting in the Earth's field gradient. Geology and Geomagnetic noise compensation need not be included). Objective: Real-Time processing of noise compensation in the UAV with an integrated magnetometer system. (Geomagnetic noise compensation is not required since this would require a separate reference sensor. Geology noise compensation not required.)
MAD Detection: Threshold: Demonstrate that noise compensation/reduction processing does not reduce or distort target signal. Objective: Real-time auto-detection in the UAV and demonstrate Probability of Detection and False Alarm statistics. Navy will define the target signal during Phase II.
Other Sensors: Threshold: Visible camera. Low resolution/low rate. Objective: EO/IR turret Ground Control Station: Phase I and II: Any Phase III: UAS Control Segment (UCS) Architecture.
Cost: In final form, <$5000 in quantities of 100.

PHASE I: Develop a concept for a MAD UAV that will meet the above requirements. The concept should provide detailed information on the material selection, the component selection including motor, servos, magnetometer and any associated ancillary sensor required for noise compensation and avionic components including autopilot, navigation, data links, etc. and an estimate of the magnetic effect of these components on the magnetometer. The concept should include description of any algorithms or techniques used to compensate the UAV noise. External environmental noise reduction such as geomagnetic or geologic noise need not be considered. Provide speed/endurance tradeoff if cannot meet the objectives. Also since cost is a major driver, provide a projected cost in quantities of 100.

PHASE II: Build prototype UAV system(s) and demonstrate it meets the above requirements, primarily the in air noise performance. The prototype at this stage need not be launched from the air via Cartridge Activated Device (CAD) or pneumatic sono-launch but should demonstrate the UAV can unfold and transition into stable flight. The prototype MAD performance can be demonstrated using on-ground motion data and project the in-air noise performance (threshold) through a fully integrated MAD system including noise compensation flight test (objective).

PHASE III: Complete required testing and certification for airworthiness and transition technology to the appropriate program of record.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: An expendable UAV that could be launched from the air that includes a MAD sensor and EO/IR system can be used for remote geologic surveys, underground pipeline tracking in remote or hazardous areas not readily accessible by ground vehicles or near suitable UAV runways.

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KEYWORDS: Uav; Magnetic Anomaly Detection; Magnetometer; Asw; Autonomy; Magnetic Compensation

N141-015 TITLE: Low Profile antenna for Multi-Band (X, Ku, and Ka SATCOM) including potential option for Ku band Tactical Common Data Link (TCDL)

TECHNOLOGY AREAS: Air Platform, Battlespace

ACQUISITION PROGRAM: PMA 266

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: Develop a low-profile, lightweight, high bandwidth Multi-Band (X, Ku, and Ka SATCOM) including potential option for Ku band Tactical Common Data Link (TCDL) with the same effective radiated power as standard size antennas.

DESCRIPTION: There is a need for a low profile antenna for Multi-Band (X, Ku, and Ka SATCOM) including potential option for Ku band Tactical Common Data Link (TCDL) capable of operating at bandwidths up to 14 Megabits per second (MBS) while maintaining the same effective radiated power as standard size antenna apertures. Standard size satellite antennas have a greater height projection which creates greater aerodynamic drag. An antenna with a lower outward projection that does not sacrifice antenna gain does not currently exist. A successful antenna could be used for "through the rotor" helicopter applications on Vertical Take-off Unmanned Air Vehicle (VTUAVs) and other manned helicopters. An antenna design incorporating antenna diversity feature for dual antenna operations which would allow for continuous availability "without interruption" of data rates during all aspects of aircraft maneuvering is desired.

The target weight of a X/Ku/Ka SATCOM Aircraft system (antenna, radome, modem and power amplifiers - excluding aircraft unique supporting structure) is 35 pounds or less for each antenna system. An antenna aperture diameter of 18 inches is the maximum allowable due to size constraints. Radome vertical height cannot exceed 15 inches. There is a need for X, Ku, and Ka modes to be reconfigurable during flight. Design solution must account for losses (forward and return gain) when going through the rotors. Modem type and whether the modem design is intended for through the rotor applications should be specified (prototype modems are sufficient). It is understood that design trades may yield higher weights if a TCDL capability was to be incorporated into this antenna system (in addition to multi band X/Ka/Ku SATCOM).

PHASE I: Develop an initial concept design of an antenna system which is capable of dual antenna diversity tracking and model results on a VTUAV helicopter (Bell 407). Demonstrate feasibility of the concept to meet the objectives of this SBIR.

PHASE II: Develop diversity tracking capability and identify any hardware architecture required to interface two separate antenna systems. Perform ground demonstration with rotors turning on a rotary wing aircraft (A Bell 407 aircraft is desirable). Government may not be able to provide a test asset so the Offeror will have to provide a suitable test asset with their plan.

Demonstrate Diversity tracking on 2 antennas mounted under the aircraft on a test stand with rotors turning during aircraft ground test. (One of these antennas needs to be the antenna developed as part of this effort. The 2nd antenna can be a surrogate to show proof of concept).

PHASE III: Perform flight demonstration of the antenna system (with diversity tracking) while showing near continuous data exchange and minimized interruption of video signal. Transition to an appropriate platform.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial aviation could benefit from dual band low-profile antenna given they share the same band in some cases

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KEYWORDS: SATCOM, Antenna, Helicopter, communication, modem, satellite

N141-016 TITLE: Persistent Maritime Target Tracking Using Automated Target Fingerprinting and Discrimination

TECHNOLOGY AREAS: Air Platform, Sensors

ACQUISITION PROGRAM: PMA 299

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OBJECTIVE: Develop a Feature Aided Tracking and Discrimination (FAT-D) approach operating under the control of an automated resource manager to provide persistent target tracking (across extended breaks and even over multiple missions) of vessels (including ships and small boats) along with non-geometric discrimination capabilities to separate small boats, semi-submersibles and periscope masts from potential confusing returns generated by sea spikes and flotsam.

DESCRIPTION: Improvements in surface target classification performance, track lifetime, and track association in dense target environments and clutter backgrounds are needed. Utilization of a Feature Aided Tracking and Discrimination (FAT-D) capability could significantly improve situational awareness of the surface picture through surveillance of a larger region of interest, more efficient target interrogation, extended track life, improved classification/identification performance, and optimization of radar resources. FAT-D approaches are not currently utilized in standard Navy airborne radar systems. When compared to kinematic-only trackers the FAT-D approach should provide 100x track life improvement as quantified by initial track identity lifetime (ITIL) and dominant track identify lifetime (DTIL) metrics. The general approach follows a chain of increasing confidence in target classification using traditional surface search modes to first detect moving vessels and to classify them based on their estimated length information and high range resolution bulk filtering to identify those vessels of interest. The FAT-D approach should exploit vessel length information during a search and acquisition mode to identify different classes of vessels. By interleaving the high range resolution mode with search modes a more efficient use of radar resources is possible along with the ability to pre-filter targets before committing the radar to longer Inverse Synthetic Aperture Radar (ISAR) dwells. Extraction of target discrimination features is performed simultaneously to separate target types though the exploitation of non-geometric features including the nature of the object's wake transfer impedance. The desired deliverable is a FAT-D software application suitable for demonstration with a candidate Navy radar system.

PHASE I: Develop, and demonstrate feasibility of FAT-D algorithms using realistic simulated data in a lab environment representative of a candidate Navy radar system. Demonstrate the improvement in target association performance across extended track breaks in stressing high-density littoral environments.

PHASE II: Implement the algorithms developed in Phase I in a real-time environment and demonstrate with the candidate radar in a field test. Demonstrate how the FAT-D application can be integrated with a candidate Navy radar system.

PHASE III: Transition the developed technology to appropriate platforms/sensors.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The most direct dual use applications are in remote economic exclusion zone (EEZ) monitoring or possibly search and rescue operations.

REFERENCES:
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KEYWORDS: Maritime Surveillance; Radar; Resource Management; feature aided tracking; detection and discrimination; small boats

N141-017 TITLE: Environmentally Friendly Alternative Synthesis and Process to Manufacture Cost-Effective Hexanitrohexaazaisowurtzitane (CL-20)

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Weapons

ACQUISITION PROGRAM: PMA 259

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: Develop and demonstrate a viable alternate synthesis route for Hexanitrohexaazaisowurtzitane (CL-20) with efforts directed to lowering production costs for CL-20 bulk use.

DESCRIPTION: CL-20 is the most energy-dense explosive material. CL-20 surpasses current state of the art nitramines, cyclotetramethylene-tetranitramine (HMX) and cyclotrimethylene-trinitramine (RDX) in performance by up to 20 percent as an explosive and has a better oxidizer to fuel ratio as a propellant ingredient. In the correct configuration, particle size, and morphology, CL-20 shows similar or even improved impact, shock, and thermal responses than RDX and HMX, but with significant performance improvement. There is a significant increase in interest for CL-20 in a wide variety of applications. However, CL-20’s potential as a large-scale replacement for the widely used RDX and HMX is limited due to its cost-prohibitive nature. The United States’ (US) primary domestic source of CL-20 has been using the benzylamine synthesis route to prepare the tetra-acetyldiamino isowurtzitane (TADA) precursor. This source was given exclusive right to the CL-20 work approximately 14 years prior with the belief that they would be able to increase production and reduce cost, allowing this material to be utilized as a tool for our warfighter capability. In all actuality, the reverse has occurred with reduced production and increased cost. The source originally purchased this precursor from a non-US source at a fairly hefty price, which resulted in initial CL-20 costs of $550/lb. The non-US source stopped supplying the material. As it stands, no firm manufacturing replacement has been identified domestically. This continues to hamper the ability of CL-20 to be produced at a reasonable cost and production rate, thus resulting in ever increasing costs which stand currently at $950/lb. CL-20’s production process suffers from several economic and environmental disadvantages resulting in a low number of US-based suppliers. As such, discovery of novel applications for this material and the continued development of promising applications have been limited. The synthesis route needs to redefine or tailor alternate synthesis routes, using pharmaceutical methods and/or other approaches, in order to improve and advance these efforts towards a final environmentally friendly and cost effective solution.

Novel synthetic routes to CL-20 that will significantly reduce the cost associated with this material are of great interest. Specifically seeking novel synthetic routes to CL-20 that avoid starting reagent benzylamine, (thus eliminate chlorine waste streams), and costly transition metal catalysts (palladium and platinum). The approach to designing a lower-cost process begins with the use of inexpensive commodity chemicals and no more than four synthetic steps during processing. Proposals which incorporate widely used and inexpensive commodity chemicals as starting materials while featuring fewer synthetic steps will be given priority. Strong considerations will also be given to the alternate chemistry proposing environmentally-friendly. A successful development should reduce the cost of CL-20 to around $150/lb or lower, and upon transition to industrial scale would provide even greater cost savings making CL-20 competitive with RDX and HMX, the current explosive and propellant nitramines. Once, cost becomes competitive with RDX or HMX, a variety of programs would benefit enormously in performance and sensitivity as an alternate to the other nitramines.

In the development of alternate synthesis routes, characterization of chemical structure, thermal, and physical properties using widely accepted chemistry and scientific methods and techniques is required to validate precursor and intermediates developed and utilized in the alternate synthesis pathway to CL-20 end product. Final characterization and verification of the CL-20 end product is required to validate the feasibility of the alternate synthesis route.

PHASE I: Design and determine feasibility of a concept for an alternate synthesis route of CL-20. Prepare a minimum of 5-grams of a novel direct precursor to CL-20 at laboratory scale. Characterize the key thermal and physical properties of all intermediates and potential hazard sensitivity.

PHASE II: Using results from Phase I, develop and optimize laboratory process for production of minimum 100-gram scale of new precursor to CL-20. Demonstrate the production of CL-20 from this precursor at multi-gram scale, Verify the structure, thermal stability and potential hazard sensitivity. Validate that the laboratory synthesis exhibits a lower cost than the current state-of-the-art process.

PHASE III: Complete and transition a scale-up process design and data package that has demonstrated production and reproducibility for lower-cost commercial production of CL-20 with direct scale-up to be demonstrated in conjunction with Naval Air Warfare Center Weapons Division (NAWCWD).

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: As a low-cost alternative oxidizer, CL-20 could be utilized as a high energy material in solid rocket boosters for satellites or space travel. CL-20 could be used for specialize gun propellant and also as a method for demolition as a 'cutter' in detonation cords.

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KEYWORDS: RDX, HMX, Synthesis, CL-20, explosive, Scale-up

N141-018 TITLE: Efficient 3-D Imaging of Vessels for Improved Classification and Persistent Tracking

TECHNOLOGY AREAS: Air Platform, Sensors

ACQUISITION PROGRAM: PMA 290

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: Develop, implement and assess a true 3-D Inverse Synthetic Aperture Radar (ISAR) algorithm for maritime surveillance and identification of ships and small boats.

DESCRIPTION: Inverse Synthetic Aperture Radar (ISAR) processing relies on both radar processing leveraging optimal orientations and angular rates, but also motion prediction within the processing. Typical 2-D ISAR processing produces a number of frames in a movie-like sequence that then relies on image analysts to interpret and identify the craft. These 2-D sequences rely on short segments of good cross-range resolution that are then combined to produce a rough approximation of a 3-D realization. Autofocus approaches incorporate curved phase histories or angular motion trajectories that improve the Synthetic Aperture Radar (SAR) processing and produce clearer imagery. These automated image processing methods attempt to resolve ambiguities of perspective and to deduce pseudo-3-D ISAR images that are used to deblur and sharpen the 2-D imagery are much less than optimal.

Small boats (<100 feet) pose additional challenges to ISAR processing, since small watercraft will have more complex and responsive motion than larger vessels. These more complex motions make the ISAR processing very different. Autofocus and other deblurring approaches designed for larger ships are less effective for small boats.

A true 3-D ISAR approach to reconstruct the 3-D structure of the target is sought to meet the challenge of imaging and identifying small boats. An ISAR approach that would lead to an accurate reconstruction of the 3-D boat image is desired. In addition, the approach requires an efficient use of less radar resources with minimal image analyst and operator input. The algorithm should be able to handle small boat structure and small boat motion to produce true 3-D imagery for identification. More efficient ISAR processing with automatic, unambiguous 3-D ISAR image construction should eventually enable robust automatic ID processing. Performance metrics include gauging the ability to resolve the 3-D motion and fidelity of the imagery. Of vital importance is to gauge the efficiency of the approach, if it extracts useful information from most of the data frames and how many frames would be required for robust processing.

For small boat identification, accurate retrieval of the boat motion behavior and the boat response to the ocean dynamics would also be of interest. This additional information could have value and be used to help identify and classify the imaged boats.

PHASE I: Develop a true 3-D ISAR algorithmic framework. Implement the algorithm for post-processing. Test and estimate the potential performance of the algorithm using real or simulated data.

PHASE II: Test and assess the performance of the algorithm as implemented in Phase I using actual ISAR data from a representative sample of large and small vessels. Produce a design and plan forward for real-time implementation of this 3-D ISAR approach.

PHASE III: Transition to maritime surveillance radar systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: 3-D ISAR imaging has a variety of applications in maritime surveillance and vessel tracking for both commercial and military interests.

REFERENCES:
1. Su, Fulin, Lu, Jing, & Su, Yuan. (2012). A method of 3-D image reconstruction of target based on ISAR image sequences. Synthetic Aperture Radar. EUSAR. 9th European Conference on, Topic(s): Fields, Waves & Electromagnetics, Page(s): 123 – 12

2. Suwa, Kei, Yamamoto, Kazuhiko, Iwamoto, Masafumi, & Kirimoto, Tetsuo. (2008). Reconstruction of 3-D Target Geometry Using Radar Movie, Synthetic Aperture Radar (EUSAR), 7th European Conference on, Topic(s): Fields, Waves & Electromagnetics. Page(s): 1 - 4

KEYWORDS: Maritime Surveillance; Imaging; Radar; ISAR; vessel classification persistent tracking

N141-019 TITLE: Applying Advanced Human Engineering Methods to Mission Planning for Multi-Manned or Unmanned Air Vehicles

TECHNOLOGY AREAS: Air Platform, Information Systems, Human Systems

ACQUISITION PROGRAM: PMA 281

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: Develop an advanced human engineering based interface for multiple manned or unmanned aircraft mission planning.

DESCRIPTION: Currently, the mission planning process is labor and time intensive, complicated, and requires considerable training and proficiency. Nearly every aircraft requires a digital mission plan to be completed prior to being able to launch. Additionally, prior to being able to deviate from an existing plan, long range unmanned Intelligence, Surveillance, and Reconnaissance (ISR) platforms require a completed and validated plan to be authorized to deviate from the existing route. This can have serious impact to the ability of a vehicle to prosecute time critical popup targets that require anything more than a minor change to the approved route. This is due in large part to the time required to generate an approved/validated delta plan.

New innovative human factors workflows and visualizations as well as significantly improved data handling algorithms are needed to bring mission planning into a near real time process. Current planning algorithms and processes are based on single vehicle planning from the late Vietnam War era. Joint Task Force integration of Naval assets require an integrated planning environment that allows for quick assimilation of tasking and constraints while allowing automated algorithms to complete repetitive labor intensive processes. Innovative workflows are needed to allow operators to tailor specific planning processes to optimize their output for the time and materials required (e.g. manned-unmanned integrated search and rescue effort vs a 50 nm deviation from an existing 12 hour surveillance mission).

Particular focus of the development is to create an innovative user interface to guide mission planners in a streamlined approach through highly complex and detailed mission planning procedures. The development must address human factors engineering to effectively simplify data entry and uploading process through intuitive human-computer interactions and visualization techniques. Any proposed planning method/technique should be highly adaptive to accommodate mission planning for new and enhanced weapon systems and platforms.

PHASE I: Develop and determine feasibility of a design for the above that shows the simplification of mission planning and provides an innovative approach to visualization of information.

PHASE II: Implement the conceptual design in software and demonstrate in a prototype system.

PHASE III: Integrate software into the Joint Mission Planning System and transition onto appropriate platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Flight planning systems for private pilots and airlines.

REFERENCES:
1. Menner, W. A. (1997). The Navy's Tactical Aircraft Strike Planning Process. Johns Hopkins APL Technical Digest, 18(1), 90-104.

2. Damilano L., Guglieri G., Quagliotti F., Sale I., Lunghi A. (2013). Ground Control Station Embedded Mission Planning for UAS. Journal of Intelligent and Robotic Systems, 69(1-4), 241-256.

3. Boukhtouta A., Bedrouni A., Berger J., Bouak F., Guitouni A. (2004). A Survey of Military Planning Systems. Paper presented at 9th International Command and Control Research and Technology Symposia (ICCRTS), Copenhagen, September 14-16, 2004. Retrieved from http://www.dodccrp.org/events/9th_ ICCRTS/ CD/papers/096.pdf

KEYWORDS: Mission Planning; Aircraft; Human Computer Interface; Visualization Techniques; Joint Mission Planning System; Data Transfer

N141-020 TITLE: Enhanced Small-Target Detection and Tracking Using a Mode-Adaptive Constant False Alarm Rate (CFAR) Detector

TECHNOLOGY AREAS: Sensors, Electronics

ACQUISITION PROGRAM: PMA 265

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: Develop adaptive Constant False Alarm Rate (CFAR) Detectors that support rapid mode interleaving under resource management control that allows simultaneous support for range dependent multi-resolution processing.

DESCRIPTION: Advancements in sensor resource management are needed that would utilize rapid mode interleaving on dynamic irregular time scales, capable of multi-resolution processing and data rate management. Current fielded radar systems offer only the most rudimentary resource management approaches to support detection and tracking. In a coherent radar system the dynamics of the target plays a critical part in determining if the target is detected against either a clutter or noise like background. Optimal detection of targets with different dynamics requires different Constant False Alarm Rate (CFAR) schemes and parameters. Optimal performance therefore requires utilizing variant CFAR’s in a hierarchal manner as well as making the threshold parameters of the CFARs adaptive. The CFAR processing must be capable of maintaining consistent performance across multiple waveform resolutions at the pulse repetition interval (PRI) level. In a maritime environment an objective of this approach is to provide small target detection and false alarm performance in sea-state four equal to that provided by conventional approaches in sea-state two or three. The desired deliverable is an adaptive real-time CFAR software application suitable for demonstration with a candidate Navy radar system.

PHASE I: Develop CFAR detector approaches capable of maintaining performance across multiple resolutions at the PRI level and demonstrate using realistic simulated littoral maritime data. The demonstration should show how the adaptive CFAR approach improves detection and false alarm performance in stressing high-density littoral environments within a constrained radar timeline.

PHASE II: Implement the algorithms developed in Phase I and demonstrate in a real-time environment. Demonstrate how the adaptive CFAR application can be integrated with a candidate Navy radar system.

PHASE III: Transition the developed technology to appropriate platforms/sensors.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Mode adaptive CFAR detectors can be utilized in a wide range of radar, optical and even communication systems with both civilian and military applications.

REFERENCES:
1. Weinberg, G.V. (2012). Suboptimal Coherent Radar Detection in a KK-Distributed Clutter Environment. International Scholarly Research Network, ISRN Signal Processing, Volume 2012, Article ID 614653, 8 pages

2. Rosenberg, L., Crisp, D.J., & Stacy, N.J. (2010). Analysis of the KK-distribution with medium grazing angle sea-clutter, IET Radar Sonar Navig., Vol. 4, Iss. 2, pp. 209–222

KEYWORDS: Radar; Clutter; small target detection; constant false alarm rate; resource managment; adaptive modes

N141-021 TITLE: Improved Reliability Laser Based Ignition System

TECHNOLOGY AREAS: Sensors, Electronics

ACQUISITION PROGRAM: JSF-Prop

OBJECTIVE: Develop an innovative laser based ignition system to increase the reliability of igniters and excitation systems on aircraft gas turbine engines.

DESCRIPTION: Aircraft gas turbine engines normally operate at high altitude where conditions for an engine relight in the event of a flameout are far from ideal. The low temperatures encountered at high altitudes cause a decrease in fuel volatility, which makes it difficult to ignite the fuel charge. Ignition systems are usually of the spark igniter type where it is necessary to have a very high voltage to jump a wide igniter plug spark gap, and also, a high intensity spark. The high energy capacitor type ignition system is generally used for gas turbine engines since it provides both a high voltage and an exceptionally hot spark which covers a large area. Excellent chances of igniting the fuel/air mixture are assured at high altitudes. A typical system uses aircraft electrical power per MIL-STD-704 of 113 volts /400 hertz to generate high voltage pulses of 27 kilovolts at 4 joules of energy level for a period of 15 sparks/second. The igniter plug spark gap is sealed into the combustion chamber where running temperatures are high with fast transients and high pressures.

Igniters are a leading cause of removals on aircraft gas turbine engines. Top problems are cracked ceramic insulators, buildup of combustion contaminants at the plug tip, erosion of the plug tip, and fouling. Cracked ceramic insulators occur due to the combined environment effects of temperature, thermal transients, and moisture. Buildup of combustion contaminants at the plug tip results in tracking that diverts and shorts out the spark energy. Erosion of the plug tip is a natural effect of the plasma arc sparking process. Fouling is due to the accumulation of unburnt fuel or other airborne particles.

Prevalent ignition system designs also contain the failure modes within the exciter box. Components are hermetically sealed in the boxes. Seal malfunction requires replacement of the entire exciter. There can be breakdown or short circuits in the high tension circuitry. Breakdown damage to high tension igniter wires results in loss of abrasion and radio interference protection.

An innovative laser based design solution is sought to reduce or eliminate these failure modes in ignition systems. A successful solution will also have key characteristics comparable to typical ignition system designs on metrics of, response, power consumption, Electromagnetic Interference (EMI), package size, weight, cost, and electrical interface. Key environmental concerns that need to be taken into consideration are temperature, noise, humidity and vibration extremes. The laser based ignition system must be compatible with a current aerospace gas turbine engine control system.

Collaboration with an aircraft gas turbine manufacturer is strongly encouraged.

PHASE I: Determine technical feasibility and design a concept for an innovative laser based ignition system.

PHASE II: Develop, test using procedures defined by SAE AIR784C, and demonstrate a prototype ignition system and characterize the response, power consumption, and EMI.

PHASE III: Finalize testing and transition the technology to the appropriate platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Ignition systems of this type are typically very similar to those used on commercial, business or general purpose turbine engine aircraft. Slightly modified derivatives of this technology could find use on most types of internal combustion engines. Therefore, improved ignition system technology can benefit multiple industries including power generation, marine, automotive, and other ground or air vehicle applications.

REFERENCES:
1. SAE International. (1995). Interrelation of Engine Design and Burner Configuration with Selection and Performance of Electrical Ignition Systems for Gas Turbine Engines (SAE Standard AIR784C). http://standards.sae.org/air784c/

2. Department of Defense (1977). Aircraft Electric Power Characteristics: Military Standard (MIL-STD-704C). Washington, DC. http://www.everyspec.com/MIL-STD/MIL-STD-0700-0799/MIL-STD-704C_21344/

3. Patent EP2458177A1 (2012). Advanced laser ignition systems for gas turbines including aircraft engines. www.google.com/patents/EP2458177A1?cl=en

4. Optical Society of America. (2011, April 20). Laser sparks revolution in internal combustion engines. http://phys.org/news/2011-04-laser-revolution-internal-combustion.html

5. Marshall, L. S. (Ed.). (2012). Laser Car Ignition Dream Sparks Multiple Approaches. http://www.photonics.com/Article.aspx?AID=51731

KEYWORDS: Laser, Ignition, Igniters, Gas Turbine Engines, Electronics, Sensor

N141-022 TITLE: Net-Centric Collaborative Environment for Littoral Combat Ship (LCS)

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PEO IWS 5.0, Undersea Systems

OBJECTIVE: Develop an innovative collaboration environment for Littoral Combat Ships (LCS) that provides interaction across various software and hardware platforms.

DESCRIPTION: The Navy is interested in an innovative algorithm solution to improve the collaboration abilities for Anti-Submarine Warfare (ASW) capabilities as they relate to the Littoral Combat Ships (LCS) program. LCS is working toward supporting a broader surface combatant force transformation strategy, recognizing that many future threats are emerging in shallow water regions, where the ability to operate near-shore and in rivers will be vital for mission success. With current lower manning levels assigned to the ASW mission, the need exists to enhance operator efficiency with a focus on ease-of-use, intuitive situational awareness, and data sharing across multiple LCS users and computer platforms through an innovative solution.

Currently, the LCS platform has a number of displays for showing tactical data. Each display is configured to show a limited data set from a predefined application suite. Operator efficiency will be enhanced if data is not limited to a single display, application, or hardware platform. The current process involves moving user interfaces to other monitors. This requires an application that supports virtual network connections with a broader vision of various hardware types. Existing virtualization solutions are typically limited by computer operating systems, and by only showing the desktop of one machine on another. The end result is a restrictive collaboration space. The Navy supports forms of collaboration, such as chat. A single collaboration paradigm would address sharing of various data types. A solution that meets this need would improve the performance and capability of the LCS ASW mission.

Expanded desktop sharing to the next generation of collaboration of pictures, videos, screen shots, chat, video white boarding, and remote desktop sharing is needed. Creating an algorithm for a collaborative environment that allows this would enable easier, less expensive integration of the best-of-breed applications and simplify bringing in new future capabilities. This requires a seamless, unified system where operating systems, display resolutions, and hardware are not inhibiting factors [ref. 1]. With a unified set of collaboration algorithms, the user can repeatedly use the same interfaces, including common mouse and gesture swipes and same menu items to open, close, and transfer data objects. Training time is reduced with the reuse of interfaces and a solution that mimics widely-available commercial collaboration tools (Facebook, iPads, etc.).

An algorithmic solution is needed to support a blend of different technologies across different acquisition life cycles, leverage existing technologies, minimize the need for extensive training, and support traditional communication channels while augmenting innovative ideas [ref. 2]. A reduction in maintenance, manning, and operation costs will be a part of any proposed resolution.

PHASE I: The company will develop a concept for a collaborative environment for LCS that meets the requirements described above. The company will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be feasibly developed into a useful product for the Navy. Feasibility will be established through collaborative demonstrations and Commercial Off the Shelf (COTS) capability assessments. The small business will provide a Phase II development plan, which addresses technical risk reduction and provides performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for the collaborative environment for LCS. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles with LCS ASW specific data sets and ASW pertinent user interfaces. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop a collaborative environment for LCS according to the Phase III development plan for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The use of social networks (such as Facebook, Twitter) and mobile platforms (such as iPhone, Android, tablets) are ubiquitous in terms of their daily use both in and out of the Navy. Efforts as part of this SBIR that achieve broad collaboration across technologies and platforms could operate well in the wider context of the commercial market and companies interested in rapid prototyping and reducing time to market (TTM). Any large corporation or organization that has the need to communicate across wide area networks or internet technologies could leverage the use of this new collaborative technology.

REFERENCES:

1. Maybury, Mark. "Collaborative Virtual Environments for Analysis and Decision Support." Communications of the ACM Volume 44 December 2011: 3 pages.

2. Tossell, Chad (CAPT), "Collaborative Tool for Command and Control Team Effectiveness Studies", Nov 2008. Institute for Information Technology Applications, United States Air Force Academy. 13 Mar 2013 <http://www.usafa.edu/df/iita/Technical%20Reports/Collaborative%20Tool%20for%20Command%20&%20Control%20TeamTR-08-1.pdf>

KEYWORDS: Desktop sharing, Anti-Submarine Warfare (ASW), collaboration space, virtual network connections, virtualization solutions, intuitive situational awareness

N141-023 TITLE: <u>Wireless Monitoring of Hydraulic Actuators for Reducing Total Ownership Costs</u>

(TOC)

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: Acquisition Program: PMS450, VIRGINIA Class Program Office. This effort al

OBJECTIVE: The objective is to develop an innovative wireless sensor system that measures data on hydraulic actuators and creates actionable information at the node that leads to demonstrable improvements in Condition Based Maintenance (CBM) programs.

DESCRIPTION: The Navy has an ongoing need to reduce total ownership costs and extend the life-cycle of components and systems by improving the reliability and overall operational readiness of the fleet. Virginia-class submarines have more than 100 large hydraulic actuators, which are removed, overhauled, and reinstalled as a part of 600 Series work. These actuator overhauls are performed on a fixed schedule, regardless of their use or condition. Because many of the actuators that are sent back for overhaul require little or no maintenance, this fixed schedule approach is overly conservative, expensive, and introduces risk because the components can be damaged or improperly re-installed as a result of excessive actuator handling. Wireless sensor systems are a promising enabling technology for cost-reduction initiatives (ref 2). However, the machine prognostic requirements of high sampling frequency and synchronized data acquisition exceed the total amount of wireless data that can be transmitted continuously (ref 3). An innovative solution is needed to produce actionable prognostic information at the measurement location to reduce the bandwidth.

Wireless sensor systems can provide distributed intelligence collection for performance evaluation, prognostic maintenance efforts, and situational awareness. Technology exists for efficient low bandwidth wireless data collection. Wireless solutions for applications that require high bandwidth measurements become expensive to accommodate large energy storage, or are overly limited due to inadequate energy storage. Sending all the raw measurements stresses bandwidth and decreases the life of the wireless node. Directly inserting diagnostic or data compression algorithms at the node level requires high data rates and computational effort which decreases the value of the wireless node. New techniques are needed at the node level to minimize power usage while converting the raw data into maintenance instructions.

A successful technology development and transition will result in fewer machinery overhauls, shorter work task times, and optimized maintenance logistics. These workload reductions will result in cost savings through shorter depot times, increase overall fleet availability, and reduced total operational costs (ref 1).

PHASE I: The company will develop a wireless system concept that produces maintenance instructions for hydraulic actuators. The company will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be developed into a useful product for the Navy. Feasibility will be established by material testing and analytical modeling. The company will prepare a development plan for Phase II, which will address technical risk reduction, as well as performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype for evaluation. The prototype will be evaluated to determine its capability to meet the performance goals defined in Phase II development plan and Navy sensor requirements. Sensor performance will be demonstrated through prototype evaluation and modeling, or analytical methods over the required range of parameters, including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that can be used in a shipboard demonstration and will meet Navy requirements. The company will develop a Phase III development plan to transition the technology into a system that can be acquired by the Navy.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology to Navy use should a Phase III award be made. Based on the Phase II results, the company will develop sensor systems to achieve the desired systems in submarine sensor systems. The company will support evaluation aboard ship and in qualifying and certifying the system for use on the OHIO Replacement Class submarine and for back fit to the VIRGINIA Class submarine.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology developed under this topic could be used in a wide range of industry applications, providing specific system performance information, and a method for collecting and analyzing such information, to enable a breakthrough in wireless monitoring and actuation and control capability.

REFERENCES:
1. Goff, C. I., McNamara, C. L., Bradley, J. M., Trost, C. S., Dalton, W. J. and Jabaley, JR., M. E. (2011), “Maximizing Platform Value: Increasing VIRGINIA Class Deployments”. Naval Engineers Journal, 123: 119–139. https://www.navalengineers.org/Hamilton_Award_Papers/2011/Goff.pdf

2. Byington, Carl S., Michael J. Roemer, Gregory J. Kacprzynski, and Thomas Galie. “Prognostic Enhancements to Diagnostic Systems for Improved Condition-Based Maintenance”, 2002, DTIC Document Accession Number: ADA408880. http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA408880

3. Yick, Jennifer, Biswanath Mukherjee, and Dipak Ghosal. "Wireless sensor network survey." Computer networks 52.12 (2008): 2292-2330. http://ahvaz.ist.unomaha.edu/azad/temp/ali/08-yick-wireless-sensor-network-localization-coverage-survey-good.pdf

KEYWORDS: Hydraulic actuator maintenance; wireless sensor nodes; condition based monitoring; Virgina-class overhaul; Maintenance Reduced Total Ownership Costs, component reliability

N141-024 TITLE: Galley-Scullery Water Conservation System (GSWCS)

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: PMS501, Littoral Combat Ship Program Office

OBJECTIVE: Research, develop and demonstrate an innovative water conservation system for shipboard application in the Galley-Scullery that significantly reduces water usage, both potable and wastewater.

DESCRIPTION: The Littoral Combat Ships (LCS) are designed for coastal shallow water operations and protection against terrorist and asymmetric threats. The requirement for coastal shore operations prohibits them and other naval vessels from discharging wastewater from galley, scullery and other potential water drainage systems in accordance with Maritime Pollution (MARPOL), federal, state and international regulations (ref 1). Executive Order 12088 requires forces afloat, as appropriate, to cooperate with federal, state and local environmental protection organizations and comply with the official substantive standards and criteria promulgated by such agencies (ref 3). Consequently, all US Navy ships, including the LCS, have to store all wastewater generated aboard ship in the Collection Holding Transfer (CHT) tanks, which are designed to support a 12-hour holding period. As stated in the white paper (ref 4),”Evolution in U.S. Navy Shipboard Sewage and Gray water Programs”, the need for U.S. Navy ships to operate for extended periods in littoral waters, and anticipated discharge regulation changes require a need for innovative water conservation and recycling systems. In some areas of the United States such as, Washington State, Alaska, and the Great Lakes region ships are not allowed to discharge any wastewater at all. Due to the Navy’s increase of littoral operations, costly upgrades to the CHT tanks on some ships are being made to increase the size of the CHT holding tanks. Two examples include the LHA and LPD-17 amphibious class ships. The upgrades were implemented to increase gray water holding times from a norm of 12 hours to 36 hours. These upgrades for just two LHA-1 class ships cost the Navy $1,014,000 to implement during an overhaul period (ref 7). The relatively high water demand associated with supporting the galley, scullery and other water drainage systems can place a significant demand on the CHT systems due to the limited tank size and holding capacity (ref 2). There is a critical need to reduce water consumption through recycling, and to decrease the amount of wastewater entering these CHT systems by leveraging innovative water conservation and repurposing technologies, particularly for scullery and galley operations. The GSWCS is intended to significantly reduce the logistics burdens and high costs associated with shore side offload and disposal of ship wastewater. In addition to water, fuel, and manpower savings associated with offloading of waste, the technology will allow increased operational time for future naval vessels operating in littoral waters without performing costly upgrades to CHT systems or offloading of wastewater.

The current commercial off-the-shelf (COTS) water recycling systems that could possibly be installed aboard ships utilize filters that tend to foul easily with the induction of gray water. This is why procuring a filtration type COTS solution would not work for gray water recycling aboard naval vessels. The filtration devices would cause added maintenance and a need to change out filters more frequently, thus increasing operation and maintenance support costs.

Current state-of-the-art gray water recycling technologies utilized in some commercial applications include: Membrane Bioreactors, Advanced Oxidation processes, Brine Concentrator and Evaporator Recovery Systems, and Forward Osmosis Treatment Systems. These technologies have been proven in the commercial sector to effectively reduce water consumption by recovering and reusing up to 95% of all wastewater. The Naval Sea Systems Command (NAVSEA) (ref 4) as well as the National Aeronautics and Space Administration (NASA) (ref 5) are both exploring Membrane Bioreactor technology for wastewater recycling. NASA's wastewater exploration process combines a membrane-aerated bioreactor with a forward osmosis treatment system. The combination effectively destroys harmful pathogens and removes solids. The processed liquid's biochemical oxygen demand is reduced rendering the water fit for reuse. The NASA wastewater processing system is anticipated to reduce water consumption by more than 90%. According to NASA and the Environmental Protection Agency, (refs 5, 6) "forward osmosis technology is an innovative, sustainable, and affordable alternative to reverse osmosis technology." One key advantage of the state-of-the-art technologies for naval vessel integration is the modularity of the systems and the ability to fit within a small footprint or confined space such as a shipboard application. In addition, the innovative combination of more than one technology could solve the existing shipboard issue of waste water holding within a limited tank size or footprint and save the Navy millions of dollars in CHT upgrade and support costs (ref 7).

The GSWCS is envisioned to reduce potable water consumption, weight, and the amount of wastewater entering the CHT tanks aboard these vessels by reuse of water in the galley and scullery areas. The weight reduction will be due to fewer gallons of wastewater being held in the CHT systems.

The GSWCS should be configured for use in the galley and scullery, where compact, modular and/or under-counter installation should be employed. The GSWCS is envisioned to use smart control system technology, modularity, and automated processes to perform all functions. The GSWCS capabilities should include self diagnostics and prognostics for reduced system maintenance and repair. The autonomous system should be developed with a modular, open systems architecture approach to permit life-cycle upgrading, flexibility for inclusion of various commercial technologies, and adaptability to shipboard spaces and configurations. The system is envisioned to include computer-controlled sensors and operating mechanisms able to function in all shipboard environments and withstand shipboard motions and sea states.

PHASE I: The company will develop approaches for an automated water conditioning and recycling system concept for LCS that meet the requirements described above. The company will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be feasibly developed into a useful product for the Navy. Feasibility will be established by material testing and analytical modeling. The small business will provide a Phase II development plan that addresses technical risk reduction and provides performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II development plan and the Navy requirements for the GSWCS. The system performance will be demonstrated through prototype evaluation over the required range of parameters including deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop a GSWCS according to the Phase III development plan for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The potential for commercial application includes cruise ships that have technologically advanced smart appliances, cargo ships, tankers, restaurants, institutional food service operations, and workboats. The additional capability to employ a modular lightweight GSWCS automated system that conditions and recycles water will appeal to the commercial sector as a cost effective measure to reduce labor, water and energy costs.

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KEYWORDS: waste water reuse; shipboard water conservation; galley waste water; membrane bioreactor; Collection Holding Transfer (CHT) tanks; potable water recovery

N141-025 TITLE: Improved Periscope Video Pre-Processing

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO IWS 5.0, Undersea Warfare Systems.

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: Develop imaging techniques for periscope video that improves the quality of the picture during the pre-processing and downstream presentation of the video creation process.

DESCRIPTION: The Navy seeks advanced imaging processing techniques for periscope video. When a periscope video is being recorded it leaves camera interlacing artifacts and records smudges which occur on the periscope lens. Videos from legacy periscopes will have etched reticle lines which are recorded. The interlacing artifacts, smudges, and reticle lines complicate the video picture and reduce the performance of existing video processing capabilities. It requires manual labor to edit the video so that a true picture is available. Providing an innovative technique to improve video processing will reduce the costs of operator workload and increase the performance of sailors.

Due to camera and scene motion in periscope videos, reticles and smudges are impacted differently than imagery in the scene. The current process involves a sailor taking the video that has been recorded and editing it manually using editing software such that the smudges and reticle lines are removed. Removing the interlacing lines is even more time consuming as the sailor attempts to blend a picture into a discernible scene that accurately depicts the true picture of what was recorded. This is a laborious, time consuming process. It only provides marginal results with many inconsistencies still remaining within the video scenes.

The Navy is seeking automated techniques to improve processing of video pictures during the pre-processing stage. This will improve the sailor's ability to effectively use periscope video by increasing the quality of the video image before it reaches the processing stage. The solution will include techniques that replace current labor intensive processes associated with manual removal of visual artifacts. It will address automatic contact detection, classification and tracking, and video stitching. The capability will also allow for scene motion correction through improving de-interlacing [ref 1], reticule and smudge removal [ref 2], and possibly Bayer color de-mosaicing [ref 3], through the innovative integration of pre-processing steps.

PHASE I: The company will develop a concept for imaging techniques for periscope video that meet the requirements described above. The company will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be feasibly developed into a useful product for the Navy. Feasibility will be established by analytical testing and modeling. The small business will provide a Phase II development plan that addresses technical risk reduction and provides performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a scaled prototype for evaluation as appropriate. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for the imaging techniques for periscope video. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including various testing cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop imaging techniques for periscope video according to the Phase III development plan for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Video algorithms would also have application in a variety of remote video capture situations including surveillance video and video capture from moving platforms in externally located cameras in support of industrial security, homeland defense, and other law enforcement settings. Any industry that incorporates video cameras in their security systems could benefit from the technologies developed under this topic.

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KEYWORDS: Periscope video; de-interlacing; reticule lines; smudge removal; scene motion; Bayer de-mosaicing

N141-026 TITLE: Innovative Velocity Sensors

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO IWS 5.0, Undersea Warfare Systems

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: Develop innovative acoustic particle velocity sensors for SONAR arrays that achieve requirements for greater sensitivity, environmental stability, and lower costs.

DESCRIPTION: The Navy has identified needs to improve performance of submarines to decrease vulnerability and increase maneuverability. Currently, the Navy is developing technologies for building and installing large SONAR arrays external to the hull of a submarine. These technologies allow for a lightweight, scalable array which provides many options for installation and deployment. Integral to these arrays are the acoustic particle velocity sensors.

There are several velocity sensors available for use: however, these sensors do not meet the improved sensor sensitivity desired by the Navy in order to increase the capability of submarine flank SONAR arrays. In addition, current sensor technology does not meet all the sensor environmental requirements that come with being installed on a submarine external to the pressure hull. Available sensors also require a significant amount of hands on labor to manufacture and test which drives the per channel cost up. Improvements to the current sensor technology are needed to meet these evolving requirements. The Navy requires a sensor with at least 6dB (goal of 10dB) improved sensitivity over current velocity sensor technology over the frequency band of 0 – 20kHz [Ref 1]. The sensors must be neutrally buoyant and respond to flexural excitation on a viscoelastic material [Ref 2]. The form factor should be similar to current technology [Ref 3]. The sensor must also be a higher electro-magnetic field resistance sensor and be robust so that it can survive the operational, physical, environmental, and compatibility challenges encountered in a shipboard submarine environment. The manufacturing and subsequent qualification and production testing should minimize the amount of hands on labor in order to reduce the recurring sensor cost. The Navy needs an innovative sensor solution that can meet all the performance, form factor, and environmental requirements while striving to reduce per channel cost. This requires innovation at the design level to trade off all the performance and environmental requirements against packaging of the sensor as well as to facilitate automation during the production phase. Attention is needed to materials used and their integration into the design to yield a sensor with highly repeatable performance so that the amount of post-production testing and verification can be reduced.

Integrated electronics packages will be considered, but are not desired as the sensors will mount externally to the submarine hull and maintenance and replacement will be difficult and costly. A more complex sensor design (i.e., including electronics) introduces more failure mechanisms that could lead to increased life cycle costs which should be avoided. However, designs which include integrated electronics packages will be considered if they provide increased sensitivity over current technologies in the range of 6dB to 10dB. This technology will include concepts such as investigations into design principles, materials, and construction techniques, as well as create a benchmark “trade space” of innovations against sensor sensitivity, sensor weight and neutral buoyancy, volume, cost, robustness against environmental concerns, and other pertinent parameters of velocity sensors

If this technology is implemented successfully, it will benefit the Navy by providing a lower cost sensor solution that enables affordable array development. Performance improvement and cost are two key benefits the Navy will seek with this technology. The Navy needs improved detection, giving the platform an increased likelihood of mission success while maintaining a less vulnerable state. Sensor improvement will increase situational awareness which will result in improved operations. Reduced costs will lead to acquisition affordability and improved reliability will lead to lower maintenance.

PHASE I: The company will develop concepts for improved velocity sensors that meet the requirements described above. The company will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be feasibly developed into a useful product for the Navy. Feasibility will be established by material testing and analytical modeling. The small business will provide a Phase II development plan that addresses technical risk reduction and provides performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype improved velocity sensor for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for improved velocity sensors. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop improved velocity sensors according to the Phase III development plan for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The oil and mineral exploration and automotive industries will benefit from having adaptable and scalable sensor acquisition systems for industrial floor and/or harsh field environments.

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KEYWORDS: acoustic particle velocity sensor, sensor weight and neutral buoyancy, submarine flank sonar array, improved sensor sensitivity, sensor environmental requirements, viscoelastic material, higher electro-magnetic field resistance sensor

N141-027 TITLE: Submarine Combat Systems Advanced Processor Build (APB) Operations Learning Environment

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PMS401, Submarine Acoustic Systems Program Office.

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 is to develop a learning environment for Submarine Combat Systems that facilitates rapid, dynamic, and timely learning on modernized Advanced Processor Build (software) Operations.

DESCRIPTION: The introduction of Commercial-Off-The-Shelf (COTS) components to Submarine Combat Systems has increased the pace of systems and tactical software upgrades. Navy need dictates that submarine crews require shore-based training on combat systems operations either before or during their platform upgrade. The current training system uses adapted tactical software and tactical system recordings to replicate combat systems independently in a classroom local area network environment. While the use of actual tactical software results in higher fidelity and efficiency in operations, training without a full Combat Systems Trainer can result in limitations which include lack of full functionality, interactivity, scenario control and integration. The trainer, which includes hardware and software at multiple sites, is becoming less relevant to fleet configurations because it is cumbersome, costly, and difficult to synchronize with the Advanced Processor Build/Technical Insertion APB/TI schedule. Additionally, a current requirement calls for combat systems to be integrated (aka federated) to train common displays, much like Rathnam describes in Figure 1.2: Vision for an Ontology-Based Framework to Support Automated Simulation Integration (ref 1).

Innovative technologies are required to ensure enhanced learning of Submarine Combat Systems operations because current technologies cannot emulate the tactical system within the necessary timeline and with required fidelity. Promising approaches may include innovations in technology such as High Definition, 3D, immersive technology, virtual realities, and others. Investigate the advantages of instructional characteristics and motivational features of PC-based games. The company should conceptualize innovative or creative approaches to learning delivery, methods, and environments. The company should research learning delivery techniques described by Nicholson, (ref 2) including portability and configurations for a wide range of training skill levels (journeyman to master), embedded/automated instructional capability, and trainee operation/familiarization prior to training opportunity. Innovative designs should be flexible to minimize the impact of changes and additions to the overall simulation capability. Key features for the proposed learning environments are flexibility, scalability, and rapid modernization consistent with the Advanced Processor Build/Technical Insertion APB/TI process at multiple geographic sites. The learning environment would be scalable to allow for future integration of additional submarine warfare federated tactical subsystems training solutions. A successful learning environment will have a clearly defined path for Participating Managers (PARMs) to integrate their subsystem training solutions and has sufficient portability and.

Upon transition of the Submarine Combat Systems Advanced Processor Build (APB) Operations Learning Environment to the Navy, benefits to the Fleet/Program include: the Modernization Training Teams (MTT) will be able to meet the fleet operator and employment training requirements of the new capabilities provided by the APB process; responsive operations and employment training conducted by MTT will continue to improve fleet readiness; MTT will have improved capabilities to train the crew simultaneously, utilizing common displays; MTT will be able to train basic operations, employment, communications team skills utilizing a Sonar to Combat Control interface; training will not have to be performed onboard the modernized platform displacing other training requirements, impacting system installation and shipboard schedules, and further compressing training time due to dependence on a stable and available system; training will not have to be performed onboard, eliminating high attendance risk as sailors are directed to perform other duties or respond to emergencies during allocated training time; elimination of significant risk that training on a tactical system could be discontinued due to a system casualty. The Submarine Combat Systems Advanced Processor Build Operations Learning Environment will ensure the fleet will be able to employ and maintain tactical submarine combat systems and maintain readiness.

PHASE I: The company will develop concepts for Submarine Combat Systems Advanced Processor Build (APB) Operations Learning Environment that meet the requirements described above. The company will demonstrate the concepts in meeting Navy needs and will establish that the concepts can be feasibly developed into a tactical training simulator/stimulator that supports multiple skill objectives and levels for the Navy. Design confidence and feasibility will be established by material testing and analytical modeling. The company will provide a Phase II development plan with performance goals and key technical milestones, and that addresses technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the company will develop a scaled prototype for evaluation as appropriate. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for the Submarine Combat Systems Advanced Processor Build (APB) Operations Learning Environment. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: If Phase II is successful, the company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop a Submarine Combat Systems Advanced Processor Build (APB) Operations

Learning Environment for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Modeling and simulation of federated combat systems can be used in many commercial maritime environments: for example, enhanced radar, navigation, and ship handling operator training.

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<<https://www.navalengineers.org/ProceedingsDocs/HSIS2011/Papers/Nicholson.pdf>

KEYWORDS: Training simulation; game design; immersive learning technology; perceptual training systems; tactical emulation; virtual learning environment

N141-028 TITLE: SONAR Visual Reconstruction Environment (SVRE)

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO IWS 5.0, Undersea Warfare Systems

OBJECTIVE: Develop an innovative interactive visual reconstruction capability for Navy sonar systems to improve Navy ASW proficiency for both training and operational use.

DESCRIPTION: The Navy seeks an innovative virtualization software tool to enhance Anti-submarine warfare (ASW) proficiency through intuitive visual animations that use actual sonar, ground truth, and environmental data combined with sensor performance modeling to provide understanding of complex environmental and tactical situations.

The Navy has a need to improve both operational proficiency and training of operators within a constrained operational training environment. Current sonar operator training includes classroom training on a sonar user interface driven by recorded sea data and/or sonar simulators. These sonar user interfaces match in function what is aboard ship. However, current training cannot teach advanced concepts and operation in complex environments. Also, the effectiveness of current training has been degraded by compressed training cycles.

New innovative reconstruction software tools that work with the sonar user interfaces and provide an intuitive animated visualization would allow the instructor to reveal complex environmental effects to determine what is displayed on the sonar user interface. These tools would allow the instructor to decompose the environment by selecting individual SONAR settings, ship operations, and environmental decisions for visualization. The tools would need to be able to effectively communicate complex acoustic propagation phenomena such as multi-path, bottom bounce, reverberation, convergence zones, and mutual interference. Of particular interest is the potential to use technology related to virtual 3D simulations to help SONAR operators better understand how to improve tactical system employment. The use of such tools to create an active learning environment is anticipated to increase student engagement, comprehension, and retention, as has been explored by Bonwell and Falvo (Ref 1, 2). The unique ability of electronic media and virtual environments to enable such active learning has been discussed by Barjis et al., Franzoni and Assar (Ref 3, 4). The training tool would reside within fielded surface ship sonar systems, such as the AN/SQQ-89 A(V)15, The reconstruction tool could also be used during at-sea operations to enhance situational awareness and operational proficiency.

Key features would include: the ability to conduct “what if” analysis that cannot be achieved with recorded sea data; the ability to manipulate sonar settings to maximize acoustic sensor capabilities based on acoustic propagation and the other sonar equation elements; the ability to manipulate the entire sensor suite to reinforce the impact of operator action; and the ability to conduct interactive instructional playback of operational data or training scenarios. The reconstruction capability will enable research into how sailor learning and proficiency can be enhanced. It would be desirable to focus on task-based (vice data-based) target detection and localization displays, along with imaging system enhancements to support automated visual detection, tracking, classification, and ranging. These features should provide the operator with automated information, including threat and trend data.

The desired capability will replay either synthetic data or real world data collected during operational exercises. It will illustrate sonar signal origins, resulting sonar display features, and operational impacts. The software tool should concentrate on methods proven to effectively train adults (andragogy). System design should consider adaptive training models that allow the tool to match teaching strategies to individual student learning styles (cf. Felder & Silverman) and quantify the benefit of this optimization. Due to rapid evolution of hardware technology, the software tool should be hardware agnostic to allow for transportability as system architectures evolve.

The reconstruction visualization tool will cover the required Knowledge, Skills and Abilities (KSA) objectives required of the Sonar operator and evaluator. It is anticipated that this technology will significantly improve teaching efficiency and retention of perishable skills, yielding a 30% improvement in 6 month skill retention levels and 25% reduction in training time.

PHASE I: The company will develop a concept for an interactive visual reconstruction capability that can be applied to the problem above. The company will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be feasibly developed into a useful product for the Navy. Feasibility will be established by testing and analytical modeling. The small business will provide a Phase II development plan and addresses technical risk reduction providing performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for an interactive visual reconstruction capability. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The Company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop an interactive visual reconstruction capability according to the Phase III development plan for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Innovative reconstruction and teaching tool with automated animated visualization creation would provide training improvements in any complex ocean environment that includes sonar/acoustic sensors used on commercial platforms like remotely operated vehicles (ROV) and unmanned vehicles (UV), including surface vehicles and underwater gliders. Automated animated visualization will provide benefit to any dynamic commercial application requiring operators to adapt and conform to changing environments such as firefighting, meteorology, law enforcement, pilots, academia, etc.

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1. Bonwell, Charles C. Ph.D.,“Active Learning: Creating Excitement in the Classroom”, ERIC Clearinghouse on Higher Education Washington DC, 1991

2. Falvo, David A., Delaware State University, “Animations and Simulations for Teaching and Learning Molecular Chemistry”, International Journal of Technology in Teaching and Learning, 2008

3. Barjis, Joseph, et alii, “Innovative Teaching Using Simulation and Virtual Environments”, Interdisciplinary Journal of Information, Knowledge, and Management, Volume 7, 2012

4. Franzoni, A. L., & Assar, S.,“Student Learning Styles Adaptation Method Based on Teaching Strategies and Electronic Media”, Educational Technology & Society, 2009

KEYWORDS: Sonar Operator; Sonar Reconstruction Tool; Andragogy; Geospatial Information Systems (GIS); diverse littoral environments; Anti-Submarine Warfare (ASW)

N141-029 TITLE: Advanced Submarine Monitoring with Improved Diagnostics and Prognostics

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: VIRGINIA Class Program Office. This effort also has applicability to benef

OBJECTIVE: The objective is to develop an innovative on-node functionality for wireless sensor systems that enables high bandwidth transient capture and analysis within the constraints of energy harvester-powered wireless sensors.

DESCRIPTION: The Navy has an ongoing need to reduce total ownership costs and extend the life-cycle of components and systems to improve the reliability and overall operational readiness of the fleet. A cost effective method for ensuring component reliability is to augment the fixed schedule maintenance approach with deterministic component health and usage data to inform selective and targeted maintenance activities. The earliest indicators of machine failure occur at high frequencies and through impacts and transients. Pumps and bearings require high frequency data acquisition and transient event capture to predict the failure modes and capture operational events such as cavitation. This opportunity is enabled through Micro Electro Mechanical Sensors (MEMS), wireless communication, and energy harvesting, which are providing cost effective, scalable, reliable, and accurate solutions for acquiring data to determine health and usage status.

These types of monitoring systems provide essential data and secondary benefits that include information for improving component design and tailoring of maintenance work tasks. For most sensor applications, including those on submarines, wireless technology is the key enabler of monitoring applications because it reduces sensor installation cost, reduces maintenance associated with wiring faults, and enables system flexibility to add or remove sensors. The capability to measure and analyze transient events such as pump cavitation and bearing fault impacts is a key to extend the applicability to more applications (ref 1). A range of sensor hardware, energy harvesting, and algorithm technology has been developed to make this a reality (ref 2, 3). However, a technology gap exists for accurately capturing, analyzing, and wirelessly transmitting information from transient events (ref 4). Many prognostic and condition based maintenance capabilities would be improved by a sensor node with the ability to capture and analyze transient events. An innovative solution is needed to develop this capability in submarine environments.

Wireless sensor systems can provide distributed intelligence collection for performance evaluation, prognostic maintenance efforts, and situational awareness. Technology exists for efficient low bandwidth wireless data collection. However, the power requirements for constant monitoring with standard technology preclude transient event capture and analysis. Wireless solutions for applications that require transient event capture become expensive to accommodate large energy storage, or are overly limited due to inadequate energy storage. New techniques are needed at the node level to minimize power usage for high frequency transient event measurement, analysis, and transmission.

Responsive proposals will address the unique challenges of implementing challenging wireless sensor solutions in submarine environments, including limitations on acceptable battery chemistries, dense machinery environments for wireless communications, limited application knowledge, and high required operational availability. A successful technology development and transition will result in fewer machinery overhauls, shorter work task times, and optimized maintenance logistics. These workload reductions will result in cost savings through shorter depot times, increase overall fleet availability, and reduced total operational costs.

PHASE I: The company will develop a wireless node concept that enables high bandwidth transient capture and analysis within the constraints of energy harvester-powered wireless sensors. The company will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be developed into a useful product for the Navy. Feasibility will be established by material testing and analytical modeling. The company will prepare a development plan for Phase II, which will address technical risk reduction, as well as performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for the wireless sensor. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop the wireless sensor node according to the Phase III development plan for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology developed under this topic could be used in a wide range of applications throughout industry to enable a breakthrough in wireless monitoring and actuation and control capability.

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KEYWORDS: Pump cavitation monitoring; wireless sensor nodes; transient event capture; energy harvesting; prognostic maintenance; health and usage monitoring

N141-030 TITLE: Sense and Respond Technology Enabling Condition Based Maintenance (CBM)

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: PMS 501, Littoral Combat Ship Program Office

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: Develop an innovative Sense and Respond maintenance system for the LCS platform

DESCRIPTION: The Littoral Combat Ship (LCS) was designed to operate with a significantly smaller crew size than would be expected from a traditional manning concept (Ref 1). Commercial off the Shelf (COTS) and Open Architecture (OA) were maximized to reduce developmental timelines as part of the acquisition strategy. COTS proliferation, which includes significant capabilities of advanced sensors, could be maintained more effectively and efficiently through Condition Based Maintenance (CBM) and Distance Support (DS). Effective utilization of CBM has been identified as a class-wide requirement for LCS (Ref 2). Two primarily COTS-based systems that are critical to the warfighting capabilities of LCS are the Mission Package Computing Environment (MPCE) and the Total Ship Computing Environment (TSCE). Both of these systems do not have CBM capability and successful execution of this topic would deliver the necessary CBM capability to both LCS variants using one common solution. These systems also form the backbone of the shipboard Combat System (CS) for LCS since they house the servers the CS runs on as well as provide the network to transfer information between combat systems elements. Bringing CBM capability to these systems will deliver system health data in an actionable format to shore-based Subject Matter Experts (SMEs) to be used to predictively identify maintenance actions and remotely provide technical support. The current State of the Art (SOA) for MPCE and TSCE allows for the collection of performance indicators for a variety of computer components. However, no system currently exists that bridges the gap between the warfighter and the SME. The current SOA is not limited by policy, only by the fact that no system has been developed to provide this needed capability. Successful execution of this topic would allow for the collection, processing and transmission of those performance indicators to SMEs. In specific, current troubleshooting sessions are conducted using voice, email, and Secure Internet Protocol Router Network (SIPRNet) chat. While this approach in many cases provides a quick fix to the issue at hand, it places an unnecessary burden on the Fleet sailor to deal with the back and forth nature inherent in e-mail troubleshooting or the burden of having to schedule and execute a chat session. The desired solution would in many cases eliminate the need for the sailor to send data to shore-based SMEs and allow the SME to determine system faults and design solutions without burdening the sailor. In essence this topic describes the creation of a sense and respond system that is able to process data from the CS shipboard computing environment and provide it to SMEs who can use that data to improve the health of the network much like many systems in natural world perform the same functions (Ref 3).

One technology that could be useful to mitigate these limitations is the built-in Fault Detection and Fault Isolation (FDFI) capability employed on LCS ships in the Mission Package Computing Environment (MPCE) and the Total Ship Computing Environment (TSCE). Specifically, the SMARTS system installed on LCS 1 variant ships and the Solarwinds system installed on LCS 2 variant ships and available to both variants through the common Mission Package Computing Environment (MPCE) provide this type of FDFI capability. Both of these systems were chosen by the respective design agents of each system and are used in the computer networking industry. Specifically, these two systems are used in the commercial sector to monitor the availability and performance of the networks, storage environments, and servers through the use of specialized software. Today the information contained in SMARTS and Solarwinds is not used to improve the uptime of the computer systems they are running on or to help in quickly troubleshooting system faults. Successful execution of this topic would include building a common sense and respond system that would work on either the LCS 1 or 2 variants using data from SMARTS and Solarwinds respectively. SMARTS and Solarwinds cannot be used in their current state because no system exists to mine, analyze, reduce and communicate the critical information off ship to SMEs. To successfully address this gap it is necessary for the small business to design and build a common sense and respond system for both variants of LCS.

Current practices today for combat systems computing elements are characterized by systems failing without any warning leading to increased logistics costs, greater need for support personnel and, most significantly, reduced readiness. A good example of the potential advantages of this future sense and respond technology can be seen in the reasonably common failure of a network hard drive. Currently, the shipboard operator is provided no warning of an impending drive failure and is often presented with generic messages that the system is non-operational. This leads to a having to submit an Automated Work Notification (AWN) ticket to troubleshoot the problem, conducting one or more troubleshooting sessions, ordering a replacement part and then installing the part. With a successfully installed sense and respond system the shore-based SME would automatically be sent status of the hard drive, knowing in advance that it may be getting too fragmented and in need of defragmenting. The SME could then send a procedure to the crew to run the defragmentation routine or run it by him or herself remotely thereby restoring performance to the drive and potentially avoiding a complete drive failure. The only potential limitation to the future sense and respond system is current Information Assurance (IA) requirements in the Navy. These requirements place limitations on the electronic exchange of information to minimize the likelihood that computer systems are compromised. These are limitations that can be overcome through good system design and working with IA professionals early in the design process by the small business. The Navy intends to provide assistance to the small business to successfully address IA requirements for this topic.

Successful execution of this project will generate significant cost savings to maintain and operate a variety of systems on LCS platforms. These systems include the TSCE, MPCE and combat system computing hardware. To date, no one system or technology exists that performs this function in a way that will maximize the Navy's current investment and address the Human Systems Integration (HSI) requirements in order to enable wide spread adoption using a common architecture across the LCS program. The technology gap that must be closed through Research & Development (R&D) is to aggregate, analyze, reduce, transmit, and display shipboard data from the TSCE, MPCE and combat system computing hardware in a way that allows the shore-based SME to make better decisions, effect repair more rapidly, and reduce the impact on ship's force.

The goal is to develop a system to get CS CBM data into the hands of SMEs in an easily actionable format. The TSCE, MPCE and combat systems computing hardware are already sensorized but no system exists that addresses the unique requirements of both variants. One of the first requirements of this system would be to develop a methodology to aggregate, analyze and reduce this data. The data would then need to be transferred off ship to the SME. One system that exists to transfer data off ship that could potentially be used for this topic is the Navy Information Application Product Suite (NIAPS) system. However, the successful small business would have to consider in their design whether or not NIAPS would provide the needed functionality and may have to provide an alternate solution. The final product would be a complete sense and respond system that works on both LCS 1 and 2 variants that takes advantage of the currently-installed technology and allows shore-based SMEs to prevent system faults and significantly improve the availability of Combat Systems computing resources on-board LCS.

PHASE I: The small business will develop a concept and feasibility study for a sense and respond system that takes advantage of currently available sensors and distance support technology and meets the goals in the description above. The small business will provide a Phase II development plan that addresses technical risk reduction and provides performance goals and key technical milestones.

PHASE II: Based on the results of Phase I, the small business will generate system architecture diagrams that provide both a high level and detailed system design. Detailed designs will include all components to be used in the proposed system and mock-ups of all user interfaces. They will then develop a prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The small business will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The small business will be expected to support the Navy in transitioning the technology for Navy use. The small business will develop a sense and respond technology systems according to the Phase III development plan for evaluation to determine its effectiveness in an operationally relevant environment. The small business will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The potential for significant commercial application and dual use exists for this technology. The system designed here could be put to use in many industries that rely upon equipment sensorization and analysis by remote support personnel.

REFERENCES:
1. Commander, U.S. Fleet Forces Command. (2013, January). Littoral Combat Ship Platform Wholeness Concept of Operations (Revision D). San Diego, CA: Author.

2. Rowden, Tom. "Littoral Combat Ship: All Head Full!." Proceedings Magazine. January 2013.: Vol. 139/1/1, 319.

3. Chandy, K. Mani. "The Impact of Sense and Respond Systems." IEEE Internet Computing. 2010: 14 (1). pp. 14-16.

KEYWORDS: Sensorization; remote troubleshooting; distance support; remote fault detection and fault isolation; electronics prognostics; sense and respond systems

N141-031 TITLE: Innovative Power Control System Software Utilizing Smart-grid / Micro-grid Technology for Naval Applications

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS 320, The Electric Ships Office.

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OBJECTIVE: This topic seeks innovative power management approaches for a shipboard power grid to effectively manage power for advanced high power loads.

DESCRIPTION: Future ships are expected to have considerably increased power demands compared to ships of similar size constructed today. In addition, high energy weapons such as lasers and high energy sensors may be installed onto existing legacy power systems. Currently, naval power systems provide little or no coordinated communications beyond generator synchronization and hard-coded load shedding functions. These functions are dispersed in independent controllers with very little coordinated communications or interface definition to enable the optimized deployment and use of electric power capability, and are specific to each ship class. An advanced Platform Management System (PMS), Machinery Control System (MCS), or other tool that works within the existing control system infrastructure is needed to integrate large power sources and loads within the existing power system architectures or as part of a future architecture, to ensure safe and efficient operation of the power system. A new infrastructure and framework using Open System Architecture (OSA) is needed to provide new applications on existing and future control systems and electrical power systems. (Ref. #1)To support directed energy loads with limited generation resources, the power system will have to act as an Energy Magazine, incorporating power conversion and energy storage to meet ship and high power load requirements.

The Navy seeks to leverage recent advances in intelligent power and energy management technologies driven by Smart Grid and micro grid concepts to enable power systems that are more autonomous and reconfigurable. The Global Smart Grid Federation defines a Smart Grid as, “… an electricity network that can intelligently integrate the actions of all users connected to it – generators, consumers and those that do both – in order to efficiently deliver sustainable, economic and secure electricity supplies.” (Ref #2) Smart grids support distributed generation, supply and demand balancing, intermittent renewable generation, bi-directional power flows and real time information flow. This mimics closely what needs to occur with Naval power systems. While Naval ships are not implementing renewable generation, many shipboard loads exhibit a similar stochastic behavior. The Navy is moving towards more electric ships to meet both existing and emerging threats in a more affordable manner. By employing Smart and micro grid concepts, existing Navy power management functions can be modernized to enable the use of distributed localized control of generation, storage, and load assets to coordinate and optimize the use of the ship’s electric power capacity and provide increased intelligence and operation to the MCS.

This topic seeks to explore innovative electrical system hardware architectures and power management algorithms that will autonomously determine and actuate existing and future electric power systems. The software needs to address security requirements and must be capable of responding to changing mission priorities. Future platforms may feature multiple high energy loads on the same order of magnitude as the generators. The ability to quickly channel power from one load to another, or from distributed energy resources such as Energy Storage Modules (ESM), in order to maintain bus stability and support the ships real time mission power and energy demands is desired. (Ref. #3) Proposed solutions must be cost effective and enable energy efficient operation, support system and device prognostics, real time situational awareness, and compatibility with open architecture standards.

PHASE I: The company will develop a concept for an Advanced Machinery Control System Software Utilizing Smart-grid / Micro-grid Technology for Naval Applications that meet the requirements described above. The company will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be feasibly developed into a useful product for the Navy. Feasibility will be established by material testing and analytical modeling. The small business will provide a Phase II development plan that addresses technical risk reduction and provides performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for the Advanced Machinery Control System Software Utilizing Smart-grid / Micro-grid Technology. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. Assess integration and risk and develop a Software Development Plan (SDP). The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop an Advanced Machinery Control System Software Utilizing Smart-grid / Micro-grid Technology according to the Phase III development plan for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology would be applicable to any terrestrial smart and micro-grid applications. Intelligent power and energy management technologies driven by Smart Grid and micro grid concepts will enable commercial power systems to be more autonomous and reconfigurable.

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1. Mochulski, John and Malina, Rich. "Naval Open Architecture Machinery Control Systems for Next Generation Integrated Power Systems" EMTS 2012, May 23-24, Philadelphia PA. <https://www.navalengineers.org/ProceedingsDocs/EMTS2012/Papers/24_Mochulski_EMTS2012Paper.pdf> Retrieved February 9, 2013

2. The Global Smart Grid Federation, "Smart Grid Report 2012," <http://www.globalsmartgridfederation.org/documents/May31GSGF_report_digital_single.pdf > Retrieved February 25, 2013

3. Doerry, Norbert and Amy Jr., John. "Implementing Quality of Service in Shipboard Power System Design," Presented at IEEE ESTS 2011, April 11-13, 2011, Alexandria, VA. Presentation <http://doerry.org/norbert/papers/20110325QualityOfService-final.pdf>
Retrieved February 9, 2013

KEYWORDS: Smart Grid; Microgrid; Machinery Controls; Power System; Power Management; Electrical Architecture, Marine electrical control systems, Industrial Power management

N141-032 TITLE: Simulation of Mechanical System Kinematic Operation Subsequent to High Intensity Loading.

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS 397, OHIO Replacement Program Office.

OBJECTIVE: Develop an innovative solution to simulate kinematic operation of a mechanical system subsequent to high intensity loading.

DESCRIPTION: The Navy's shock hardening program is a critical element of the commitment to ensuring crew safety and mission capabilities of its war fighting vessels to extreme loadings. To certify complex mechanical systems meet Navy shock hardening requirements, the current practice is to install the system in a test vehicle, detonate an explosive charge near the vehicle, and subsequently demonstrate the system operates properly (ref 1). Tests of large, complex systems can be prohibitively costly, sometimes greater than $10M. Systems too large to be tested on Navy standard test vehicles can be certified using either the Dynamic Design Analysis Method (DDAM) or transient shock analysis. These methods typically evaluate structural integrity of the system; however, they infer, rather than demonstrate, operational capabilities.

A method, which moves away from shock tests of mission critical systems, is required to meet both the Navy's shock hardening requirements and ship design for affordability goals. There is no proven method that allows for the certification of shock worthiness of complex mechanical systems other than a shock test. An innovative approach which applies kinematic modeling to simulate the operation of complex mechanical components, such as submarine hatches, will allow shock certification of these complex components via test simulation.

Kinematic modeling involves simulating contact and friction between surfaces, large deformations, and non-linear material behavior. Several approaches exist to treat these phenomena (ref 2). Solution convergence when simulating contact between surfaces can be problematic (ref 3).

The expected product is software capable of accurately simulating kinematic operation of complex mechanical systems.

PHASE I: The small business will develop a concept process for successful application of kinematic simulation to complex mechanical systems. The small business will demonstrate feasibility of meeting Navy needs and will establish that the process can be feasibly developed into a useful product for the Navy. Feasibility will be established by accurately simulating simple contact and sliding friction problems. The small business will provide a Phase II development plan with performance goals and key technical milestones, and that addresses technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop prototype software for evaluation. The small business will perform the laboratory tests outlined in phase II development plan. The company will simulate the laboratory tests and compare the results to the data. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The small business will be expected to support the Navy in transitioning the technology for Navy use. The small business will develop the software according to the Phase III development plan for evaluation to determine its validity against a set of existing data for kinematic operation of a mechanical system subsequent to intense loading. The company will support the Navy for test and validation to certify and qualify the software for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: An analytical method for demonstrating operability of a complex component subjected to high intensity loadings has potential commercial applications where high intensity loading are of concern, such as the automobile and aircraft industries.

REFERENCES:
1. Scavuzzo, Rudolph and H. Pusey, Naval Shock Analysis and Design. Arvonia, VA: SAVIAC/HI-TEST Laboratories, Inc. 2009.

2. Belytschko, Ted, et. al., Nonlinear Finite Elements for Continua and Structures, Chichester: John Wiley & Sons Ltd, 2000.

3. Bathe, Klaus-Jürgen, Finite Element Procedures, Upper Saddle River: Prentice Hall, 1996.

KEYWORDS: Kinematic contact modeling; modeling sliding surfaces; modeling sliding friction; Hertzian contact stresses; large displacement modeling; underwater explosions

N141-033 TITLE: Application of Phase Noise Discrimination to Electronic Warfare (EW)

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO IWS 2.0, Above Water Sensors

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OBJECTIVE: Research and develop methods to detect and quantify the phase noise and phase noise statistical parameters that correlate to threat types and platforms.

DESCRIPTION: Phase noise is the change in the relative electrical phase of a radio frequency (RF) signal caused by other than intended modulations. Phase noise is generated not only by idiosyncrasies of the transmitter, but by the superposition of reflections from side and back lobes of the threat platform [Ref 1]. The statistical distribution of amplitude and phase from these scattering centers correlates with the physical extent and material composition of the radiating platform. The effect is relatively small and difficult to measure.

Newer imaging radars can provide target details to support non-cooperative target classification and identification. The objective of this topic is to provide a like capability, but by passive means. This would be especially useful under conditions when the active sensors are not available such as EMCON or when a resource limitation due to jamming or a dense environment has been reached. Recent advances in receiver and signal processing technology have made it feasible to consider using phase noise in an operational environment. The Navy needs to determine the applicability of discrimination of phase noise from target radar and jammer intercepts as a means of passive non-cooperative target recognition, classification and identification.

Current passive Electronic Support Measures (ESM) rely on matching the modulation characteristics of an emitter, such as the radar's Pulse Repetition Interval (PRI), Frequency, and Pulse width to a previously determined set of parameters.

The major limitations of this approach are:
1) The parameter sets, in many cases, are not complete or unique, which causes ambiguous identifications;
2) Error free measurements are difficult to achieve under operational conditions;
3) These parameters can be changed to spoof the detection system.

Therefore, a need exists to add additional independent discriminants [Ref 2, 3] so as to provide a more robust identification process. Since phase noise is a higher order effect, usually measured with advanced analysis receivers, an innovative approach that is practically implementable in an operational system will be required. It is proposed that this development be performed with the aim of adding this signal processing capability to future EW systems, particularly Surface Electronic Warfare Improvement Program (SEWIP) Block 2/3.

PHASE I: The company will determine the applicability and feasibility of implementing phase noise target discrimination algorithms into SEWIP Block 2/3 EW systems. The basic approach should include the development of phase noise models for various types of platforms/emitters in order to determine detectability and degree of correlation of the phase noise parameters and statistics with the platform and emitter types. The small business will provide a Phase II development plan that addresses technical risk reduction and provide performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop an implementation of their processes in a hardware baseboard system suitable for field/range testing. Evaluation results will be used to refine their product into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The company will be expected to support the Navy in transitioning the technology for Navy use. This will include working with SEWIP Block 2/3 industry teams to implement the algorithms in fielded and future systems. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology developed here may have applicability to commercial radar applications such as air traffic control, ground surveillance radar, weather radars, and Navy and Coast Guard systems. Furthermore, any system, passive or active, that can benefit from more precise and detailed analysis of detected signals, will enhance its performance and capabilities by using this technology.

REFERENCES:

1. Juan Diego Morales, David Blanco, Diego Pablo Ruiz, and María Carmen Carrión, "Non Cooperative Radar Target Identification Using Exponential Single-Mode Extraction Pulse"; IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION, VOL. 59, NO. 6, JUNE 2011

2. Marvin S. Cohen and Martin A. Tolcott, A COGNITIVE BASIS FOR AUTOMATED TARGET RECOGNITION INTERFACE, FINAL TECHNICAL REPORT, 15 December 1992

3. Kastella, Keith, "A Nonlinear Filter for Real-Time Joint Tracking and Recognition" Lockheed-Martin Tactical Defense Systems, Eagan December 31, 1997

KEYWORDS: Signal processing; Non-Cooperative Target Recognition; Electronic Support Measures; Electronic Warfare Systems; Phase Noise; Surface Electronic Warfare Improvement

N141-034 TITLE: Monolithic Microwave Integrated Circuit (MMIC) Compatible Phase Shifters for Phased-Array Radars

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO IWS 2.0, Above Water Sensors

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OBJECTIVE: Develop Monolithic Microwave Integrated Circuit (MMIC) compatible phase shifters for phased array radar applications to lower system cost while maintaining radar performance.

DESCRIPTION: Modern active electronically scanned phased array radars provide outstanding capability and performance, but they are very expensive because of the need for Radio Frequency (RF) power amplifiers at each antenna element (RF amplifiers are a primary cost driver in modern radar). The Navy is pursuing a sub-array architecture which mitigates this restriction by splitting the power from a single, highly efficient, solid-state power amplifier to multiple antenna elements, thereby reducing cost.

Sub-array architecture opens completely new possibilities in radar design trade space which will result in flexible, scalable designs with increased efficiency and decreased parts-count. Savings in initial acquisition cost, maintenance cost, and operational cost (decreased power consumption through scalability and efficiency) are therefore realized without compromising radar performance. However, sharing amplifiers among multiple antenna elements requires a phase shifter for each. This imposes power handling challenges and places significant insertion loss requirements on the phase shifter. Successful demonstration of new phase shifter technology, consistent with the performance goals given herein, is therefore a key step toward affordable future radar.

MMIC compatible switches in various physical implementations have been offered as a critical control component for use in phased array radars employing digital phase shifters. MMIC compatible phase shifters bring the potential of low insertion loss per bit and ultra-linear performance, while requiring very low operating power. The Navy needs device innovations that build on proven design principles. The goal is to develop reliable MMIC-compatible phase shifters exhibiting increased power handling, low insertion loss, highly accurate insertion phase, minimal activation power, and extremely fast switching times. The Navy is seeking to develop MMIC-compatible phase shifters meeting military system reliability requirements that will support a 4-channel phase shifter network composed of a single RF input divided into 4 independent phase-shifted output channels. The phase shifters will be capable of output power levels of greater than 5W peak/channel, greater than 2W average/channel, switching delay of less than 1msec, phase resolution greater than 3 bits (4-bits would be desirable), and less than 1 dB total insertion loss between the input and the output of each phase shifter channel. Innovative approaches which can significantly exceed one or more of these goals are highly desirable. The proposed phase shifters should target S, C and X Band solid state radar applications.

RF micro-electromechanical systems (MEMS) based phase shifters have been developed (ref. 1, 2, 3, 4). They are a valid approach, providing the RF-MEMS phase shifters can show significant improvement over the current state-of-the-art. In a MEMS approach, reliability is a key consideration that needs to be addressed. Innovations in material, process, and design are needed, which can lead to increased reliability and performance.

This technology will provide an enabling component that provides completely new possibilities in radar front-end architecture resulting in affordable, flexible, and scalable designs with increased efficiency and decreased parts-count. The developed technologies will lead to high performance radar systems at acceptable life cycle cost.

PHASE I: The company will develop a concept for an innovative MMIC compatible phase shifter that meets the requirements detailed in the description section above. The company will demonstrate the feasibility of their technology concept in meeting Navy needs and will establish that the concept can be feasibly developed into a useful product for the Navy. Feasibility will be established by testing, analysis and/or modeling and simulation. The small business will provide a Phase II development plan and that addresses technical risk reduction and provide performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype MMIC compatible phase shifter for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II development plan and the Navy requirements for the MMIC compatible phase shifter. The MMIC compatible phase shifter performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous phase-shift cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The company will be expected to support the Navy in transitioning their technology for Navy use. The company will develop a MMIC compatible phase shifter according to the Phase III development plan for evaluation to determine its effectiveness in an operationally relevant Navy radar environment. The company will support the Navy in test and validation to certify and qualify their technology for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology also applies to various other radar applications such as Federal Aviation Administration (FAA) radars, law enforcement radar, Coast Guard radars, and commercial ship radars. The technology might also be applied to microwave and millimeter wave imaging systems.

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1. Yuan, X., Peng, Z., Hwang, J. C. M., Forehand, D., and Goldsmith, C., "Acceleration of Dielectric Charging in RF MEMS Capacitive Switches," IEEE Transactions on Device and Materials Reliability, Vol. 6, No. 4, 2006. <http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=4019424&url=http%3A%2F%2Fieeexplore.ieee.org%2Fiel5%2F7298%2F4019406%2F04019424.pdf%3Farnumber%3D4019424>

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3. Mansour, R., "RF MEMS-CMOS Device Integration", IEEE Microwave Magazine, January/February 2013.< http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6421094>

4. Blondy, P., Peroulis, D., "Handling RF Power", IEEE Microwave Magazine, January/February 2013.< http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6421083>

KEYWORDS: Radio Frequency micro-electromechanical systems (RF-MEMS), phased array radars, digital phase shifters, phase shifter for phased array radars, insertion loss in phased array radars, Monolithic Microwave Integrated Circuit (MMIC) Compatible

N141-035 TITLE: JTRS Compliant Waveform for LCS Unmanned Vehicle Communications

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMS420, LCS Mission Packages.

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OBJECTIVE: The objective is to develop an innovative Joint Tactical Radio System (JTRS) compliant technology that achieves LCS unmanned vehicle communication requirements.

DESCRIPTION: The Littoral Combat Ship (LCS) deploys multiple Unmanned Vehicles in support of the interchangeable Mission Packages. The Multiple Vehicle Communications System (MVCS) provides LCS Mission Packages with the capability to simultaneously communicate with multiple Unmanned Surface Vehicles (USVs) and surfaced Unmanned Underwater Vehicles (UUVs) by providing common data link and network communication services [REF 1].

The MVCS is designed as an open architecture communications system that can be adapted to support any radio. The MVCS currently uses the RT-1944/U radio for Line Of Sight (LOS) communications with USV's. The LCS Capability Development Document (CDD) has a requirement that future spirals of the external communications equipment will be JTRS compliant. The LCS CDD also has a requirement that the mission packages must operate in a jamming environment. The RT-1944/U radio does not meet these two important requirements. There is currently not a JTRS compliant waveform that meets the MVCS data rate and anti- jamming requirements.

The threshold data rate requirement is 3.0 Mbps from each Unmanned Vehicle to the LCS seaframe and 0.2 Mbps from the LCS seaframe to each Unmanned Vehicle. The threshold number of unmanned vehicles is 3. The threshold LOS range is 10 nm with antenna heights of 90 feet on the LCS sea frame and 14 feet on the USV. The operating frequency band is 2.2 GHz to 2.4 GHz. The threshold anti-jamming requirement is that the LCS sea frame and unmanned vehicles communicate in a 30 dB Jammer/ Signal (J/S) power density environment, as measured at the antenna plane of reference, and with the jamming signal being a CW tone, swept CW tone, narrowband noise, wideband noise, clone signal, and pulsed jamming located at any point in the operating bandwidth. Various radio jamming types such as CW tone, swept CW tone, Noise, clone signal, and pulsed can break the communications link to the unmanned vehicle's by causing packet loss or preventing the receiver from being able to acquire or process any signals. To counter these types of threats, an anti-jamming waveform and fast frequency hopping can be implemented.

The current state of art employs these techniques on narrower band waveforms but not on waveforms capable of meeting the MVCS LOS data rate requirement. An innovative anti-jam waveform is needed to meet the MVCS requirements.

The waveform shall comply with the JTRS Software Communications Architecture (SCA) Specification Version 4.0, which implements waveforms, protocols, encryption, communications processes, and hardware around an open standards architecture [REF 2]. This core SCA will reduce technology refresh insertion time and lower Total Ownership Costs while allowing multiple packaging and channel configurations to match evolving warfighter requirements. Once the JTRS compliant waveform is developed, it will be tested and evaluated by the JTRS Test & Evaluation Laboratory [REF 3] and made available through the Joint Tactical Networking Center for use on any JTRS compliant radio as an affordable solution for others with requirements similar to LCS. A waveform portability assessment will be performed to ensure that the delivered waveform exhibits the maximum portability achievable with other JTRS compliant radios [REF 4].

The Phase I and II efforts will not require access to classified information. If need be, data of the same level of complexity as secured data will be provided to support Phase I and II work. The Phase III effort will likely require secure access, and NAVSEA will support the contractor for personnel and facility certification for secure access.

PHASE I: The selected company will develop a concept for a JTRS compliant waveform realized on a JTRS compliant radio that meets the requirements described above. The company will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be feasibly developed into a useful product for the Navy. Feasibility will be established by material testing and analytical modeling. The small business will provide a Phase II development plan that addresses technical risk reduction and provides performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype JTRS compliant waveform realized on a JTRS compliant radio according to the Phase II development plan for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for a JTRS compliant LOS waveform and radio. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The selected company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop a JTRS compliant waveform realized on a JTRS compliant radio according to the Phase III development plan for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The private sector has a need for highly reliable wireless networks. Anti-jamming technology for wide bandwidth wireless networks has applications in police, civil defense, search and rescue, and industrial use wherever critical communications can be intentionally or inadvertently interfered with. One of the biggest risks in using wireless networks in the commercial arena is that everybody shares the same spectrum. The state of Georgia estimates that the Port of Savannah adds approximately $400,000 of economic value for every hour it operates. The threat of interference with wireless networks shutting down the port, whether intentional or unintentional, poses a very costly risk to critical national infrastructure. In applications such as this, the additional cost incurred by adding an anti-jam waveform can be easily justified. JTRS requires the waveform be implemented in software so that it can operate on any JTRS compliant software defined radio. Therefore, the waveform could be widely used in both military and commercial applications.

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KEYWORDS: Joint Tactical Radio System (JTRS); Joint Tactical Networking Center (JTNC); Anti-Jam Waveform; Wide Band Networking Anti-Jam Waveform; Software Definable Radio (SDR); Software Communications Architecture (SCA)

N141-036 TITLE: Surface Composite Tracker Component

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO IWS 1.0, Integrated Combat Systems, AEGIS

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: Develop a composite tracker component for AEGIS Weapon System that combines multiple sensor sources to optimize surface vehicular track accuracy.

DESCRIPTION: US Navy Ships have sophisticated command and control systems that manage data from multiple sensors to generate and maintain the tactical picture. The command and control system manages track-to-track association; track correlation functions and maintains a system track file that defines the surface tactical picture. Surface tracks in the maritime littoral environment are often difficult to associate and/or correlate because the sensor data may often be incomplete, non-contiguous, intermittent, or degraded (see reference 1). The uncertainties and clutter in this environment make it challenging to present an accurate surface tactical picture to warships at sea. Effective track correlation, track-to-track association, and resolution of track ambiguity require that the system managing these functions adapt to the characteristics of the environment and the kinematics of the objects of interest.

The AEGIS Weapon System (AWS) was originally developed with an anti-air warfare (AAW) focus and not adaptable to differing requirements for other warfare areas such as Surface Warfare. The Navy uses the AWS, which is the core of the AEGIS Combat System, to facilitate operations in warfare mission areas. The Command and Decision element within the AWS manages track correlation, track-to-track association, and maintenance of the system track file for the entire combat system.. Due to the existing uncertainties of the littoral regions significant track association and correlation anomalies, and/or track ambiguities which are inherent with multiple closely spaced contacts occur (see reference 2). These limitations caused by the challenges unique to the littoral regions create a need for improving situational awareness. The Navy is seeking to improve situational awareness in the littoral regions with a surface composite tracker capability that will be integrated into the AWS.

Commercially available systems are hardware boxes designed for contact-to-composite track association, track-to-track correlation, and resolution of track-to-track ambiguity (see reference 3). The Navy has an existing commercial off the shelf hardware and computing plan infrastructure in place and does not desire additional hardware based solutions that would require integrated logistics support and plans for technology refresh. This causes the Navy to have to plan upgrades to the hardware, establish and update logistics support, and provide a timeline for integration beyond the current infrastructure plan. These make the hardware trackers unviable for Navy use due to the integration impact on current and planned Navy baselines. It also increases the cost of acquisition and maintenance continually over time.

The Navy seeks a surface tracker software component for implementation within the current AEGIS hardware infrastructure. The innovative software component will be capable of subscribing to any sensor as a service on the AEGIS local area network. The delivered component will be capable of subscribing to a wide variety of kinematic sensor input forms and will include raw contact data (statistically independent) as well as reports of track state (correlated in time). The surface tracker can expect data in the form of contact and track data from surface radars, electro-optical and non-organic sensor sources that are subject to environmental uncertainties, and provide clutter masking effects inherent with the sea surface. The surface tracker component will publish a multiple source contact-to-composite track developed for maritime vehicular applications. The tracker techniques to produce and publish a composite tracker will estimate covariance data from knowledge of sensor characteristics, track kinematics, and provide prediction data when sensor data is absent or disrupted (see reference 4). It will be componentized and compliant with the US Navy's Product Line Architecture to facilitate integration within the Track Management Domain. Development of robust tracking techniques will facilitate integration of future sensor technologies.

PHASE I: The company will develop a concept for surface track management algorithms that meet the requirements described above. The company will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be feasibly developed into a useful product for the Navy. Feasibility will be established by testing and analytical modeling. The small business will provide a Phase II development plan that addresses technical risk reduction and provides performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for the surface track management algorithms. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop surface track management algorithms according to the Phase III development plan for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Does not pertain to commercial applications.

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KEYWORDS: Surface Composite Tracker; Contact-To-Composite Track Association; Product Line Architecture; Composite Tracker; Track Correlation; Track Ambiguity

N141-037 TITLE: Information Extraction and Scoring System

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PEO IWS 2.0, Above Water Sensors

OBJECTIVE: Develop an automated information extraction and scoring system for Electronic Warfare (EW) systems to provide disambiguated and intelligent sustainment solutions

DESCRIPTION: Systems exist today that track ship-board inventories of spare equipment and other sustainment related needs. The use of these tracking systems requires that a user manually research and combine the information to make an objective conclusion on how to best maintain Electronic Warfare (EW) systems for optimal operational readiness. Obtaining a true picture of the ship's operational status and risk factors is hampered by inaccurate or out-of-date information in the inventory systems and by a partial or limited view of the inter-dependencies upon systems, components, and parts. This fact is supported by the Government Accounting Office report GAO-03-887 (Ref 1), which shows the Navy recognizes that it has not met its supply goals for over 20 years.

There also exists a breadth of textual resources which remain apart from the tracking systems in use. These resources include such documents as Department of Defense (DoD) policy and instructions, Concept of Operations documents which address new equipment or new methods for using existing equipment, intelligence briefings on novel threats, systems engineering plans, system sustainment strategies and plans, revolutions in training, and technical manuals for onboard equipment. This textual information is essential to an accurate understanding of overall system design requirements, development and sustainment efforts, and their impact on the readiness and suitability of EW systems (such as identifying tools and parts inventory shortages that put the system's readiness at risk, decreasing operating and support costs, and providing accurate data-driven corrective actions). Because this valuable information is only available in a non-machine readable format as textual documents, the Navy has no cost effective and timely method for determining whether the proper support solution is available to reduce repair time and maintain its equipment in an optimal operational readiness state.

The Navy needs an automated method that identifies a physical support solution and scores the impact that solution has on the system or part replacement events, diagnoses recorded by maintenance personnel, impacts to overall spare equipment inventory, and training effectiveness throughout the design, development, and sustainment activities. The innovation sought is a software system to (a) automate linking the system and sustainment dependencies identified in acquisition documentation to the physical support solution (for parts, tools, equipment, and others) and (b) score the efforts (for example development, procurement, actual utilization rates, inventory impact estimates, and others) through unstructured text analysis.

Entity Extraction is the ability to automatically extract meaningful information trapped in a variety of non-structured technical documents and information. State-of-the-art entity extraction systems can be customized to identify tools, parts, and equipment available in non-machine-readable text narratives with high accuracy to extract the text data; however, this will not meet the need to identify the implicit information about overall system impact from the text sources and provide a recommended solution. The solutions offered should document the metrics used to monitor the accuracy of text extraction and the impact scoring analysis algorithms (see Ref 2 for examples of performance criteria typically used). It is expected that benefits can be gained by exploiting structured data available in current data sources (such as configuration data, technical manuals, parts inventories) to boost entity extraction performance and to aid in the resolution of similar and identical equipment (Ref. 3-4).

Given that the same physical piece of equipment will be identified in many different ways either by its function, by the manufacturer's part number, by a configuration item number, or by a reference designator a proposed solution will necessarily have to support a form of entity disambiguation that has the capability to gather different identifiers from the current sustainment systems and also from the extracted text, which all refer to equivalent or identical parts, systems, and stock items and provide a recommended support solution. With this technology, the reliability and the overall operational readiness of the fleet will be improved while lowering operating and maintenance costs.

PHASE I: The company will develop a concept for an automated information extraction and scoring system that meet the requirements described above. The company will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be feasibly developed into a useful product for the Navy. Feasibility will be established by demonstrating entity extraction and analytical modeling. The small business will provide a Phase II development plan that addresses technical risk reduction and provides performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype automated information extraction and scoring system for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II development plan and the Navy requirements. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop an automated information extraction and scoring system according to the Phase III development plan for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Possible commercial applications of these solutions include the medical and clinical records management environments where detailed physicians' and clinicians' notes can be extracted to track prescriptions, patient data, and others. The solutions developed here can also assist in other disciplines in which tracing textual impact on policies or availability of resources is an issue, such as for legal and regulatory agencies, software development efforts, and intelligence analysis.

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KEYWORDS: entity extraction; unstructured text analysis; entity disambiguation; information extraction and scoring; entity disambiguation; information analysis

N141-038 TITLE: <u>Coating for Electromagnetic / Radio Frequency Interference (EMI/RFI) Attenuation</u>

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMS500, DDG-1000 Zumwalt Class Destroyer Program Office.

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OBJECTIVE: Develop innovative coating to attenuate Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) without compromising required optical characteristics.

DESCRIPTION: Electronic signature control (REF #1) is one self-defense technique employed by the Navy. If the enemy can't pick up the ships electronic signal, then they can't target it. Therefore, the Navy needs to be able to attenuate EMI/RFI to control the ships electronic signature. The Navy also needs to be able to effectively use its own passive sensors to detect any threats. Metallic grids that are typically used to attenuate EMI/RFI diminish the ability of passive EO/IR sensors to detect potential threats. Sensors used for surveillance and fire-control need to be able to pass through windows unobstructed. For ships with stringent radar cross section (RCS) requirements, these EO/IR sensors need to be mounted behind RCS-compliant windows. Therefore, the Navy needs windows that will meet EMI/RFI requirements, while maintaining the ability to pass both visible and IR wavelengths for its own sensors.

New naval shipboard electro-optical sensor systems require large, strong, high optical quality windows that are transparent from 0.4 to 5 µm wavelengths (REF #2) and provide electromagnetic interference/radio frequency interference shielding of the sensor electronics.

The focus of this effort will be on shipboard Spinel windows. Current state of the art shielding accomplished by using metal grids produces undesirable optical attenuation, diffraction, and reflections and as such is unsuitable for this planned application.

A continuous, conductive coating that is transparent from 0.4 to 5 µm and has an electrical sheet resistance of <10 ohms/square could provide the needed shielding. The conductive coating must be part of a coating stack of layers that includes an antireflection coating that provides at least 68% transmission at incident angles up to 60° in selected bands from 0.4 to 5 µm for a fully coated window. No currently existing coating provides both the electrical and optical properties required (REF #3).

If the conductive coating is on the outer surface of the sensor window coating stack, it must survive shipboard salt spray and salt fog, abrasion by blowing and wave-borne particles, hail impact, and solar irradiation.

Coatings demonstrated in this effort must be scalable to deposition on 19" x 27" spinel windows. Proposals to use graphene, carbon nanotubes, or metal nanowires must provide experimental evidence that these materials can meet the optical and electrical requirements simultaneously. Previous attempts to use these materials have failed to meet all requirements simultaneously.

PHASE I: The company will develop a concept for a coating to attenuate Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) that meets the requirements described above. The company will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be feasibly developed into a useful product for the Navy. Feasibility will be established by material testing and analytical modeling. The small business will provide a Phase II development plan that addresses technical risk reduction and provides performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for the coating to attenuate Electromagnetic Interference/Radio Frequency Interference (EMI/RFI). System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The company will be expected to support the Navy in transitioning the technology for Navy use. The company will coat spinel windows provided by the government. These windows will then be evaluated to determine their effectiveness in the operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the coated spinel windows for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: In addition to the need for the DDG 1000 program, spinel windows can be used in a number of other applications, such as missile and aircraft EO/IR apertures, submarine periscopes, and directed energy weapon apertures. EMI/RFI coatings such as those developed under this topic would have applicability to all of those applications. In addition, optically transparent, electrically conductive coatings could become components of photovoltaic cells.

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KEYWORDS: EMI/RFI attenuation; conductive coating; optical coating; electrically conductive coating; electromagnetic shielding; transparent conductive coating; electronic signature

N141-039 TITLE: Active Sonar Interference Avoidance Planning

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO IWS 5.0, Undersea Warfare Systems.

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: Develop an innovative sonar planning tool for automating Active Sonar Interference Avoidance Planning (ASIAP) to optimize management of sonar parameters.

DESCRIPTION: Currently, Navy strike groups employ multiple active sonar systems to detect threat submarines [Ref 1]. These sonar systems increasingly compete for the same frequency spectrum resulting in signal interference, which increases false alarms and the likelihood of false detection.

Current ASIAP Systems require planning for air sensors, shipboard sonar, and submarine sonar. Algorithms exist to plan avoidance of mutual interference frequencies, but not for other ASIAP variables such as interference level, ducting, slope range scale, and ping history. New decision algorithms and processes are required to allow the warfighter to plan sonar deployment that goes beyond current legacy separation of frequency schemes.

Active sonar operations in littoral waters against small, quiet submarines need a hierarchy of Mutual Interference (MI) reduction techniques that can be evaluated automatically (or interactively) to determine the optimum setup, spacing, and relative orientation for combined search performance. A Graphical User Interface (GUI) that is intuitive to the search the planner would also be helpful. The program office is interested in this topic because it will improve mission capability and performance and because it has the potential to reduce manning costs.

Efficient use of ASW sonar systems will minimize deployment of expendable and fixed sensors that provide no value to threat detection and classification. A standard user interface design can lower Navy manning costs through reduced training time and increased operator performance. Training and operational efficiencies will be provided by use of intuitive Graphical User Interface that has common controls with other sonar system displays. This topic can be especially beneficial for the Undersea Warfare Decision Support System (USW-DSS) and to the Aircraft Carrier, Tactical Support Center (CV-TSC) programs in reducing mutual interference, which will reduce the likelihood of false detection and false alarm rates, thus improving the overall chances of mission success.

PHASE I: The company will develop a concept for an active sonar planning tool that meet the requirements described above. The company will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be feasibly developed into a useful product for the Navy. Feasibility will be established by material testing and analytical modeling. The small business will provide a Phase II development plan that addresses technical risk reduction and provide performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for an active sonar planning tool. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy.

PHASE III: The company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop an active sonar planning tool according to the Phase III development plan for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy acceptance.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology developed in this effort has potential applicability in Acoustic industries such as fish finding, seismic instrumentation, and ultrasonics, and in non-acoustic industries such as telecommunications to optimize location and implementation of networks.

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KEYWORDS: Sonar, Active Sonar Interference Avoidance Planning (ASIAP); sonar interference; sonar propagation; mutual interference (MI); separation of frequency; sonar waveform recommendation

N141-040 TITLE: Monolithic Microwave Integrated Circuit (MMIC) Compatible High Power RF Switches

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO IWS 2.0, Above Water Sensors

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: Develop MMIC compatible RF high power switches for shipboard phased array radars that improve reliability at a lower cost.

DESCRIPTION: Modern active electronically scanned phased array radars provide outstanding capability but are expensive. To a large degree, this results from the need for power and low noise amplifiers at each antenna element. A promising alternative architecture shares the amplifiers among multiple elements, and thus requires only a phase shifter at each element. This choice requires fast RF switches capable of handling challenging power levels with very low insertion loss.

MMIC compatible RF switches are sought with low insertion loss (< 0.2 dB), low on-state resistance (< 0.1 ohm) and fast switching time (goal of 300 ns). These switches must be capable of handling up to tens of watts of RF power. The input third-order intercept point (IIP3) is also a factor to be considered, and compatibility with standard semiconductor fabrication processes is required in order to realize the goal of reduced system cost.

RF micro-electromechanical system (MEMS) switches (ref. 1, 2, 3) are an emerging technology and may be proposed for this topic if they employ novel materials, cost saving processes, and/or innovative design features which significantly improve their performance, reliability or cost while also meeting the performance criteria specified above. Specifically sought are new switch technologies, such as phase change switches (ref. 4) or other innovative technologies that show promise of providing affordable RF high power switching for radar applications (with the performance criteria specified above). The intended application will be C, S and X Band radars and the intended (benchmark) use of the switches is in phase shifters. However, it should be noted that this technology has many other potential applications in radar as well as in electronic warfare (EW) and microwave communication systems. These applications include reconfigurable RF filters and adaptable antenna feeds. Primarily, though, this innovative technology will enable high performance radar systems at lower acquisition cost with the secondary benefit of lower sustainment and operational cost.

PHASE I: The company will develop a concept for an improved MMIC compatible high power RF switch that meets the requirements described above. The company will show the feasibility of their concept in meeting Navy needs and will establish that the concept can be feasibly developed into a useful product for the Navy. Feasibility will be established through prototype testing, modeling and simulation, or a combination thereof. The small business will provide a Phase II development plan that addresses technical risk reduction and provides performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II development plan and the Navy requirements for MMIC compatible high power RF switches. Operational performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous switching cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The company will be expected to support the Navy in transitioning their technology for Navy use. The company will develop an MMIC compatible high power RF switch according to the Phase III development plan for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology developed under this topic is expected to find many applications in radar, EW systems and communications. Examples include Federal Aviation Administration (FAA) airport radars, law enforcement and Coast Guard radars and commercial radar applications (such as navigation radar and collision avoidance radar). Airborne radar will also benefit. This technology may also be adapted for the commercial telecommunications and commercial microwave test equipment industries.

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1. Newman, H.S., Ebel, J.L., Judy, D., Maciel, J., "Lifetime Measurements on a High-Reliability RF-MEMS Contact Switch," IEEE Microwave and Wireless Components Letters, Vol. 18, No. 2, 2008.

2. Yuan, X., Peng, Z., Hwang, J. C. M., Forehand, D., Goldsmith, C., "Acceleration of Dielectric Charging in RF MEMS Capacitive Switches," IEEE Transactions on Device and Materials Reliability, Vol. 6, No. 4, 2006.

3. Rebeiz, G., Patel, C., Han, S., Ko, C., Ho, K., “The Search for a Reliable MEMS Switch?”, IEEE Microwave Magazine, January/February 2013.

4. Shim, Y., Hummel, G., Rais-Zadeh, M., “RF Switches Using Phase Change Materials,” MEMS 2013, Taipei, Taiwan, January 2013.

KEYWORDS: Phase change switches; phased array; phase shifter; RF switches; insertion loss; Micro-electromechanical System (MEMS) switches

N141-041 TITLE: Adaptable Standardized Modular Infrastructure for Optimal Space Utilization

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMS400D, DDG51 Class Program Office

OBJECTIVE: To develop an affordable innovative standardized structure that is adaptable multiple configurations, sizes, and shapes.

DESCRIPTION: Navy ships are built to stringent size constraints. Ensuring essential mission systems are accommodated is the primary objective in the design of a Navy ship. Remaining areas and space for crew accommodations have to be optimized. Efficient use of allotted space and compartments on Navy ships is essential. Often areas that are not specifically attributed to a mission system are utilized by custom outfitting. Custom outfitting areas for many crew accommodations is very costly.

One example of a shipboard structure that requires time consuming custom installations are shower stalls. The Navy currently has to custom build each shower stall to fit each uniquely shaped space. This method of custom installation is very costly and time consuming. This construction method needs to be improved and standardized, to reduce the time it takes to build each stall. Each component, of the stall, must be cut, on the ship, in an environment that can result in poor craftsmanship, wasted material, and increased production time. After the stall has been built, the Navy incurs excessive maintenance costs to maintain the seals at the joints of the components that comprise the shower. The current design often leaks and corrodes making the showers expensive and time consuming for sailors to maintain.

The Navy is seeking innovative manufacturing processes and materials to produce a shower stall that is affordable, modular, corrosion resistant, and can be built with the minimal number of standardized components that will reduce the production time and overall life-cycle maintenance associated with the system. Navy market research has been unable to find an acceptable solution to for these structures existing. Developing standardized structures that provide watertight integrity, are corrosion resistant, and prove to be adaptable to multiple configurations, sizes, and shapes could provide future opportunities to introduce modularity to other shipboard applications such as; storage compartments, boatswain lockers, or damage control lockers.

A successful approach to developing the shower stall will leverage innovations in material selection, sealing innovation, and advances in modular concept design. An ideal solution would maintain watertight integrity, at all joints, without the need for caulking, and use only components that easily fit through a standard Navy Hatch (26"x 66") to allow for quick on-site, installation. To ensure modularity the design should minimize the number of standardized, lightweight components (ref 1). Also, all approved materials shall meet Navy Shipboard requirements for fire, smoke, and toxicity(ref 2).

Effective development of an affordable innovative standardized structure that is adaptable multiple configurations, sizes, and shapes like a shower stall compartment, would be the first step in analyzing all non-mission essential areas for standardized optimal space utilization.

PHASE I: To develop an affordable innovative standardized structure that is adaptable multiple configurations, sizes, and shapes that meets the requirements described in the topic description. The company will demonstrate the feasibility of the concept in meeting Navy needs for development into a useful product. Feasibility will be established by material testing and analytical modeling as well as design/cost analysis for anticipated maintenance requirement. The small business will provide a Phase II development plan that addresses technical risk reduction and provides performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for the affordable, standardized, modular shower stall. System performance will be demonstrated through prototype evaluation in a laboratory setting and supported with modeling or analytical methods over the required range of parameters including but not limited to numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements with accompanying cost benefit analysis. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The Company shall support the Navy in transitioning the technology for Navy use. The company will develop an affordable, standardized, modular shower stall prototype according to the Phase III development plan for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The potential for commercial applications include any use that requires an optimally sized shower stall. This system will reduce the cost and scope of any installation effort. The use of standardized modular parts will reduce the complexity associated with constructed system, and reduce the cost of the logistical effort to source parts. The system shall be more corrosion resistant, and easier to maintain.

REFERENCES:
1. Cook, Rodney Longhurst. "The impact of modular ship design of the life cycle of a naval vessel", http://archive.org/details/impactofmodulars00cook

2. BEITEL, Jesse. "Overview of Smoke Toxicity Testing and Regulations." Naval Research Laboratory, <http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA342016.>

3. COMSC INSTRUCTIONS 9330.6D "ACCOMMODATION STANDARDS FOR MILITARY SEALIFT COMMAND SHIPS" (06-Jun-1991)" < www.msc.navy.mil/instructions/doc/93306d.doc>

KEYWORDS: Modular Design, Lightweight Materials, Resign, Composite Manufacturing, Corrosion Resistant Materials, Adaptable design, Sanitary Materials, Marine shower design

N141-042 TITLE: Autonomous or Remotely-operated Maintenance of Ships' Tanks

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: Cross Platform Systems Development (CPSD), R&D program

OBJECTIVE: The objective is to develop an innovative system that can autonomously or remotely perform the tasks of cleaning, inspecting and maintaining ship's tanks.

DESCRIPTION: The U.S. Navy spends considerable resources on the inspection and maintenance of ships' tanks. Currently, inspection and maintenance of tanks must be done manually. At this time, there are no known, existing systems that can meet all requirements. The Autonomous Maintenance Robot (AMR) is software developed to inspect the B-52 wing fuel tanks that has obstacle avoidance and route planning, but the robot does not have all the necessary detachments or software to complete all the tank maintenance tasks (Ref 1). The Robotic Hull Bio-mimetic Underwater Grooming system (Hull BUG) is an underwater robot used to clean a ship's hull; however, it does not have the capability to maneuver around a confined, complex space such as a tank. It also doesn't have the capability to perform many of the maintenance tasks both in regards to tools for the robot or software (Ref 2). The robot designed for unsupervised grit-blasting of ship hulls (Ref 3) which latches on to the ship hull through magnets can perform the task of de-coating, but lacks the capability to perform the other maintenance tasks, perform the tasks in a tank, or enter a tank.

This system development of this robot will require innovation that combines spatial navigation, gripping and stabilizing features, sensing capability, and ability to position and operate tools. These tanks are spaces of all shapes and sizes and often have very limited access. They may have contained hazardous materials such as kerosene and other fuels. The tanks may also present a slipping hazard due to slick surfaces. To allow human entry, certain tanks must first undergo time-consuming analysis for the presence of harmful gases. In all respects, these tanks present a challenging environment and serious safety concerns.

Periodically, tanks are opened and operations such as cleaning, de-rusting, de-coating, painting, and inspecting are performed within. The Navy is interested in automating these operations so as to minimize danger to personnel.

Ship tanks are typically constructed of steel, usually HY80 in surface ships or HY100 in submarines. However, tanks can also be constructed of aluminum. They may range in size from 100 cubic feet to 8000 cubic feet, but have no standard dimensions. Tanks may extend horizontally or vertically as much as 40 feet, and have curved surfaces. Internally, tanks are likely to contain ship structural members such as frames, bulkheads, piping, pipe hangers, cabling, ladders, and other features. These unusual configurations create inspection and maintenance challenges. A robotic system must be versatile to deal effectively with these varied landscapes.

Access to the ship's tank is typically through a hatch at the top or side of the tank, usually 18 inches x 15 inches. The hatch is usually in a ship passageway several decks below the main deck. The passageway may be as narrow as 30 inches. Any proposed robotic maintenance equipment must be able to easily disassemble or collapse and be reassembled in confined spaces in order to perform the required inspection and maintenance tasks.

The autonomous or remotely operated system must be able to enter the tanks, perform some or all of the tasks currently performed manually (cleaning, de-rusting, de-coating, painting, and inspecting), and exit the tanks. The system must allow for transport by personnel through the ship to the tank access hatch.

PHASE I: The company will develop a concept for an autonomous or remotely operated system capable of remediating ship's tanks that meet the requirements described above. The company will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be feasibly developed into a useful product for the Navy. Feasibility will be established by assessing the risks involved in various system components and assessing the ability of the system to complete some or all of the maintenance tasks. The small business will provide a Phase II development plan that addresses technical risk reduction and provides performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for an autonomous or remotely operated system. The company will demonstrate system performance through the evaluation of the prototype in mock environments similar to what an autonomous or remotely operated system would encounter in various ship tanks. The company will use the evaluation results to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop an autonomous or remotely operated system for remediating ship tanks according to the Phase III development plan for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use. A manual of the system capabilities and limitations will need to be created to ensure appropriate use of the system.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Autonomous or remotely operated systems that could remediate ship tanks would not only be of great use to the Navy, but also to commercial ships, especially large ships with many tanks. Commercial ships are also required to remediate their tanks throughout the life of the vessel. A system that can accomplish some or all tank maintenance tasks can save time and money, as well as enhance crew safety.

REFERENCES:
1. Krasny, Darren P. "The Autonomous Maintenance Robot (AMR) for Confined Space Maintenance Applications." Naval Engineers Proceedings for Fleet Maintenance & Modernization Symposium. Sept 2012. <https://www.navalengineers.org/ProceedingsDocs/FMMS/FMMS2012/FMMS12Papers/Krasny.pdf>.

2. “Robotic Hull Bio-Mimetic Underwater Grooming.” November 2010, Office of Naval Research. April 2013 <http://www.onr.navy.mil/en/Media-Center/Fact-Sheets/Robotic-Hull-Bio-mimetic-Underwater-Grooming.aspx>

3. Souto, Daniel, Andres Faina, Alvaro Diebe, Fernando Lopez-Pena, and Richard Duro. “A Robot for the Unsupervised Grit-Blasting of Ship Hulls.” International Journal of Advanced Robotic Systems. 20 June 2012. <http://cdn.intechopen.com/pdfs/39384/InTech-A_robot_for_the_unsupervised_grit_blasting_of_ship_hulls.pdf>

KEYWORDS: Robotic maintenance of ship tanks; Ship Tank cleaning; Autonomous system for maintenance of ship tanks; Remotely operated system for maintenance of ship tanks; Cleaning, De-rusting, De-coating, Painting, and Inspecting tanks.

N141-043 TITLE: Improved, Flexible Infrastructure Compatible, Open-Loop Air-Cooled Computer Rack / Cabinet

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PMS377, Amphibious Warfare

OBJECTIVE: Develop a computer rack / cabinet with an improved, more efficient, Flexible Infrastructure (FI) HVAC compatible, air cooling system to provide an alternative solution to the existing permanent ducted HVAC cooling services.

DESCRIPTION: Typical shipboard computer racks/cabinets (e.g. 19”w x 24”d x59.5”h Common Processing System (CPS) cabinets) (REF 1) have a standardized frame or enclosure for mounting multiple computer equipment modules. Because the equipment is installed and operated in small spaces a large amount of heat is generated, a more efficient, Flexible Infrastructure (FI) HVAC compatible, air cooling system is necessary to maintain the desired system operability and service life. Standard, fully-populated computer racks/cabinets use a series of fans which are rigidly mounted on the side/back of the rack/cabinet and require a duct directly connected to the ships Heating, Ventilation and Air Conditioning (HVAC) system return service to remove heat from the ships computer rooms.

This topic seeks to develop an innovative, more efficient air cooling solution to cool individual computer racks/cabinets utilizing the below-deck plenum of the Flexible Infrastructure open HVAC (REF 2,3,4) system supply air. The goals of the system would be to eliminate the standard cooling fans by bringing in cool HVAC supply air directly from below-deck plenum and allowing hot exhaust air to exit from the top of the rack near the ships overhead plenum returns. This system would also have to incorporate a means to control the cool supply air flow to compensate for varying cooling demands; be fully contained within the rack/cabinet maintaining the existing rack/cabinet footprint (size, shape, weight); maintain current shock mount effectiveness; and demonstrate reliability and performance greater than current standard fully-populated CPS racks/cabinets (REF 1).

This innovative solution would also be a more attractive alternative to large Computer Room Air Conditioning (CRAC) units, which are self-contained units used to treat sets of racks as an alternative to treating the entire room via the existing HVAC plenum system. While these units do provide energy savings when compared to using existing HVAC plenum systems, they can be very expensive and not easy to reconfigure. The Improved, Flexible Infrastructure Compatible, Open-Loop Air-Cooled Computer Rack system should also provide improved or at least equivalent energy savings as the CRAC units, at a much lower cost.

LHA 8 architects are exploring the possibility of having a number of spaces outfitted with FI systems, which consists of an open-structures track system mounted to the deck, bulkheads and in the overhead, and an open FI HVAC System with under-floor supply plenums and overhead returns (REF2, 3, 4). By reducing the need for new computer rack foundations and HVAC ducting, the FI system allows the spaces to be reconfigured as system updates and changes occur at a significantly reduced cost.

Using the FI compatible (REF 2) Improved, Flexible Infrastructure Compatible, Open-Loop Air-Cooled Computer Rack system in these newly outfitted compartments will allow large amounts of HVAC ducting to be eliminated. Use of the system will result in reduced acquisition cost by eliminating a lot of extra HVAC ducting for computer racks; reduce the need to rebalance the HVAC system; reduce life cycle cost by reducing reconfiguration cost; and allow late date procurement decisions.

The Small Business will develop a system to meet the goals of the topic. Modeling and simulation are encouraged to guide the development of overall prototype device design as well as to demonstrate the potential effectiveness of the proposed prototype device.

PHASE I: The company will develop a concept design for an Innovative Air Cooled Computer Rack System that meets the requirements described above. The company will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be feasibly developed into a useful product for the Navy. Feasibility will be established by component testing and analytical modeling. The small business will provide a Phase II Development Plan that addresses technical risk reduction and provides performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II Development Plan, the small business will develop a prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II Development Plan and the Navy requirements for the Improved, Flexible Infrastructure Compatible, Open-Loop Air-Cooled Computer Rack. System performance will be demonstrated through prototype evaluation and testing for the different configurations of the rack. Evaluation and test results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III Development Plan to transition the technology to Navy use.

PHASE III: The company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop an Improved, Flexible Infrastructure Compatible, Open-Loop Air-Cooled Computer Rack according to the Phase III Development Plan for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The Improved, Flexible Infrastructure Compatible, Open-Loop Air-Cooled Computer Rack has potential for commercial application and dual use where data and computer rooms utilize HVAC plenums for cooling. Computer rooms that are cooled in such a way often have high energy consumption due to the need to cool the entire room, not just the equipment inside them.

The proposed system will greatly reduce the energy consumption associated with cooling the equipment, since the cool air will be treating the equipment directly, rather than the ambient air around it.

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KEYWORDS: Flexible Infrastructure; Plenum HVAC System; Computer Rack Cooling; Air Cooling; Computer Rack Temperature Monitoring; Direct Cooling Air Take-off

N141-044 TITLE: In-line Testing of Fuel & Lube Oil

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMS505, Littoral Combat Ship Fleet Introduction and Sustainment Program Off

OBJECTIVE: The objective is to develop an innovative fuel and lube oil testing system that measures physical and chemical properties of fuel and lube oil with minimal operator interaction.

DESCRIPTION: The ability to effectively test fuel and lube oil onboard is critical to maintaining adequate quality in order to promote healthy equipment life and prevent operating machinery shutdowns. Primary concerns are particulates, water, and microbiological contamination: Particulate contamination can be caused by dirt, rust flakes, catalyst fines, or other foreign matter introduced into the fuel or lube oil. It can be introduced from the source, or from the ship's own storage tanks and piping. Particulates generally settle out of solution and accumulate at the bottom of storage tanks. However, biological contamination and storage stability problems also generate particulates that can stay in suspension.

Some of the specific needs are workload reduction and automation to support reduced number and seniority of manpower required. Total Ownership Cost (TOC) reduction is sought by developing and aiding the insertion of technology to reduce lifecycle and sustainment costs and achieve crew manning requirements.

Currently, fuel quality in the field or onboard a ship is assessed with a series of traditional American Society for Testing and Materials (ASTM) fuel test procedures using laborious techniques such as the clear and bright test. This test requires sampling from the fuel line, placing the sample in a clean, clear glass and visually inspecting the sample to determine if it is clear and bright. Other tests require a hydrometer, a detector or other special test equipment. A sensor-based device to perform these tests would not only provide significant savings in cost and manpower but also reduce the hazards associated with handling large volumes of fuel samples. It would also provide faster and, in many cases, more-consistent results (Ref 1).

Lube Oil analysis tools include spectrographic analysis which can be used to determine the chemical composition of the oil to indicate both its ability to perform its function and other engine faults which could cause contamination; particle analysis which can be used to identify mechanical wear by detecting and analyzing metal fragments found in oil and determining their likely source by studying their shape and size. Monitoring lube oil condition is currently achieved in two ways: Samples are drawn off and checked using portable equipment and test kits or samples are drawn off and dispatched for on-shore laboratory assessment (Ref 2).

In-line Fuel Oil and Lube Oil sensors have the capability to reduce crew workload and manning, thereby decreasing total ownership cost and increasing program affordability. A by-product of this technology would be increased reliability of the systems using fuel and lube oil.

An innovative automated testing system, which requires minimal calibration and operator oversight, is sought to reduce crew workload. This system should measure physical and chemical properties of fuel and lube oil such as specific gravity, viscosity, flashpoint and presence of particulate matter. The system shall meet all three following requirements: Sensors should report Navy standard or commercial standard values; sensors should not require frequent calibration (such as each change of oil); and sensors should not require high amounts of additional power or modification to existing ship structures to operate.

Currently, sensors being integrated into LCS and other warships fulfilled some but not all of the above three requirements, which is why an innovation is needed.

PHASE I: The company will develop a concept for an In-line Fuel and Lube Oil Testing System that meets the requirements described above. The company will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be feasibly developed into a useful product for the Navy. Feasibility will be established by material testing and analytical modeling. The small business will provide a Phase II development plan addresses technical risk reduction and provides performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and Phase II development plans, the small business will develop a prototype Fuel Oil and Lube Oil Sensor for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II development plan and the Navy requirements for the In-line Fuel and Lube Oil Testing System. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop an In-line Fuel and Lube Oil Testing System according to the Phase II development plan for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Automated Fuel and Lube Oil testing has several commercial applications in the transportation industry, specifically maritime container shipping and could be adapted to any manufacturing process using machines with fuel and lube oil.

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2. Knowles, M. "Condition Management of Marine Lube Oil and the Role of Intelligent Sensor Systems in Diagnostics," 25th International Congress on Condition Monitoring and Diagnostic Engineering Journal of Physics: Conference Series Vol 264, 2012

KEYWORDS: Fuel Oil Quality Assessment; Lube Oil Quality Assessment; Spectroscopy and Chromatography, Condition Based Monitoring; In-line Diagnostic Sensors; Automated In-line sampling; Fuel Oil and Lube Oil Sampling System

N141-045 TITLE: Rapid Computer Numerical Control (CNC) Tool-path Programming

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMS397, OHIO Replacement Program (ACAT 1).

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 rapid CNC tool-path machining is to develop a new capability to enable shorter, more efficient manufacturing processes for large scale, high tolerance Navy Hardware.

DESCRIPTION: Currently the manufacturing for Large Scale Vehicle (LSV) and Navy submarine propulsors requires casting nickel aluminum bronze (NAB) and then machining the castings into their final shape. These hydro shapes have high tolerance requirements on them, in order to ensure performance. A large part of this manufacturing process is the manual programming of the tool-paths for the CNC machines (ref 1,2)

As it currently stands, CNC programming for the NAVY requires special training and manual programming of machine paths. This can be the longestand most expensive part of the machining process. It can cause an increase in manufacturing times, result in costly hardware, as well as delay delivery of critical components.

An innovative solution is needed for the creation of a rapid CNC tool-path program, through some level of automation (ref 3,4) Proposed CNC tool-path programming shall meet the following goals: a reduction of 20% or better in programming time, maintain high tolerance requirements that are in place today, and reduce overall cost for CNC programming.

PHASE I: The small business will develop a concept for an improved CNC tool-path program that meets the requirements described above. The small business will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be feasibly developed into a useful product/process for the Navy. Feasibility will be established by material testing and analytical modeling. The small business will provide a Phase II development plan that addresses technical risk reduction and provides performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for the rapid CNC tool-path program. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The small business will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The small business will be expected to support the Navy in transitioning the technology for Navy use. The small business will develop a CNC tool-path program according to the Phase III development plan for evaluation to determine its effectiveness in an operationally relevant environment. The small business will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: There are a number of private industries that could potentially benefit from the development of this technology. Notably, machining of water jet impellers requires high tolerance machining of high strength materials. The commercial maritime industry would be able to implement this technology. Another potential application would be in the machining of turbines that are used in high temperature/high stress applications. Reference the "Inner Hub Forging Procurement Specification" to apply the 20% improvement in processing times.

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KEYWORDS: Computer Numerical Control (CNC); Manual Programming; Manufacturing process; Tool-path; large scale components

N141-046 TITLE: System-agnostic Mission Data Recording and Reconstruction for Surface Combatants

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

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OBJECTIVE: The objective is to develop a system to record data in a “data agnostic” (non-system specific or unique) manner, eliminating the current system “data stove-piping”.

DESCRIPTION: The Navy currently has specialized data recorders with the capacity to collect qualitative data on various subsystems. This approach provides little value for overall analysis of engineering improvements for system development, ignoring the need for quantitative analysis of the complete integrated system. Critical system metric measurement is not possible without stitching multiple products together. Data mining on the platform for on hull assistance in decision making or crew training is ignored and largely not possible in this collection model. Development of a common approach to data recording and reconstruction is needed to provide effective data access to the operational user and support the collection needs of the engineering development under a single product.

Development of a standardized collection methodology that is capable of supporting the unique needs of all end users in a single product is needed. The envisioned product is a single modular system that enables total Littoral Combat Ship (LCS) module reconstruction, data playback, and engineering analysis tools, for shore or sea operational personnel. The mission data recording and reconstruction system is envisioned to provide these capabilities by introducing a standardized product that will enable: operator training for mission and normal operations by facilitating the playback of system-wide recorded data, using targeted collection of native sensors; the ability to provide an immersive full-scale integrated environment using system-wide recorded data that will greatly improve readiness and training effectiveness; mission reconstruction needed to produce products for supporting operational guidance improvements using a complete integrated single system; reliability, maintainability, and system availability metrics improvements to the engineering measurement program to allow more effective analysis of the platform, by providing reporting of logistics data for extended deployments, tracking performance and failure data in an automated complete system approach.

Current systems do not provide a cohesive product to serve the needs of end users. Quantitative data is needed for the measurement of engineering improvements, intelligence and Concept of Operation (CONOPs) evaluations (ref 1). Limitations of the current model do not provide the ability to “see the ship” as it was operated, not designed. Many good engineering tools are integrated into the systems and are not utilized correctly during operations, creating significant churn in evaluating performance of the tool. Qualitative data collection is needed for improvements of general operational guidance, total system employment, and for addressing training successes or potential deficiency analysis. Navy decision makers are unable to demand improvements in system performance, change operational guidance, modify training products or provide evaluation of improvements and readiness. Collision reconstruction and other significant event lessons learned are difficult to assemble and distribute as a training product for improvements in readiness.

Current Naval recording systems stovepipe information, supporting a singular program purpose, and produce a myriad of data products, making the collection and collaboration of data very challenging. Legacy Naval recording systems have a large but often hidden program cost within the engineering process, many programs spend money to develop, field, collect, support and develop tool sets for data analysis (ref 2). The legacy systems also rely on the operator to collect data from multiple sources for critical data sets resulting in potential data loss and incomplete analysis of the situation.

Commercial companies take a different approach to data collection, focusing on collaboration from heterogeneous networks for data collection. This allows formatting data for maximum flexibility across platform operating systems to reduce costs and achieve the greatest collaboration of collected products. Careful selection of software and hardware for the effort is a prime consideration for cost control. When possible, the selection of a replacement technology is designed to be backward compatible, reducing rework of existing archive products. Open format product development provides standards that all industry partners embrace. This allows for data compatibility and reduced development costs for the end-user. Tape technology such as Linear-Tape-Open (LTO) is an example of the commercial industry standard driven by the need for a standard collection process.

The Navy's shift to a data agnostic recording approach, will net a product that maximizes the ability to consistently analyze data on or off hull, and provide potential training products on data recorded from a variety of different systems under a single funded source. This commonality will not just be a new recorder but a complete recording paradigm shift.

Use of scalable hardware and software components is envisioned to collect data under this new approach to control costs and offer the maximum program flexibility. The reduction of hardware required for legacy systems is envisioned as having a common approach that allows all programs to benefit from common tools and collected data (ref 3). The new design will allow the addition of hardware assets, and software agents using a modular approach as mission directives change, vice standing up full hardware recording programs for each shift in the program's lifecycle.

Obstacles to overcome in the development effort include design stage impacts, identifying the data critical to all system stakeholders, analysis of the interfaces associated with current systems, supporting network architecture analysis, selection of technology solutions that will allow data portability at the lowest cost, and establishment of a standardized collection schema that meets but allows growth with evolving system architecture changes.

PHASE I: The Company will develop a concept for a data recorder and reconstruction system that meets the requirements stated above. The company will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be feasibly developed into a useful product for the Navy. Feasibility will be established by analytical modeling. The Contractor will also will provide a Phase II development plan with performance goals and key technical milestones, and that addresses technical risk reduction.

PHASE II: Based on the results of Phase I and the Phase II development plan, the company will develop a prototype data recorder and reconstruction system for evaluation. The prototype will be evaluated to determine its capability in meeting both technical and programmatic objectives of the Navy. System performance will be demonstrated through prototype evaluation, using simulated mission system data. Evaluation will also employ modeling and analytical evaluations of the prototype's design, with an emphasis on open interfaces for injecting data, and the ability to transform reconstructed data to different, but compatible data formats. Another key factor in this evaluation will be determining performance impacts of the reconstruction system when applying data transformations. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The Company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop a data recorder and reconstruction system for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The system has applications for other DoD environments, employing multiple systems with varying data formats. Commercial applications include the ability to instrument factory assembly units to record data captured during machining or other automated assembly processes. The ability to reconstruct and analyze this data can lead to optimized manufacturing or assembly systems and processes.

REFERENCES:
1. “Addressing the challenge of data for all: but securely” Defense Systems, February 2013. <http://defensesystems.com/articles/2013/02/25/cyber-defense-secure-data-storage.aspx>

2. “The 2002 User-Friendly Handbook for Project Evaluation”, Division of Research, Evaluation and Communication National Science Foundation; January 2013. <http://www.nsf.gov/pubs/2002/nsf02057/start.htm>

3. “High-performance computing benefits signal-and data processing in aerospace and defense applications”, July, 2011. <http://www.militaryaerospace.com/articles/2011/07/high-performance-computing.html>

KEYWORDS: Data Agnostic Recording; Heterogeneous Networks; Data Stove-Piping; Qualitative data; Quantitative data; Recording Technology; Mission Reconstruction

N141-047 TITLE: Multiple Sonobuoy Data Association and Classification

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO IWS 5.0, Undersea Systems.

OBJECTIVE: Develop data association and classification processing techniques for multiple sonobuoys that improve tracking and fusion

DESCRIPTION: Improved acoustic tracking and measurements of target acoustic frequency signatures are needed in the Aircraft Carrier Tactical Support Center (CV-TSC). CV-TSC provides acoustic contacts from passive sonobuoys. Ways to improve the detection, localization and classification of acoustic contacts which will aid in successful fusion with radar, Forward-Looking Infrared (FLIR),Electronic Warfare (EW), and other tactically integrated sensors are sought. In order to correctly associate these contacts with data being provided by non-acoustic sensors (RADAR, (EW), Electro-Optical [EO)/Infrared (IR)], an accurate localization and uncertainty region must be computed. This reduces the amount of false tracks, duals, and clutter passed on to the correlation process by the acoustic tracker. CV-TSC has the need for a capability in acoustic tracking and measurements of the acoustic frequency signature of targets that will provide a complete Anti-Submarine Warfare (ASW) situational awareness (SA) picture. These techniques also need to provide research and support development of target localization and acoustic identification aids. In particular, it addresses acoustic tracking and identification for ASW assets and sensors

Current ASW SA is derived by tracking objects using single frequency or harmonic frequency sets. Many of the acoustic contacts obtained are naturally broadband in nature and have fundamental frequencies that do not lie within the frequency spectrums used by ASW [ref 1]. This degrades tracking them under the current ASW means and thus limits the ASW SA picture.

The Navy seeks methods that involve recognition and classification of arbitrary frequency sets which are obtained from sonobuoys and provide the Navy with a complete Anti-Submarine Warfare (ASW) Situational Awareness picture. The method must be capable of having the obtained frequency set give input to the data association algorithms. It must also provide a method of initializing tracking of an object. The resulting spectrum signatures will be stored for later stages of attribute data fusion and used with other nonacoustic sensor data.

Improvements to tracking performance are the basis for determination whether the proposed data association and frequency signature formation are successful [ref 2]. The tracking metrics of track swap score and track ambiguity ratio will improve through the tracking of a frequency signature. Improved data association provides an enhanced bearing bias estimation that yields accurate spatial tracking which will improve the ASW situational awareness by detection, classification and localization of threats.

Data association and classification processing will provide CV-TSC improved acoustic tracking and measurements of the arbitrary acoustic frequency signature of targets. The frequency signature is used for situational awareness of a previously tracked target which will potentially be reacquired for tracking. The Navy seeks high level data fusion with other nonacoustic sensors with the ultimate goal of integrating and combining multiple sensor systems into a complete ASW situational awareness picture.

PHASE I: The company will develop a concept for data association and classification processing technique that meets the requirements described above. The company will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be feasibly developed into a useful product for the Navy. Feasibility will be established by analytical modeling. The small business will provide a Phase II development plan that addresses technical risk reduction and provides performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for data association and classification processing techniques. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop data association and classification processing techniques according to the Phase III development plan for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The data association and classification algorithms and techniques have application in the medical industry, where multiple ultrasonic transducers are used for tracking anomalies in tissue.

REFERENCES:
1. Sildam, Juri. Passive Tracking and Detection of Underwater Narrow-band Acoustical Spectrum Signatures. OCEANS 2008, Pages 1-6. September 15-19 2008.

2. Bar-Shalom, Y. Li, X.-R, and Kirubarajan, T. “Multitarget-Multisensor Tracking: Principles and Techniques. YBS, 1995.

KEYWORDS: sonobuoy detection; localization and classification; signature attributes; Anti-Submarine Warfare (ASW); situational awareness; data fusion with nonacoustic sensors; acoustic frequency signature

N141-048 TITLE: LCS Unmanned Vehicle Sensor Data Compression

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMS420, LCS Mission Packages.

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 is to develop an innovative data compression capability for the Littoral Combat Ship (LCS) Unmanned Vehicle’s sensor data that can send large amounts of sensor data over the horizon using a limited bandwidth High Frequency (HF) radio link.

DESCRIPTION: The LCS deploys multiple Unmanned Vehicles in support of the interchangeable Mission Packages. The Multiple Vehicle Communications System (MVCS) provides LCS Mission Packages with the capability to simultaneously communicate with multiple Unmanned Surface Vehicles (USVs) and surfaced Unmanned Underwater Vehicles (UUVs) by providing common data link and network communication services. MVCS uses a High Frequency (HF) radio link for OTH communications between the LCS seaframe and the Remote Multi-Mission Vehicle (RMMV).

The LCS Mine Countermeasures (MCM) Mission Package has a requirement to send high resolution sonar and camera images Over the Horizon (OTH) from the RMMV to the LCS seaframe using the limited bandwidth HF radio link. An image compression capability is required which is both bandwidth efficient and error tolerant (ref 1-3). Low signal-to-noise ratios, strong rapidly varying multi-path, and noise interference mean that relatively high error rates can be expected. Unique research and development will be required to achieve the required data compression for sonar images due to the speckle noise content. An innovative compression technique is needed to compress the RMMV sonar and camera data so that high resolution images can be transmitted over the limited bandwidth, error prone, HF radio link. The image compression solution can be in the form of hardware, software, or both.

An improved data compression capability for communications between LCS seaframes and unmanned vehicles will allow for more efficient use of valuable communications bandwidth and reduce the cost of the MVCS. High resolution sonar data is required in order to perform the mine identification mission with the RMMV. The data rate required to transmit the high resolution sonar data exceeds what the MVCS Over the Horizon (OTH) datalink can support. Compressing the sonar data so that it can be transmitted via the MVCS OTH communications datalink will improve performance by enabling the RMMV identification mission to be conducted at over the horizon ranges. It will also improve safety since the LCS unmanned vehicles don’t have an autonomous obstacle avoidance capability. Increasing the resolution and frame rate of obstacle avoidance images will improve the operator’s ability to avoid obstacles.

The data compression requirement is 8:1 or greater lossless or visually lossless compression for the AN/AQS-20 sensor images and RMMV obstacle avoidance camera images. State of the art compression algorithms for sonar images currently provide 2:1 lossless and 4:1 visually lossless compression.

The Phase I and II efforts will not require access to classified information. If need be, data of the same level of complexity as secured data will be provided to support Phase I and II work. The Phase III effort will likely require secure access, and NAVSEA will support the contractor for personnel and facility certification for secure access.

PHASE I: The selected company will develop a concept for compressing the AN/AQS-20 sonar images and RMMV obstacle avoidance camera images that meet the requirements described above. The company will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be developed into a useful product for the Navy. Feasibility will be established by analytical modeling and feasibility testing. The small business will provide a Phase II development plan that must addresses technical risk reduction and provides performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop an image compression (hardware and software) prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for data compression. System performance will be demonstrated through prototype evaluation with AN/AQS-20 sonar data and RMMV mast camera data. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop image compression hardware and software according to the Phase III development plan for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Data compression of sonar images has private sector commercial application for storage and transmission of images. Sonar is widely used in oil and gas exploration, and in medical imaging.

REFERENCES:

1. Collins, T. & Atkins, P. " Error-tolerant SPIHT image compression", IEEE Proceedings Vision, Image & Signal Processing, Volume 148, Issue 3, Jun 2001.

2. Tomasi, B. & Toni, L. & Casari, P.& Preisig, J. & Zorzi, M. "A Study on the SPIHT Image Coding Technique for Underwater Acoustic Communications".
http://www.dei.unipd.it/~zorzi/ONR2011/WUWNET2011_SPIHT.pdf

3. Higdon, Thomas. "The Compression of Synthetic Aperture Sonar Images", May 2008, Free Ebooks.
http://free.ebooks6.com/The-Compression-of-Synthetic-Aperture-Sonar-Images-pdf-e31801.pdf

KEYWORDS: Data compression; image compression; sonar image compression; lossless image compression; visually lossless image compression; sonar image compression algorithms

N141-049 TITLE: Operational Console Modernization Tool

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PMS505, Littoral Combat Ship Fleet Introduction and Sustainment Program Off

OBJECTIVE: The objective is to develop an innovative tool that is tailored to assess and predict performance impacts of potential changes to a ship combat system operational console.

DESCRIPTION: Operating with a minimally manned crew is only possible by relying on extensive cross-training. In an environment which requires personnel to perform a high level of multi-tasking, any change that may result in additional workload or reduced crew performance must be carefully considered. A predictive tool for synthetic environments, such as a virtual reality training facility, is sought in order to evaluate prospective changes for performance impact prior to actual shipboard implementation. There are several commonly acknowledged uses of cognitive models in synthetic environments. These include but are not limited to: testing existing doctrine, testing new doctrine, testing possible future procurements (Ref 1.) Testing possible future procurements is the focus of this effort. A design tool that accurately models the impact of console on a minimally manned crew can forestall unanticipated adverse performance impacts that are realized only after equipment is installed, requiring the costly redesign and replacement of equipment to maintain performance standards.

Many human factors and ergonomics tools and technologies have evolved over the years to support early analysis and design of the effects of change in a work environment, such as a ship's combat system console. Two specific types of technologies are design guidance and high-fidelity rapid prototyping of user interfaces. Design guides have the shortcoming that they do not often provide methods for making quantitative trade-offs in system performance as a function of design and have limited value for providing concrete input to system level performance prediction. Rapid prototyping, on the other hand, supports analysis of how a specific design will affect system-level performance but is usually slow and costly. What is often needed is an integrating methodology that can extrapolate from the base of human factors and ergonomics data, as reflected in design guides and the literature, to support system level performance predictions as a function of design alternatives. A prime candidate for this integrating methodology is computer modeling and simulation. (Ref 2)

Design methods and analytical tools that enable the integration of complex, and often contesting, disciplines into effective and efficient platforms are essential. The development of design tools capable of rapidly analyzing and evaluating platforms with advanced system performance characteristics is a high priority. Design decisions should take into account the full Human Systems Interface implications and constraints, including the significant life cycle costs attributed to manpower as well as performance characteristics.

The desired tool will include a model of the operational console and permit evaluation of potential changes to the console by modeling the impact on computer processing load, individual operator cognitive performance, and the overall tactical performance of the console and operator pair within the combat system. The computer-based tool shall be capable of analyzing environments for their multitasking requirements, creating multitasking synthetic environments based on the current shipboard configuration and potential modifiers, and include the means to assess human performance and to elicit feedback, including suggestions, from operators on improvements to the console.

PHASE I: The company will develop a concept for an operational console modernization tool that meets the requirements described above. The company will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be feasibly developed into a useful product for the Navy. Feasibility will be established by analytical modeling. The small business will provide a Phase II development plan which that addresses technical risk reduction and provide performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for the Operational Console Modernization Tool. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including deployment cycles (if available). Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop a tool to assist in Operational Console Modernization according to the Phase III development plan. The company will support evaluation of the tool to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The negative consequences of on-the-job multitasking are well documented. Many different multitasking work environments, such as air traffic control, emergency nursing, and emergency dispatching, produce increased human performance error, burnout, stress, high drop-out rates during training, and post-training attrition.

REFERENCES:
1. Gray, Wayne D. “Simulated Task Environments: The role of high-fidelity simulations, scaled worlds, synthetic environments, and laboratory tasks in basic and applied cognitive research” Cognitive Science Quarterly, Vol 2, 2002. p205-227.

2. Laughery, Ronald K. Jr. Modeling Human Performance in Complex Systems. Handbook of Human Factors and Ergonomics. Wiley, John & Sons, Incorporated. 2006.

KEYWORDS: Environmental simulation; cognitive modeling; design and impact analysis tools; human performance measurement; computational and behavior models, virtual reality and synthetic environments

N141-050 TITLE: <u>Intelligent Information Algorithm for Electronic and Computer Network Systems</u>

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO IWS 1.0, Integrated Combat Systems, AEGIS

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OBJECTIVE: Develop an intelligent information repository software tool for shipboard technicians that automates comples troubleshooting of maintenance and operations of naval electronics.

DESCRIPTION: The complexity of naval electronic systems, which includes radars, weapons, and integrated combat systems, is increasing, while the experience, skill levels and numbers of on-site technicians are decreasing. This creates a void in the knowledge and expertise needed to maintain and operate the Navy’s electronic systems. The problem is exacerbated because experienced shore-based technicians cannot easily provide assistance to a ship at sea which is likely the most critical time when system issues will emerge. An innovative means to capture and leverage the knowledge of more experienced shore-based technicians to assist shipboard technicians in the operations and maintenance of electronic systems is needed.

Shore-based radar and combat system operations and maintenance experts have accumulated a wealth of relevant knowledge that resides in databases, detailed test plans, repair procedures, etc. Shipboard technicians are unable to leverage this disparate knowledge. A common repository software tool would enable them to operate, maintain, and repair their systems quickly, efficiently, and accurately.

An intelligent algorithm is needed that can quickly and correctly access and manipulate data from shore based maintenance documentation that contain the required information for the shipboard technicians. Sailors typically use computer programs to access repair procedures for most predictable and routine component troubleshooting and repair [Ref 1]. These procedures are often little more than static “if, then” statements that may not account for problems driven by external or multiple causes, or that may be concealed by not readily apparent symptoms. Existing procedures do not account for experience and skill gaps, thus preventing proper system maintenance, troubleshooting, and repair beyond the rote instructions provided. There is currently no way to dynamically troubleshoot unplanned situations.

Currently, work is being done to improve the usefulness of data repositories by adding heuristic reasoning algorithms as the means by which the data is accessed. However, this work deals with software code and other static types of databases [Ref 2]. An area where intelligent repositories are being used is in the information technology and web customer service venues.

The Navy needs robust, adaptive, information repositories that will help the Sailor with dynamic troubleshooting in complex electronic repair situations. Such comprehensive repositories would be able to improve sailor performance through self-monitoring results of their diagnostic recommendations.

PHASE I: The company will develop a concept for an intelligent information repository software tool that meets the requirements described above. The company will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be feasibly developed into a useful product for the Navy. Feasibility will be established by testing and analytical modeling. The small business will provide a Phase II development plan that addresses technical risk reduction and provides performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II development plan and the Navy requirements for an intelligent information repository software tool. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop an intelligent information repository software tool according to the Phase III development plan for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Any number of complex electronic systems would be able to take advantage of this intelligent repository. Large communication networks such as telephone switching stations or the control systems for any modern automated manufacturing facility would benefit from the use of this repository during maintenance.

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1. Ivey, Jr., LT Robert. "Diagnostic Expert Systems Use in the United States Navy." DoD Technical Information Center. 1992, Naval Post Graduate School. 25 March 2013, <http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA251789>.

2. Russell, Stuart and Norvig. Peter. Artificial Intelligence: A Modern Approach, 3rd Edition. Upper Saddle River, NJ: Prentice-Hall, Inc., 2010.

KEYWORDS: intelligent agent algorithms, intelligent repository, dynamic troubleshooting, heuristic reasoning, detailed test plans, data repositories

N141-051 TITLE: Thin Walled Corrosion Resistant Steel (CRES) Pipe Inspections

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMS 312 In-Service Aircraft Program Office, PMS 378/379 Future Aircraft Car

OBJECTIVE: The objective is to develop an innovative technology that inspects thin walled CRES welded joints within Jet Propulsion Grade JP-5 fuel lines.

DESCRIPTION: Thin walled (Schedule 10) CRES 316L pipe (ref. 1) has been used in JP-5 fuel systems (ref. 2). The pipe joint design uses a belled end fitting creating an inherent crevice. The thinness of this piping may lead to poor weld quality at the welded joints which could cause additional crevices within the pipe joint. Crevices create areas for corrosion to form eventually resulting in leakage across the pipe joints. This type of pipe is currently in use and there is a need to create an easily applied method to non-destructively inspect welded joints to identify areas where repair work may be necessary to preclude possible leakage. In many instances, there is limited access space surrounding the pipe joint.

Pipe joint leakage failures were identified on the Aircraft Carrier USS George H.W. Bush (CVN 77) within the first three years of service. The JP-5 fuel system installed on CVN 77 and planned for all FORD Class Carriers have over 28,000 welded joints per ship. Additional failures are expected to be identified.

Any material or technique developed must be safe for use in fuel piping and applicable for pipe sizes ranging from 2 to 12 inches. Joint types include couplings, tees and elbows which may be made using sockets or belled end fittings. Currently available non-destructive inspections for pipe interiors are too expensive and cumbersome to be applied on a wide scale for In-Service Carriers. Due to pipe lengths and configurations, current visual test inspections have not proven reliable. Therefore, a low cost method to non-destructively measure wall thickness and determine internal pipe weld quality is needed to ensure safe and efficient JP-5 system operation. Replacing all thin walled welded joints or non-destructively testing all welded joints with currently available testing techniques are both impractical and too expensive.

The new thin walled CRES pipe inspection technique shall be safe to use with fuel piping and achieve competing objectives of low cost, ease of inspection, and accurate identification of areas of potential leakage in the thin walled pipe joints. Current Radiographic Testing (RT) approaches are expensive, cumbersome, require greater access to pipe location than is often available, and have many environmental restrictions and require the use of trained technicians on their use. Ref. 3 (pages 5 through 10) identifies an American Society of Mechanical Engineers (ASME) Code Case discussion regarding “Use of Ultrasonic Examination of Welds as an Alternative to Radiographic Examination ASME B31.3, Chapter IX”. Due to the size of the components, current RT systems require several inches of access around the pipe. In addition, highly restrictive access is required due to the presence of radiological components. Recent advances in Ultrasonic Testing (UT) and Automated Ultrasonic Testing (AUT) (ref. 4 and 5) have been primarily focused on large pipes (>12 inches), require specialized development for specific materials and applications, and have similar cost and pipe access requirements as RT. An innovation to existing technologies or development of new approaches is needed to address these shortfalls while delivering equal or better test results.

PHASE I: The company will develop a concept for an inexpensive and easily performed non-destructive inspection method to use on thin walled CRES pipe joints. The concept should demonstrate how the non-destructive method could be performed with limited access to the pipe joint, and should present reasonable cost estimates. Feasibility will be established by material testing and/or through analytical modeling. The small business will provide a Phase II development plan that addresses technical risk reduction and provide performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II development plan and the Navy requirements for the thin walled CRES pipe joint non-destructive method. The non-destructive inspection device and method performance will be demonstrated through prototype evaluation and testing over the required range of parameters including numerous deployment cycles and destructive testing to verify non-destructive test results. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology for Navy use.

PHASE III: The company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop a thin walled CRES pipe joint non-destructive inspection device and/or method according to the Phase III development plan for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: If successfully demonstrated, there may be a commercial market for this thin walled pipe joint non-destructive inspection method in any industry that employs thin walled CRES piping such as petroleum production or distribution.

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KEYWORDS: Thin walled CRES; inspection of welded joints; non-destructive pipe inspections; leakage across pipe joints; low cost method to non-destructively inspect; non-destructive in-situ pipe inspection; JP-5 fuel

N141-052 TITLE: Thin Walled Corrosion Resistant Steel (CRES) Pipe Leak Repair

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMS 312, In-Service Aircraft Carrier Program Office

OBJECTIVE: The objective is to develop an innovative technology that stops leakage in a thin walled CRES welded joint within Jet Propulsion Grade JP-5 fuel lines without causing further damage to the fuel line.

DESCRIPTION: Thin walled (Schedule 10) CRES 316L pipe (ref. 1) has been used in JP-5 fuel systems (ref. 2). The pipe joint design uses a belled end fitting creating an inherent crevice. The thinness of this piping may lead to poor weld quality at the welded joints which could cause additional crevices within the pipe joint. Crevices create areas for corrosion to form eventually resulting in leakage across the pipe joint. This type of pipe is currently in use and there is a need to create an easily applied repair to staunch any leak which may result from possible crevice corrosion without causing any further damage to the pipe. The welded joint repair is to be applied on In-service Aircraft Carriers while underway. In many instances, there is limited access space surrounding the pipe joint.

Pipe joint leakage failures were identified on the Aircraft Carrier, USS George H.W. Bush (CVN 77), within the first three years of service. The JP-5 fuel system installed on CVN 77 and planned for all FORD Class Carriers have over 28,000 welded joints per ship. Additional failures are expected to be identified.

Any material and/or technique developed must be safe for use in fuel piping and applicable for pipe sizes ranging from 2 to 12 inches. Joint types include couplings, tees and elbows which may be made using sockets or belled end fittings. The leakage repair for the intended pipe system must be able to tolerate contact with JP-5 fuel without contaminating the fuel, and must be able to withstand internal pressures up to 190 psi. Current state of the art pipe patches intended for damage control purposes are expensive and may not work well on thin walled piping or with JP-5 fuel. Repair techniques currently available use epoxy resins which require extensive surface preparation and curing time. In addition, due to the confined spaces on the ship, fumes from the application of epoxy resins can be hazardous and therefore require environmental protection. There is no evidence that epoxy resin pipe joint repairs being used by the Navy will last as long as the rest of the piping system or if the resin will tolerate contact with JP-5 fuel. Any repair approach should be expected to last as long as the base piping installation (~25 years). Currently, there is no available patch or industrial technique to meet this need.

The new CRES Pipe Leak Repair shall stop existing leaks, prevent future leaks, and achieve competing objectives of low installation and maintenance costs, and easy application. Any repair concept must stop an existing leak onboard an In-Service Carrier while it is underway. Ideally, any proposed repair method should not require hot work or evacuating the system.

Epoxy resin patches and welding options are already available to repair defective pipe joints. A variety of damage control for fuel lines related leak repairs exist. However, the damage control related repairs are expensive and generally do not provide a permanent repair (ref. 3). Composite materials could be used for this pipe repair application (ref.4). The bulk of research into this area is directed at large pipe repair for the petroleum or construction industry where metal sleeves are an option (ref. 5). Although this type of sleeve may not be an option for this application, the related research may be helpful. Another potential area to investigate is metal deposition which can be applied similarly to welding (ref. 6) or applied with high pressure gas (ref. 7 and 8).

PHASE I: The company will develop a concept for an inexpensive and easily applied thin walled CRES pipe leak repair that can stop an existing leak, withstand pipe pressure up to 190 psi and tolerate contact with JP-5 fuel. The concept should demonstrate how the leak repair could be applied with limited access to the pipe joint on an In-Service Aircraft Carrier while underway. The concept should also present reasonable cost estimates for the technique to stop an existing leak and prevent future leakage. Feasibility will be established by material testing and/or analytical analysis/modeling. The small business will provide a Phase II development plan that addresses technical risk reduction, and provide performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II development plan and the Navy requirements for the thin walled CRES pipe leak repair. Repair performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology for Navy use.

PHASE III: The company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop a thin walled CRES pipe leak repair according to the Phase III development plan for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: If successfully demonstrated, there may be a commercial market for this thin walled pipe joint leak repair in any industry that employs thin walled CRES piping, such as petroleum production or distribution.

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KEYWORDS: Thin walled CRES; repair welded joints; welded pipe joints; stop existing leaks; pipe repair; damage control for JP-5 fuel piping; JP-5 fuel

N141-053 TITLE: Compact High Speed Signal Processor

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PMS415, Undersea Defensive Warfare Systems Program Office

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OBJECTIVE: To develop an innovative compact, high speed signal processing method to support data fusion for torpedo defense applications that achieves the requirements of compact size, high speed processing for signal detection and assessment, power and affordability.

DESCRIPTION: Defensive systems for submerged and surface platforms rely on a variety of sensor systems. Planned and emerging missions for the Navy will increase the demand for the number of sensors and improved situational awareness. Data fusion and advanced signal processing of data from these sensor systems will play a key role supporting these new missions. The ability to process data at rates equivalent to what unmanned aerial vehicles (UAVs) perform at for video and other imagery will represent a dramatic increase in performance improvement for the torpedo defense systems.

Increased signal processing capacity is an urgent and constant need. Applying technological advances developed for UAVs or telecommunications to Navy platform defensive systems enables affordable performance improvement. The ability to process data in the form of radar captured video or images presents major system design challenges for developers of military platforms. However, new commercial products are easing these challenges with a variety of solutions that address the particular needs of moving image-based data at high speed and processing it for the demanding real-time needs of UAV applications (ref 1). The challenge is in leveraging or building from these technologies and applying them to the undersea environment with its unique challenges.

Mission capability will be increased through rapid integration of new and more complex sensors, and in some cases, sharing of data from these sensor systems for the first time. The deployment of multiple sensors for signal detection improves system survivability, results in improved detection performance and may provide increased coverage in terms of surveillance region and number of targets. The acquisition program is supportive of this topic because it specifically addresses commonality in signal processing among multiple systems while improving performance and capability through data fusion. Life-cycle costs will be reduced when a signal processing architecture is implemented that allows for simple upgrades in software algorithm implementations and leaves headroom for additional sensors to be added to current systems. In the past, a new, platform specific, signal processing system would have to be developed and introduced to support changes in data throughput. Data fusion would not be possible.

A suitable technology requires innovative conceptualization and design since a straightforward engineering solution is not obvious. Proposed solutions should promote a total systems approach for torpedo defense systems: this would include computationally efficient signal processing and data fusion algorithms, processor design, and integration into the proposed platforms. Solutions may be comprised of technologies or concepts developed for other military applications (such as unmanned aerial vehicles and Field Programmable Gate Arrays [FPGAs) (ref 2), mobile communication (ref 3), and other commercial applications that have yet to be included in torpedo defense systems. A successful effort will support current and near-term processing requirements and allow for data fusion among a set of unique sensor systems that vary from platform to platform. The solution should also support upgrades in sensor systems with significant growth in data throughput from acoustic data up to video imaging requirements. Proposals will be accepted for countermeasure and platform defensive applications. Systems commonality for platform defensive applications is encouraged.

PHASE I: The company will develop concepts for innovative, compact, high speed signal processing for torpedo defense applications. The feasibility of the concept in meeting Navy needs should include a tradeoff study and performance comparisons with legacy systems developed into a useful product for the Navy. The performance data of the legacy systems will be measured during laboratory testing conducted by NUWCDIVNPT. Feasibility will be established by material testing and analytical modeling. The small business will provide a Phase II development plan that addresses technical risk reduction and provides performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the company will perform systems analysis and benchmarking trade studies to create a compact, high speed signal processor. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for the compact high speed signal processor system. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will also prepare a Phase III development plan to transition this technology to Navy use.

PHASE III: The company will develop a compact high speed signal processor system according to the Phase III development plan for evaluation to determine its effectiveness in an operationally relevant environment. The company will be expected to support the Navy in transitioning the technology for Navy use by successfully supporting processing requirements which allow for significant growth in data throughput for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology would be applicable to applications involving USVs and UUVs, such as those used for oil and gas exploration, bathymetry, harbor and coastal surveillance for homeland defense, especially in high alert conditions.

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KEYWORDS: Signal Processing; Embedded Processing; Data Fusion; Waveform Intensive Applications; FPGA; Multi-sensor Processing

N141-054 TITLE: Predictive Condition-Based Maintenance for High-Powered Phased Array Radar Systems

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO IWS 1.0, Integrated Combat Systems, AEGIS

OBJECTIVE: Develop an innovative, predictive condition-based radar maintenance forecaster for high-powered radar systems to reduce maintenance costs and increase operational availability.

DESCRIPTION: An innovative predictive algorithm for forecasting the performance and maintenance of naval radar systems is required to address issues with the present method of maintenance. Currently, preventative maintenance for high-powered phased-array multi-function naval radars is primarily time-based and dependent upon human monitoring of subject systems. Computer-controlled test and monitor systems provide system status and allow for monitoring of key sub-system parameters such as voltage, power, capacitance, etc., but this data is not captured and thus not analyzed over time. Preventative maintenance is not driven by automated system status or performance indicators and trends. Thus, maintenance is performed inefficiently and often fails to predict or prevent component and system failures.

Corrective radar system maintenance usually occurs after a component or system fails, or if component degradation is observed during routine preventative maintenance. Failure to anticipate corrective maintenance requirements increases mean time to repair (MTTR), and decreases operational availability (Ao). Unanticipated corrective maintenance actions also drive up costs due to increased labor costs and expedited shipping costs when parts have to be obtained quickly.

Expert systems have been developed over the past 40 years that are used in a number of fields where diagnoses or predictions are possible and useful. As a subset of the computer application known as artificial intelligence, an expert system is capable of making decisions and can be trained to improve its performance [Ref 1].

An expert system that can use readily available, but not currently recorded, radar system performance parameters to predict and thus preempt component and system failures is sought to improve overall system Ao, reduce MTTR, and reduce system maintenance and repair costs [Ref 2].

An example of a desired solution is an innovative expert system that continuously monitors the radar's component parametric data streams and then conducts trend analysis. The expert system would combine the trend analysis data with component degradation and failure data reports to improve its prediction algorithms. The desired result is a system that is capable of providing a report such as, "switch tube "A" has a 90% probability of failure within the next 72-96 operating hours" or "the output of component "B" decreased by 10% in the last 7 days with the rate of output decrease accelerating significantly in the last 24 operating hours, indicating there is an 89% probability of component failure in the next 96 operating hours."

The Navy seeks an innovative condition-based maintenance technology (i.e., a predictive condition-based radar maintenance forecaster) that can use adaptive learning techniques to "understand" component interdependencies and can accurately predict component failure of radar transmitters based on all available parametric data. The specific parts of interest include, but are not limited to, all vacuum and traveling wave tubes (TWT), high voltage power supplies, inverters, sidewall capacitors, faint rectifiers, and cross-field amplifiers. The technology will correlate to the component parametric data and potentially the modes of operation of the radar, power output, phase waveforms, waveform demands, waveguide VSWR, voltages, and will adaptively "learn" to associate different conditions to different failure rates. [Ref 3]

PHASE I: The company will develop a concept for a predictive condition-based radar maintenance forecaster that meets the requirements described above. The company will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be feasibly developed into a useful product for the Navy. Feasibility will be established by testing and analytical modeling. The small business will provide a Phase II development plan that addresses technical risk reduction and provides performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II development plan and the Navy requirements for the predictive condition-based radar maintenance forecaster. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop the predictive condition-based radar maintenance forecaster according to the Phase III development plan for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Numerous commercial air-search radars are in use today. A predictive maintenance forecaster would improve the operational reliability of these radars and improve their availability. Commercial radar manufacturers would be able to incorporate the technology into their radar condition monitoring software. This is an innovative capability that can be used in a growing and wide spectrum of sensors, electronic and high powered radar systems to increase operational availability (Ao).

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KEYWORDS: Expert Systems; Phased Array Radar; Condition-Based Maintenance; Adaptive Learning; Mean Time to Repair (MTTR); Prediction Algorithms

N141-055 TITLE: Automated Function Point Analysis

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PEO IWS 1.0, Integrated Combat Systems, AEGIS

OBJECTIVE: Develop an innovative function point analysis software tool for program managers that achieves requirements for estimating software costs.

DESCRIPTION: The Navy uses estimates of software size such as Source Lines of Code (SLOC)) to determine software development efforts and their associated combat system development costs. There are significant variations in methods used for estimating SLOC, which introduce risk. Current SLOC estimates are a prediction of end-product code size that varies with code language (such as Java, C++) and software design approach. Estimates of new, modified, and reused SLOC to implement a capability are based upon a Subject Matter Expert's (SME) judgment which makes the resulting estimate highly subjective (Ref 1).

Program Managers are required to prevent program cost overruns. They rely upon accurate cost estimates and software development metrics to ensure programs are executable and not at risk of cost overruns. The use of SLOC creates high risk cost estimates due to the potential for significant variation in methods for estimating end-product source lines of code.

The International Function Point User Group (IFPUG) has developed a Function Point based methodology to estimate software costs that is more accurate than the SLOC methodology. The Navy's transition to the Function Point based methodology has been hindered because existing historical cost data is based upon SLOC. Significant manual effort is needed to transition from the current Navy SLOC practice to the current industry Function Point methodology. The Object Management Group (OMG) recently adopted an Automated Function Point (AFP) Specification. The standard defines how to count function points that can be used to ensure software counting consistency and will provide the standard required to enable transition from SLOC to Function Point based software estimation methodologies (Ref 2, 3). However, innovation is required to adapt the standard for Navy use. Techniques will be needed to provide information required to support software size estimation. The Navy has already adopted a number of OMG standards such as the Unified Modeling Language (UML), Data Distribution Service (DDS) publish/subscribe, and the System Modeling Language (SysML). The Navy has determined that using the OMG AFP Specification will provide better estimates related directly to capability requirements that are available prior to software design.

The Navy needs a tool to identify existing function points within its collection of software. After identifying the function points, innovative approaches are required for the development of algorithms that can use the function points to efficiently sort through the source code and generate accurate function point estimates that comply with industry standards. Techniques will be required for determining which files have associated functionality, association of functionality to desired software capability, and presentation of the data to support size estimation. The resulting technology should assist with identifying key areas of focus and provide understandable rationale for reported function point estimates.

Once function points have been calculated, the user should be able to identify changes in capability requirements to enable calculation of changes in function points and associated software size. The tool should determine how requirements will be used to support analysis of software impacts related to implementing the new capability. This innovation will ensure accurate estimates of end product software size and thus reduce escalated cost estimates.

PHASE I: The company will develop a concept for an innovative function point analysis software tool that meet the requirements described above. The company will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be feasibly developed into a useful product for the Navy. Feasibility will be established by analytical modeling. The small business will provide a Phase II development plan that addresses technical risk reduction and provides performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype tool for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for an innovative function point analysis software tool. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters including numerous deployment cycles. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: The company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop an innovative function point analysis software tool according to the Phase III development plan for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Given that the proposed tool is based upon an OMG standard, the tool has private sector commercial applicability. Numerous industries (e.g. banking, security, aerospace, etc.) use function points as a basis for estimating software development effort. Function point estimates are currently calculated manually, but an OMG standard based tool provides for added efficiency and estimating consistency.

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KEYWORDS: Function Points; Source Lines of Code (SLOC); Software Cost Estimates; Automated Function Point; Software Size; International Function Point User Group (IFPUG)

N141-056 TITLE: <u>Waterproof Towed Array Hosewall</u>

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMS401, Submarine Acoustic Systems Program Office

OBJECTIVE: The objective is to develop a towed array hosewall that prevents water molecules from migrating through and saturating the Isopar inside the array.

DESCRIPTION: Fat Line Towed Arrays (ref 1,2) are experiencing hydrophone failures due to interaction with water molecules and require extensive repairs after limited use. The Navy seeks an innovative hosewall material, coating, or additives that preserve all of the existing hosewall properties, while also preventing water permeation. The ideal solution is one that completely prevents water permeation for more than two years in the underwater environment. The objective is to slow down permeation by a factor of five (5).

The existing hose material is a polyether-based thermoplastic polyurethane (TPU) manufactured by the Lubrizol Corporation, designated at 58300 Estane. The extrudable material was tailored for towed array applications; with abrasion resistance and ultraviolet resistance built-in. Water molecules from the ocean environment are able to permeate through the hosewall in the Navy's towed array application. Under typical pressure and temperature profiles, water molecules can migrate through the ¼ inch hosewall in 2 to 3 months. These molecules eventually saturate the Isopar fill fluid used in the array, and attack critical array internal components.

The challenge is to preserve all of the hose properties (tan delta, density, flexure resistance, Isopar compatibility, abrasion resistance) that required a substantial test program to qualify, while providing this new capability. The end result will be a hosewall that does not impact the existing beneficial properties of the hose; acoustic self-noise, specific gravity, hoop strength, tensile modulus and manufacturability by extrusion. An ideal solution is an additive that is sufficiently small to minimize hose property changes while making the array waterproof. This improvement will greatly reduce repair costs and improve the operational availability of Fat Line towed arrays by allowing the arrays to remain within specification and fielded.

PHASE I: The company will develop concepts that demonstrate substantial improvement in the reduction of water permeation in the towed array hosewall either by innovative material, coatings, or additives. The concepts will also make a detailed comparison to all mechanical hose properties of the Lubrizol 58300 Estane baseline material, to aid in quantifying the risk of using this new hose as a substitute for the baseline. The company will demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be feasibly developed into a useful product for the Navy. Feasibility will be established by material testing and analytical modeling. The small business will provide a Phase II development plan that addresses technical risk reduction and provides performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the small business will develop a prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in Phase II development plan and the Navy requirements for the Fat Line towed array hosewall. System performance will be demonstrated through prototype evaluation and modeling or analytical methods over the required range of parameters, including toe testing and critical array self-noise properties. Evaluation results will be used to refine the prototype into an initial design that will meet Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: If the Phase II prototype is successful, the company will work with the Navy and array manufacturers to transition the new cable design into existing systems. The company will be expected to support the Navy in transitioning the technology for Navy use. The company will develop a Fat Line towed array hosewall according to the Phase III development plan for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the Navy for test and validation to certify and qualify the system for Navy use.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Innovative improvement techniques to reduce or eliminate water permeation are applicable to other Navy towed array programs, as well as oil and seismic exploration applications.

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KEYWORDS: Self-noise acoustic properties of towed arrays; towed array; hosewall; permeability of towed array; 58300 Estane; thermoplastic polyurethane (TPU)

N141-057 TITLE: Innovative Approach for Modeling the Impact of Paint Gloss on Visual and Near IR Detection

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: PMA-261 CH-53E; PMA-262 Global Hawk; PMA-207 C-130

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OBJECTIVE: Develop and demonstrate the analytical means to model the visual through near infrared detection of an air vehicle with specularly reflecting top coat finishes.

DESCRIPTION: Program Offices are trying to reduce operation and maintenance (O&M) costs and need to understand the susceptibility trade-offs between the gloss, semi-gloss, and flat topcoat finishes. Glossy paints are less prone to environmental degradation, especially service fluids, which reduce maintenance costs as compared to flat, or “camouflage” paints. However, flat paints reduce the susceptibility of aircraft to detection as the reflective characteristics of flat paints typically yield a more diffuse distribution of reflected energy, i.e., less susceptible to glints or persistent glares.

The Navy currently has an excellent capability with the SPIRITS code to model mid wave and long wave infrared detection for air vehicles with a diffuse (flat) topcoat finish. The Navy's modeling capability is deficient for more specular surfaces down in the visual and near infrared spectrum. Semigloss and gloss finish paints are examples of specular surfaces. This task is intended to expand the Navy's capability and proficiency with the available analytical codes to include the visible and near infrared spectrum. We need to fully understand the survivability implications of changing from flat paint schemes to more glossy paint schemes.

Beginning with a selection of simple shapes and moving on to full scale air vehicles, the contractor will model the differences in radiance and detection range achieved by using several FED-STD-595B colors of various surface finishes of MIL-PRF-85285 topcoats. The colors to be studied include: blue-green 25237 and 35237, white 17925, 27925, 37925, and gray 26373 and 36373. Variants of a specific color or close commercial surrogates are negotiable. The modeling effort shall be focused heavily in the visible and near IR spectrum. For calculation of detection ranges in Phase II, use the human eye as the threat sensor for the visible spectrum. Threat sensor data in the near IR spectrum will be provided during Phase II.

PHASE I: Develop and demonstrate the capability to accurately model the radiance of reflected solar energy from simple shapes (flat plate, cylinder, sphere) painted with flat, semi-gloss and gloss versions of the paints specified in the description above. The selected contractor(s) will need the capability to acquire the bidirectional reflectance distribution function (BRDF) and directional hemispherical reflectance (DHR) data required to complete this task. Clearly define all technical assumptions and any known shortfalls. Develop a plan of action and milestones to expand the analysis to a full scale air vehicle.

PHASE II: Apply modeling techniques and lessons from Phase I on a full scale CH-53E and/or other Navy air vehicle under consideration for changes to paint scheme. Use this model to calculate differences in detection range between the various paint schemes. The government will work with the contractor to generate a suitable geometric model of the selected air vehicle. The outcome of this phase would involve actual air vehicle signatures and therefore be classified. The selected contractor(s) must have the capability to work with classified data up to the SECRET level.

PHASE III: Transition the data and lessons learned from the previous two phases to the relevant government agencies that can use these analytical codes. Improvements and modifications to codes developed under this effort may be marketed to any other customers of the codes, however, signatures and/or detection ranges of specific air vehicles may not.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Modeling and simulation software developed under this effort can be made commercially available through proper code distribution and licensing agreements and limitations coordinated with the government sponsor.

REFERENCES:

1. MIL STD 2161B(AS) Paint Schemes and Exterior Markings for US Navy and Marine Corps Aircraft

2. MIL PRF 85285 Coating: Polyurethane, Aircraft and Support Equipment Performance Specification

3. FED STD 595B Colors Used in Government Procurement

KEYWORDS: Infrared; Analysis; Visual; Codes; Gloss; Paint

N141-058 TITLE: High Sea State Automated Deployment and Retrieval of Towed Bodies from a Small Surface Platform

TECHNOLOGY AREAS: Ground/Sea Vehicles

OBJECTIVE: Develop and demonstrate a prototype system for automated deployment and retrieval (D&R) of a towed body from a small surface platform in a high sea state.

DESCRIPTION: The Navy is developing towed underwater systems that are deployed and retrieved (D&R) from surface vessels. D&R of these underwater systems is sea-state limited, due to wave-induced relative motion. This topic focuses on the "near-field" challenges of D&R of a tethered underwater body, the period of time during which the towed underwater body and surface vessel are in close proximity and on managing/mitigating the relative motions to minimize chances of collision and damage. It also focuses on automation of the D&R process, the ability to cross-deck the D&R system between various surface vessels, and analysis of mechanical stresses of D&R system and deck loads. The key technical risk is the motion between the 2 platforms. This topic solicits innovative approaches that employ, for example, state-of-the-art computational modeling, short-term platform motion forecasting algorithms, mechanical and inflatable structures to minimize impacts of a collision and automated D&R. The Topic will focus on surface craft of 7-12 m in length operating in SS 4 and towed bodies of 300-2000 lbs. In addition, the ability to operate with a freeboard of up to 6 meters is of key importance due to future desire to operate the D&R system from a larger surface vessel.

Several previous projects have addressed the problem of automated D&R of a Unmanned Underwater Vehicle (UUV) from a USV, for example, STTR N07-T037, and the ongoing ONR Single Sortie Detect-to-Engage program. These have made progress in far-field capture of the UUV and recovery of the UUV on the USV in low SS or in higher SS with a human in-the-loop. This topic extends the previous work to high SS, which is a technically challenging problem, and addresses the issue of D&R from platforms with high freeboard.

PHASE I: Develop a concept design for a D&R system according to the parameters listed in the Description section. Perform modeling and simulation (M&S) for an initial evaluation of design concept. Phase I deliverable shall include a report describing: (1) the concept design, (2) performance predictions, (3) the M&S approach and results, in view of the considerations in the Description section. Phase I Option, if awarded, could address initial work in preparation for building a prototype in Phase II.

PHASE II: Fabricate and demonstrate the operation of a prototype D&R system in on-water tests. Phase II deliverables shall include: (1) the prototype system, (2) the detailed design, and (3) a report describing on-water test approach and results.

PHASE III: As part of the transition program, conduct in-depth on-water validation of deploy and retrieve prototype using transition program's towed asset and participate in a Fleet Experiment. Phase III deliverables shall include a report describing on-water test approach, metrics and results.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Marine Survey, Bathymetry.

REFERENCES:

1. Automated Launch and Recovery of Small, Untethered Unmanned Underwater Vehicles from Unmanned Surface Vehicles, http://www.dodsbir.net/sitis/archives_display_topic.asp?Bookmark=30457, accessed 12 Jun 2013.

2. An Unmanned Underwater Vehicle Launch, Recovery, and Onboard Handing and Servicing System (LROHSS) for use with Unmanned Surface Vehicles, https://www.navalengineers.org/SiteCollectionDocuments/2010%20Proceedings%20Documents/Launch%202010/Selzler.pdf, accessed 12 Jun 2013.

3. USV Payloads for Single Sortie Detect to Engage (SS-DTE) Mine Counter Measures, Solicitation Number: ONRBAA12-018, https://www.fbo.gov/?s=opportunity&mode=form&id=b693f0517649f4b737ad96292ebd2c7d&tab=core&_cview=0, accessed 12 Jun 2013.

KEYWORDS: Deploy and retrieve, surface vessel, towed payload, sea state-induced relative motions

N141-059 TITLE: Threat Agnostic, Guided Expendable Decoy (TAgGED)

TECHNOLOGY AREAS: Sensors

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: Develop a threat agnostic expendable decoy that has a guided trajectory, fits in a standard decoy dispenser and significantly improves the probability of decoy success over current countermeasure techniques.

DESCRIPTION: Military aircraft can be attacked by anti-aircraft missiles that are designed to impact the aircraft and initiate a warhead. These aircraft often have a self-protection procedure of sensing incoming missiles and deploying an expendable decoy to lure the missile away from the targeted aircraft. However, once the expendable is deployed its trajectory is usually uncontrolled and the effectiveness of the decoy can be compromised by non-optimal positioning of the decoy and the aircraft within the missile seeker's field of view. The purpose of this project is to advance decoy technology by improving the trajectory control of deployed decoys. A decoy with a controlled trajectory capable of interposing itself between the missile and the targeted aircraft, and presenting a more desirable target to the anti-aircraft threat, would significantly increase its effectiveness. In addition, guidance control opens the possibility to optimize decoy trajectories so that their effectiveness is always maximized. In order to achieve this advance, expendables need to be designed to include thrusters and propellant sufficient to achieve and maintain the desired trajectory, guidance command and control hardware, and an obscurant/decoy payload, while still achieving a form factor to permit deployment from a standard aircraft decoy dispenser (e.g. Navy/Marine Corps AN/ALE-47 Aircraft Chaff/Flare Dispenser). The allowable decoy trajectory needs to be controlled such that it is capable of progressively moving away from the aircraft it is protecting while maintaining a position in between the aircraft and the incoming threat. Once it is in this position, the decoy would then be maneuvered to draw the threat away from the aircraft. The goal of this project is to develop a guided expendable decoy concept, perform a trade study and an optimized system design, fabricate and test a prototype system, and transition the technology to the fleet.

PHASE I: Develop a guided expendable decoy concept that fits into a standard decoy dispenser. The expendable should be approximately 5.8 inches in length, 1.4 inches in diameter and weigh less than 400 grams. Longer and heavier expendable designs would require justification. The company will quantify the benefits of their design using a designer's trade space for current/anticipated threats. The company will make a design recommendation and demonstrate the feasibility of achieving the requirements described above and will establish that the concept can be developed into a useable product for the Navy. The design recommendation and trade space will address capabilities such as flight duration, maneuverability, volume available for payload, etc. The company will provide a Phase II development plan that addresses technical risk reduction and provides performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, the company will develop a prototype that demonstrates the guided expendable capabilities. The prototype will be evaluated to determine its capability in meeting Phase II performance goals and Navy requirements. The company will prepare a Phase III development plan to transition the technology to Navy use.

PHASE III: Upon successful results at the end of Phase II, the company will be expected to support the Navy in continuing the transition of the developed guided expendable technology through the RAPIER FNC. The business will produce a guided expendable for evaluation to determine its effectiveness in an operationally relevant environment and will provide support for test and validation to certify and qualify the new technology in navy systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The guided expendable decoy developed also has potential to protect civilian aircraft.

REFERENCES:
1. The Infrared & Electro-Optical Systems Handbook. Countermeasure Systems, Volume 7.

2. Propellants, Explosives, Pyrotechnics, An International Peer-Reviewed Journal on Energetic Materials, Official Journal of the International Pyrotechnics Society.

KEYWORDS: Decoy; obscurant; expendable; guided; countermeasures; protection

N141-060 TITLE: Flexible Solid State High Power Radio Frequency (HPRF) Test Capability

TECHNOLOGY AREAS: Electronics, Battlespace, Weapons

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OBJECTIVE: Develop HPRF architectures capable of generating arbitrary waveforms with frequency and bandwidth agility using solid-state systems for counter electronics vulnerability testing.

DESCRIPTION: Most current high power (MW class) radio frequency (HPRF) test sources are limited to commercial off-the-shelf (COTS) vacuum electronics based technologies. These sources are inherently limited in waveform flexibility with respect to frequency, bandwidth, pulse-width and duty cycle [1]. While solid-state power amplifiers offer increased waveform flexibility and continuous wave (CW) operation, they are limited to single kW levels. Navy laboratories require a flexible test capability to support both vulnerability and susceptibility work at power levels greater than the current state-of-the-art amplifier technology can provide. The test capability will provide critical data to inform future technology development efforts for emerging high power solid state technology. A core dataset is required for these novel waveforms to provide technology maturation goals.

Potential technological solutions include, but are not limited to, non-linear transmission lines (NLTL) and photoconductive semiconductor switches (PCSS). In the case of the NLTLs, the output is varied via physical alteration of the system, variable driver parameters and magnetic biasing. PCSS systems have the potential to achieve purely arbitrary outputs, but require large and costly laser systems. In both cases, materials research has, and will continue to, play a leading role in their development. A potential solution may also take advantage of a modular design, arrayed elements, or other power combining techniques; however, a high power, broadband power combiner design will require special attention and should be described in detail.

The proposed concept demonstrator should be able to transmit an arbitrary waveform at power levels of 10 MW at a minimum, with an objective power output of 100 MW and a rep-rate on the order of kHz in the range of VHF to S-band. The prototype design should include all elements of the devices including prime power, power conditioning, control hardware, thermal management, RF source, RF transition, and antenna.

PHASE I: Conceptualize, design, and model key elements for an innovative, all solid-state, arbitrary waveform, HPRF source. The design should establish realizable technological solutions for a device capable of achieving output power levels of 10 MW, at a minimum, and rep-rates on the order of kHz in the frequency range of VHF to S-band. The proposed design should be an 80% complete solution and include all sub-systems from prime power up through the RF source and antenna. The design should include circuit modeling and analysis of both the HPRF source and any critical support system elements such as a high voltage (HV) driver. The proposed brassboard system should be designed for vehicle portability, i.e. contained in/on a pallet or trailer. The antenna design is not the focus of this SBIR; however, the chosen solution, whether a novel design, COTS or interchangeable antenna arrangement should be supported by modeling and simulation efforts. Additional modeling and simulation should be performed to determine predicted efficiency, prime power, and thermal management requirements. An overview of the current state of the art for each of the key prototype elements along with manufacturer information should also be provided, focusing on the solid state components required for this application. Cost analysis as well as material development should be included so as to ascertain critical needs not yet fully developed or readily available given current technology.

PHASE II: Phase II will involve the design refinement, procurement, integration, assembly, and testing of a proof of concept brassboard prototype leveraging the Phase I effort. The Phase II brassboard prototype will be capable of greater than 500 kW output at a rep-rate of 100's of Hz. The brassboard system should be capable of operating in a laboratory environment, such as an anechoic chamber or Gigahertz Transverse Electromagnetic (GTEM) test cell. This brassboard prototype must demonstrate a clear path forward to a full scale concept demonstrator based on the selected technology. Data packages on all critical components will be submitted throughout the prototype development cycle and test results will be provided for regular review of progress. The use of actual hardware and empirical data collection is expected for this analysis. A refined design package should also be submitted that meets the solicitation threshold of an HPRF arbitrary waveform source capable of power levels exceeding 10 MW, with an objective of 100 MW, and a rep-rate on the order of kHz.

PHASE III: The performer will apply the knowledge gained during Phase I and II to build and demonstrate a full scale prototype device capable of transmitting an arbitrary waveform at power levels exceeding 10 MW and a rep-rate on the order of kHz. The prototype will represent a complete solution and include all system elements including prime power, power conditioning, control hardware, thermal management, RF source, RF transition, and antenna. The prototype should be ruggedized for, at a minimum, testing in an outdoor environment and be environmentally enclosed. The prototype will be applicable for direct test range use within government or with a commercial partner against candidate test articles relevant to EMI or HERO testing and validation relative to perceived threats and system vulnerabilities. Potential utility in a non-lethal, non-kinetic engagement option against a wide variety of electronic targets will be considered depending on potential platforms, pulse flexibility as well as size/weight/power requirements.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: HPRF sources are used in a wide variety of commercial applications including communications, sensor and medical applications. A source of this type would also be highly valuable in industrial EMI testing.

REFERENCES:
1. High Power Microwaves, J. Benford, J. Swegle, E. Schamiloglu, Taylor & Francis, New York, 2007.

2. Microwave Engineering, 3rd Ed., M. Pozar, John Wiley & Sons Inc., New Jersey, 2005.

3. R. Pouladian-Kari, A. J. Shapland, T. M. Benson, "Development of ferrite line pulse sharpeners for repetitive high power applications," Microwaves, Antennas and Propagation, IEE Proceedings H, 1991, Vol. 138, pp. 504–512.

4. Characterization of a Synchronous Wave Nonlinear Transmission Line, P. Coleman, et al., Proc. Pulsed Power Conf., pp. 173-177, 2011.

5. Wide Bandgap Extrinsic Photoconductive Switches, J. Sullivan, Lawrence Livermore Nation Laboratory Report, LLNL-TH-523591, Jan. 2012.

KEYWORDS: High Power Radio Frequency; High Power Microwave; Frequency Agile, Solid State, Directed Energy

N141-061 TITLE: Sensing and Control Technology to Assist in Vehicle Launch and Recovery

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors

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OBJECTIVE: Develop motion sensing and control capabilities that can be implemented on a large surface vessel for the at-sea launch and recovery of mission systems that support Mine Warfare and Special Forces operations.

DESCRIPTION: The Military Sealift Command will operate the Afloat Forward Staging Base (AFSB), references [1,2], in support of mine warfare and special operations that require multiple manned and unmanned off-board systems requiring launch and recovery in a range of sea conditions. Unlike the interim platform, the USS PONCE (AFSB-I), reference [2], which is a refitted Austin-class amphibious transport dock (LPD-15), the AFSB is to be built upon the third Mobile Landing Platform (MLP) hull and will not have an internal well deck to provide a sheltered environment from which to launch, recover, and support mission essential offboard systems.

This effort will develop an automated launch and recovery system for AFSB-based vehicles; however, a manual or semi-automated system is acceptable. Most vehicles operated from the AFSB are presumed to be manned or unmanned surface vessels, but some such as the Remote Multi-Mission Vehicle described in reference [3] have most of their hull submerged during launch or recovery.

The AFSB configuration, based on the Mobile Landing Platform (MLP) hull shown in reference [1], was modified to function as a host platform for manned and unmanned vehicles performing mine warfare and Special Forces operations. The AFSB must have the capability of launching and recovering vehicles for these operations over a variety of environmental conditions. The MLP hull is 765 feet long and has a beam of 164 feet with a displacement of approximately 34,500 tons and should provide good sea-keeping performance with the exception of long period waves at specific relative wave headings. It is the smaller mission systems that will be particularly affected by wind and wave conditions and that will make launch and recovery operations outside the shelter of a well deck a challenge. As discussed in reference [5] the use of conventional cranes or davits without the assistance of sensing or control for motion compensation on a vessel in an open sea can result in uncontrolled pendulation with the potential for injury or damage to the host platform and mission payload. Also mentioned in reference [5], is the expectation that rescue boat operations can be executed through sea state 6 conditions.

The desired approach should focus on the launch and recovery system on the host platform providing the sensing and control required rather than making significant modifications to mission systems or vehicles. The mission systems were largely developed without the sensing and control technology that would enable automated launch and recovery of the vehicles. In order to maintain commonality of these systems when employed on other platforms such as the Littoral Combatant Ship (LCS) no modifications that significantly affect size, weight, power requirements or interfere with essential mission capabilities are acceptable. Therefore, all sensing or control for launch and recovery must reside solely on the host platform. Solutions could include active motion tracking by the recovery apparatus of the mission vehicle as well as mechanisms for motion mitigation. Other potential solutions could involve assisted control of manned and unmanned vehicles and thus must be compatible with vehicles that might be under manual control, either onboard or remotely, or operating autonomously. Particularly beneficial would be means to enhance the safety of launch and recovery of manned vessels, typically Rigid-Hulled Inflatable Boats (RHIBS).

The AFSB launch and recovery system must be versatile. It should be capable of launch and recovery of various mine warfare and special operations vehicles either without reconfiguration or with a quickly reconfigurable design.

PHASE I: Develop and assess feasibility of concepts for the launch and recovery of manned and unmanned systems that enhance the capability of the AFSB to perform its missions. Modeling and simulation should be performed to substantiate key performance attributes such as robust operation throughout a range of sea conditions. Identify sensor and control architectures and system performance parameters in conceptual design. Phase I Option efforts could include hardware-in-the-loop simulation.

PHASE II: Develop a preliminary design based on Phase I results. Demonstrate via physical modeling of a proof-of-concept launch and recovery system or significant unique technology components. Develop full-scale detailed designs that include documentation of the interface to the AFSB and estimated costs for fabrication and installation.

PHASE III: Fabrication of a full-scale prototype launch and recovery system, installation onboard the AFSB, and demonstration in a relevant operational environment. Develop and provide documentation to support operation and maintenance of the prototype.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The offshore petroleum industry, the offshore wind energy industry, and the commercial maritime industry could benefit from a robust capability to launch and recover manned or unmanned systems from large vessels or floating platforms.

REFERENCES:

1. Afloat Forward Staging Bases
http://cno.navylive.dodlive.mil/2012/10/15/afloat-forward-staging-bases/

2. USS Ponce (AFSB(I)-15) - Afloat Forward Staging Base (Interim)
http://www.naval-technology.com/projects/uss-ponce-afsbi-15-afloat-forward-staging-base-interim/

3. US Navy Fact File, Remote Multi-Mission Vehicle.
http://www.navy.mil/navydata/fact_display.asp?cid=2100&tid=453&ct=2

4. Paper, "Design of an Unconventional ASV for Underwater Vehicles Recovery: Simulation of the motions for operations in rough seas"
https://www.navalengineers.org/ProceedingsDocs/Launch_Recovery/LR2012/LR2012_Day2/Brizzolara.pdf

5. Paper, "Boat Launch and Recovery – A Key Enabling Technology for Flexible Warships"
http://www.bmtdsl.co.uk/media/1057740/BMTDSL-Boat-Launch-and-Recovery-Conpaper-Pacificcon-Jan12.pdf

KEYWORDS: AFSB; Launch and Recovery; Mine Warfare (MIW); Special Forces; Sensors; Controls

N141-062 TITLE: Aluminum Alloy Development and Use in Additive Manufacturing Process Design for Drive System Gear Boxes

TECHNOLOGY AREAS: Air Platform, Materials/Processes

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OBJECTIVE: Develop, optimize and then demonstrate the use of an optimizable aluminum alloy composition and associated additive manufacturing process for the advanced fabrication of gear boxes, to exceed the mechanical and chemical properties of investment cast A357.

DESCRIPTION: Cast magnesium alloys are used extensively in the fabrication of helicopter gear boxes because they are lightweight. Unfortunately, magnesium alloys have serious corrosion challenges and must be protected, inspected, and maintained via costly and time consuming sustainment procedures in order to ensure safe operation. Cast aluminum alloys are beginning to replace some magnesium castings because of their higher corrosion resistance. Unfortunately, industry has experienced challenges consistently producing the complex, quality aluminum casting needed with the strength and weight comparable to magnesium.

Additive manufacturing (AM), a process in which a part is fabricated layer by layer from a digital design package, offers the potential to produce complex components at reduced cost, and time. AM has the potential to conserve material, reduce energy consumption, part cost, and fabrication time. However, in order to use AM effectively, new aluminum alloys need to be developed that take advantage of the AM process in order to enhance strength and reduce weight.

To-date, only two traditional aluminum casting alloys have been used in the AM of aluminum components. However, these alloys were designed for casting operations in which alloy viscosity and elemental partitioning during solidification (10 deg/sec) must be minimized at the expense of strength, ductility, and fatigue resistance. A new class of alloys is needed to take advantage of the much faster cooling rates (>1000 deg/sec) and unique processing condition used during AM.

PHASE I: Demonstrate the feasibility of a new or optimized aluminum alloy composition for powder/feedstock material via an additive manufacturing process; focusing on alloy composition optimization for resulting initial mechanical properties (modulus, etc.) and effects on homogeneity and microstructure as a function of deposition and cooling rate.

PHASE II: Optimize, select, and demonstrate the full mechanical (strength, toughness, stiffness, modulus, etc.) and chemical (density, durability, galvanic, substrate and coating compatibility, etc.) properties for the new or optimized AM aluminum alloy composition(s); with the "as-cast" investment cast A357 as the baseline fabrication/processing and material property improvement, including relative cost/time to produce and sustain. Require demonstration of both static and fatigue strength of equivalent or superior performance to as-cast investment cast A357.

PHASE III: Transition alloy composition to commercial supply via OEM, bulk material vendors, or other partnering agreement. Demonstrate and transition AM process controls and settings to FRC and other DoD production/maintenance facilities.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial aviation, automotive and industrial applications for advanced fabrication of lighter, stronger, more durable aluminum alloy drive system components via an AM process. Additional DoD transition opportunities in ground and amphibious vehicle components should also be pursued at this time if resulting properties and process requirements so warrant.

REFERENCES:

1. Frazier, W. “Direct Digital Manufacturing of Metallic Components: Vision and Roadmap" MAY 2010: USN Workshop - Direct Digital Manufacturing of Metallic Components: Affordable, Durable, and Structurally Efficient Airframes.

2. Herderick, E. "Additive Manufacturing of Metals" OCT 2011; Materials Science and Technology (MS&T) 2011.

KEYWORDS: Aluminum Alloy, Additive Manufacturing, Casting, Gearbox, Aircraft

N141-063 TITLE: Advance Growth Methods for Aligned and Ultra-long Carbon Nanotubes for Naval Applications

TECHNOLOGY AREAS: Materials/Processes, Electronics

OBJECTIVE: To develop new manufacturing approaches that allow the growth of ultra-long or continuous carbon nanotubes (CNTs), with low but controlled defect density, with controlled number of CNT walls, and high CNT density and alignment. The primary target application is structural, in the form of yarns, mats, prepegs, or nanocomposites but other applications such as electrical wires, electrodes, and cables are envisioned.

DESCRIPTION: Despite incremental morphological advances in this class of materials over the last 10 years, there are but a few companies that are able to manufacture small amounts of continuous yarns and mats made of short CNTs (between 0.1 - 1 mm). Of these, their thermal, electrical and mechanical properties are still between 5 and 10 times lower than the ultimate properties that this material could achieve. For example, the measured strain to failure for current CNT Yarn is only 1.5%, compared to 1.8% for standard IM7 carbon fiber and a predicted value of close to 20% for a continuous CNT.

What is limiting the attainment of the predicted, ultimate properties (and broadest use) of Carbon Nanotubes (CNTs) for structural, electrical, and thermal applications is our inability to grow these materials with an ultra-long or continuous length scale, with high densities, good alignment, and controlled defect densities at affordable costs. Paramount to this endeavor is the control of all aspects (geometrical, chemical, physical) of the catalyst particle, substrate, and growth environment. Any innovative growth methodology must be able to control at a minimum: the temperature of the catalyst particles; the supply of carbon feedstock and other gases into the processing chamber to optimize the supply of carbon to the catalyst particles; minimization of amorphous, carbonaceous or other poisonous deposits on the catalysts; immobilization of the catalyst particle either via chemical alloying or substrate texturing; deleterious inter CNT friction effects during growth due to differences in growth rates; the size and shape of the catalyst particles during growth; the CNT growth rate, and many other parameters. Novel, integrated substrate, reactor, and process control designs are needed for effective management of the above conditions to allow the next technical leap in CNT properties.

The ultimate goal is to attain the growth of ultra-long or continuous carbon nanotubes (CNTs), with low but controlled defect density, controlled number of CNT walls (or with a narrow distribution of diameters), and high density and alignment. Any small business submitting a proposal under this topic must have demonstrated previous experience in growing CNTs and clearly articulate how their new and innovative approach to CNT growth will control all the parameters mentioned above (and possibly many others).

PHASE I: The contractor will perform a laboratory scale demonstration of a new or improved: substrate; or reactor configuration; or catalyst; or any other process parameter for growth of high quality, dense, aligned and ultra-long (> 1 inch) or continuous Carbon Nanotubes (CNT). Precise control of catalyst composition, temperature, geometry, surface distribution, and anchoring method shall be demonstrated during CNT growth. Precise control of substrate texturing (via chemical or mechanical means) for feed stock gas distribution optimization, for controlling the size of a CNT bundles, for anchoring the catalyst particles or for other purposes shall be demonstrated. Accurate process control of carrier gases, carbon and catalyst feed stock gas chemistries, and gas temperature and pressure also shall be demonstrated. The contractor will grow CNTs with said process and processing chamber improvements and will measure their growth rate, ultimate length, diameter, crystallinity, areal density, and degree of alignment and will provide the data in a statistical format with a minimum average and standard distribution values. The contractor with the best overall values and most promising process in terms of scalability will move to the Phase II effort.

PHASE II: During the Phase II program the contractor will further develop, optimize and scale up the new technique demonstrated during Phase I and demonstrate the capability to manufacture continuous yarns (either of discreet, ultra-long , aligned CNTs or of continuous CNTs). The contractor will manufacture CNT yarns of several diameters ranging in size from 1 micrometer to several microns. The awardees will characterize the yarns elastic constant, strength, and strain to failure for various gauge lengths. The small business will also start exploring steps to lower the material manufacturing costs by possibly recycling process gases, increasing growth rates, scaling up the process, or other approaches.

PHASE III: The commercialization of the technology will be dependent upon the success of Phase I and II of the SBIR topic. Current naval needs for the technology are in the main rotor Hub in the H-1 helicopter, delamination resistant tail rotor flex beams in the CH-53K helicopter and thermally active nano-composites for de-icing applications in the MQ-4C Triton UAV. Which program will benefit most will not become clear until the program is well underway and at least the Phase II base is completed. At that time and appropriate program will be targeted. The commercial and military applications of a continuous and dense CNT fiber manufacturing process are endless. In addition to naval applications, the contractor will also pursue independent commercial applications in the sporting goods, transport, electronic and energy sectors.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The commercial aviation and shipping industry would benefit significantly from this new, low cost material form. The need for lightweight structural composites for next generation DoD naval platforms (ships, subs, and aircraft) also occurs in commercial counterparts. The commercial applications for this technology are very broad because of the extraordinary mechanical, electrical, and thermal properties that this material affords. Potential uses can be found in the transportation sector (primarily for aviation); in the energy sector (directly in the form of low resistance wires or high surface area electrodes); and in the space sector (for light weight structures and components; i.e. telescope baffles).

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2. Bronikowski, M. "Longer nanotubes at lower temperatures: the influence of effective activation energies on carbon nanotube growth by thermal chemical vapor deposition". J. Phys. Chem. C, 111, p17705-17712, (2007).

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4. Gommes, C., Pirard, J. P., & Blacher, S. "Influence of the operating conditions on the production rate of multi-walled carbon nanotubes in a CVD reactor". Carbon, 42, p1473-1482 (2004).

5. G P Sklar, K Paramguru, M Misra and J C LaCombe. "Pulsed electrodeposition into AAO templates for CVD growth of carbon nanotube arrays" Nanotechnology 16, p1265–1271 (2005)

6. M. De Volder, S. Tawfick, R.H. Baughman, A.J. Hart. "Carbon nanotubes: present and future commercial applications" Science 339: p535-589 (2013)

7. Q. Yuan, Z. Xu, B.I. Yakobson, and F. Ding. "Efficient defect healing in catalytic carbon nanotube growth" Phys. Rev. Lett., 108, 245505 (2012).

KEYWORDS: Carbon Nanotubes, CNT Growth, Composite Structures, Nanocomposites

N141-064 TITLE: MgB2 Power and High Frequency Data Leads

TECHNOLOGY AREAS: Materials/Processes, Sensors, Electronics

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: Develop and connectorize 10 and 100 line, minimum thermal conduction, flexible ribbon cable in coplanar and low crosstalk versions using MgB2 conductors. All types of signals (analog RF signal to 100 GHz, DC and AC power, and random digital data at high clock speed) will be delivered down this cabling.

DESCRIPTION: The recently announced IARPA C3 program will demonstrate that superconducting electronics (SCE) at 4K can reduce the total energy consumption of 10's of petaflop computing by more than 10X and volume by even more. Capitol ships increasingly need computational resources of this capacity for situational awareness, yet communications and ship functionality is being constrained by power requirements. However, cables that bring power into the 4K environment, and the data output cables, conduct a great deal of heat from the room down into the cold environment that must then be removed. If easily connected flexible cables with superconducting MgB2 conducting traces could span the temperature gradient between 30 and 4K this parasitic heat load could be sharply reduced, improving total system energy efficiency. The data cables will be useful for RF signal input in the SCE situational awareness receivers needed for information dominance, especially where element level digital beam forming is used. Connectors that have low contact resistance despite high vibration settings and repeated make and break cycles and high isolation between traces will be hardest goals to achieve.

PHASE I: The product of the Phase I base effort will be a technical report documenting experimental validation of the cable concept outlined in the initial proposal using a short length sample that is wire bonded for testing. Success requires the magnesium diboride (MgB2) conductors and any supporting substrate to exhibit lower thermal conduction than an equivalent length copper multi-trace cable spanning the same temperature gradient and carrying the same current. The Phase I option, if awarded should include selection and design of the connectorization. A Phase II plan should be defined during the final weeks of the Phase I base award and presented in its final report.

PHASE II: Phase II will include multiple cycles of design/fabrication/test/model activities to demonstrate rugged connectorization and to deliver cables with more than an order of magnitude lower thermal parasitics and lower resistive loss than equivalent delivered by Cu or CuBe when the cable spans 4 to 30K and carries same signals. Ease of connectorization and simplicity of connection and reconnection should also be worked to mature the product.

PHASE III: Transition for this cable product will consist of its incorporation into one of a kind, first prototype 4K (or lower) superconducting systems in DoD and the Intelligence Community (IC). This integration will be undertaken because of the simulated reduction of system parasitic heat loading (thus operating power) and reduction in the hand labor associated with lead installation and maintenance.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The need for petascale computing at affordable energy costs is definitely not limited to government. Other prime industries include telecoms, banking, and computer and movie animation.

REFERENCES:
1. Related cable demonstrated for lower temperatures: http://reference.lowtemp.org/Woodcraft_ribbon.pdf

2. Related cable demonstrated for higher temperatures in YBCO:
http://www.siemens.com/innovation/en/publikationen/publications_pof/pof_spring_2002/energy_articles/superconductors.htm

3. First demonstration of an MgB2 cable for DC applications using wire bonding:
http://www.ewh.ieee.org/tc/csc/europe/newsforum/pdf/2010-ASC/ST191.pdf

KEYWORDS: Magnesium diboride; superconductors; thermal parasitics; ribbon cable; cryopackaging; make and break connectorization

N141-065 TITLE: Large Time Band Width Product Signal Acquisition Processors

TECHNOLOGY AREAS: Information Systems, Sensors, Electronics

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OBJECTIVE: Develop a dynamically reconfigurable, minimal latency and power Digital Signal Processing (DSP) hardware base to simultaneously handle 100’s of diverse, possibly overlapping signals for multi-functional situational awareness.

DESCRIPTION: A new Digital Signal Processing (DSP) subsystem is needed that allows optimized, multi-threaded signal classification in as near real-time as possible. At a minimal, the subsystem should operate on a stream (from a first-in first-out memory buffer) of a single wideband representation of 500 MHz+ of spectrum. Signals within this spectrum will contain a mix of known and well-behaved signals as well as unknown signals with unknown behaviors or properties. The subsystem should handle numerous simultaneous signals (at least 30 with a goal of 100+) and be able of classify signals that shift their center frequency unpredictably, lie wholly or partially on top of other signals, have inherently low signal to noise ratios, or use non-commercial standard waveforms. The DSP threads should track known signals, classify unknown signals, or do a exhaustive search of a specific time/frequency swath to identify new or unknown signals for further classification or tracking. The ideal system should be composed of commercially available parts such as field-programmable gate arrays (FPGA), digital signal processors (DSP), graphical processing units (GPUs), and general processing processors (GPP) or hybrids thereof with a shared-memory architecture for extremely fast multi-thread processing of wideband signal data. The ultimate metrics quantify the wall-plug energy and time expended per signal per GHz of spectrum handled by a single chain. The system should be programmable with common languages to minimize re-transcription of DSP software.

PHASE I: Define and develop a concept for a Large Time Band Width Product Signal Acquisition Processor that can meet the performance constraints listed in the description. Perform modeling and simulation to provide initial assessment of concept performance and SWAP. Phase I Option, if awarded, would include the initial layout and capabilities description to build the unit in Phase II.

PHASE II: Development of prototype based on Phase I work for demonstration and validation. The prototype should be delivered at the end of Phase II, ready to be tested by the government.

PHASE III: Integrate the Phase II developed Large Time Band Width Product Signal Acquisition Processor prototype within the FNT-FY15-04 SIRFSUP architecture for transition to BLQ-10 Improvement Program.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Spectrum Survey, Adaptive Commercial Communications

REFERENCES:

1. Karam, L.J.; AlKamal, I.; Gatherer, Alan; Frantz, G.A.; Anderson, D.V.; Evans, B.L. "Trends in multicore DSP platforms", Signal Processing Magazine, IEEE, On page(s): 38 - 49 Volume: 26, Issue: 6, November 2009

2. A.V. Oppenheim, R.W. Schafer, J.R. Buck, "Discrete-Time Signal Processing", Prentice Hall; 2 edition (January 10, 1999)

3. B. Chapman , L. Huang , E. Biscondi , E. Stotzer , A. Shrivastava and A. Gatherer "Implementing OpenMP on a high performance embedded multicore MPSoC", Proc. IEEE Int. Parallel and Distributed Processing Symposium, 2009

KEYWORDS: Digital Signal Processing (DSP); High bandwidth Processing; Hybrid DSP Architectures; Signal Classification; Signal Detection; Spectral Awareness

N141-066 TITLE: Low-Profile, Broadband, Shear-Mode SONAR Transducer for Deep Submergence Applications

TECHNOLOGY AREAS: Materials/Processes, Sensors, Electronics

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OBJECTIVE: Design, build and test a low-profile, high-power, low-frequency, broadband, d36 shear-mode piezocrystal transducer capable of operating at submarine depths.

DESCRIPTION: Broadband d36 shear-mode transducers operating across the 1-10 kHz band have been built and tested that are only 2.5 inches high compared with the 20-30 inch height of legacy Tonpilz transducers in the fleet. This innovation, resting on the unique properties of piezocrystals, opens an avenue for undersea vessels to externally mount SONAR arrays that would normally consume space within the hull. This topic will focus on the modeling and assembly technology needed to enable such transducers to operate under high hydrostatic pressure. The performance of the d36 shear-mode design will be compared with that of the classic Tonpilz design made with piezocrystals. This innovation opens up a whole new engineering design space as such transducers could not be made from legacy piezoceramics. Existing devices operate at depths appropriate for mine detection/classification. This project would devise and validate new designs drawing on the d36 shear-mode, but which operate at much greater depths.

PHASE I: Design an initial d36-shear-mode transducer targeting device survival/operation under high pressures (that is, at great depths) and provide a credible argument for survivability/operation at the targeted depth (ranging from submarine operating depths to Hadal depths).

PHASE II: Design, build and test prototype d36-shear-mode transducers as single elements to verify targeted depth. Assemble and test a small prototype array of such elements to ascertain array interactions.

PHASE III: The small business will design, build and test the SONAR transducers and supply them to a systems integrator for incorporation in the submarine or Unmanned Underwater Vehicle (UUV).

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The compact, light-weight, broad-band shear mode transducer will find applications in numerous civilian underwater applications: UUV and tethered ROV guidance, sea floor exploration/profiling, sea floor module mining, oil platform inspection/repair, and the like. The enhanced energy efficiency in untethered applications will dramatically decrease operating cost by extending effective utilization times per mission.

REFERENCES:
1. "Acoustic Transducer," David J. Tol and Richard J. Meyer, Jr, US Patent No. 7,615,912 B2 November 10, 2009.

2. "Low Profile, Broad Bandwidth Projector Design Using d36 Sear Mode," R. J. Meyer, Jr., T. M. Tremper, D. C. Markley, D. Van Tol, P. Han, and J. Tian, Navy Workshop on Transduction Materials and Devices, 11-13 May 2010.

3. "Cut directions for the optimization of piezoelectric coefficients of lead magnesium niobate- lead titanate ferroelectric crystals," Pengdi Han, Weiling Yan, Jian Tian, Xinling Huang, and Huixin Pan, Applied Physics Letters 86, 052902 (2005).

4. "Piezoelectric crystal elements of shear mode and process for the preparation thereof, Pengdi Han, US Patent Application Publication Number 2006/0012270 A1 January 19, 2006.

KEYWORDS: Sonar Transducer; Shear-Mode Transducer; Lead Magnesium-Niobate Lead Titanate Crystals; Broad Bandwidth Transducer; Low-Profile Transducer; Energy-Efficient Transducer

N141-067 TITLE: Adaptive Radar Detection Approaches for Low-RCS Maritime Vessels in Highly Variable Clutter Conditions

TECHNOLOGY AREAS: Air Platform, Sensors

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: Develop adaptive radar mode approaches to provide improvement in performance in highly variable maritime clutter conditions while utilizing available radar resources for wide area coverage.

DESCRIPTION: All airborne maritime surface search radars experience reduced detection performance in high clutter environments that typically limits their operational flight altitude. Operating at lower altitudes limits overall mission effectiveness in terms of area coverage for radar typically decreased platform fuel efficiency (higher burn rate). In addition, detection performance in small target modes is degraded in high clutter environments, even at these lower operating altitudes. Many current radar systems employ a fast revisit rate approach. These non-coherent modes require high peak radiated power and a high gain narrow antenna beam-width in azimuth for further mean clutter rejection. The remaining clutter that must be rejected primarily consists of sea spikes that can last for multiple seconds. These must be dealt with using sophisticated tracking techniques. This topic seeks to develop a mode structure and associated signal processing that leverages longer integration time for Doppler beam forming on the coherent component of the sea clutter and de-correlation relative to the target on the non-coherent component, and allows for other radar modes (high range resolution and inverse synthetic aperture radar) to be effectively interleave in order to take advantage of additional target classification discriminates. The approach should be applicable to both mechanically scanned and electronically scanned radar antenna systems.

PHASE I: Develop radar mode approaches capable of providing significant performance improvements (on the order of 10 dB) against small radar cross section (RCS) targets in a high clutter maritime environment. The product of Phase I will be a technical report detailing the preliminary design and expected performance based on analysis of either simulated or actual data.

PHASE II: Implement the algorithms developed in Phase I and demonstrate in a real-time environment. Demonstrate how the radar mode can be integrated with a candidate Navy radar system.

PHASE III: Transition the developed technology to appropriate platforms/sensors as part of a formal integration and test program. Candidate near term transition radar systems for this advanced radar mode include the AN/APS-153 radar used on the MH-60R Seahawk and the AN/ZPY-4 radar used on the MQ-8 Fire Scout.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The clutter suppression approaches may find application to a wide range of radar, optical and even communication systems with both civilian and military applications.

REFERENCES:
1. Weinberg, G.V. (2012). Suboptimal Coherent Radar Detection in a KK-Distributed Clutter Environment. International Scholarly Research Network, ISRN Signal Processing, Volume 2012, Article ID 614653, 8 pages.

2. Rosenberg, L., Crisp, D.J., & Stacy, N.J. (2010). Analysis of the KK-distribution with medium grazing angle sea-clutter, IET Radar Sonar Navig., Vol. 4, Iss. 2, pp. 209–222.

KEYWORDS: Radar, clutter, small target detection, coherent processing, radar timeline optimization, adaptive modes

N141-068 TITLE: Advanced Two-Phase Heat Exchangers for Environmental Control

TECHNOLOGY AREAS: Ground/Sea Vehicles

OBJECTIVE: Develop compact heat transfer technologies to improve the performance of two-phase heat exchangers.

DESCRIPTION: Tube-fin heat exchangers are used to acquire or reject heat in a wide range of military and commercial thermal control systems, including ground and sea-based environmental control units, refrigeration systems, and waste heat regeneration systems. As power-density of tactical systems continue to increase, the use of two-phase thermal control systems is becoming more widespread due to improved thermal capacity when cooling or heating through the latent heat of a working fluid. Improving the effectiveness of two-phase heat exchangers used to transfer heat between the working fluids and air streams will lead to reductions in size, weight, and power consumption of military environmental control systems.

Improved heat exchanger designs utilizing microchannels, plate-fin configurations, and surface enhancements offer performance advantages over traditional tube-fin heat exchangers, but have not yet been fully utilized in many military and commercial systems. While developers have incorporated these improvements in single-phase systems, they have yet to be utilized reliably with two-phase systems. This is largely due to two-phase flow maldistribution and condensation build-up in the heat exchanger, which results in poor heat transfer performance, as well as high manufacturing costs.

Technologies are sought to improve the volumetric heat transfer performance over tube-fin heat exchangers while maintaining flow rates, temperatures, and differential pressures characteristic of heat exchangers used for environmental control. Methods to ensure proper distribution of a two-phase mixture at the entrance to multiple fluid passages and through the device must be proven.

PHASE I: Develop concepts to provide improved heat transfer performance over conventional heat exchangers and provide a uniform distribution of a two-phase working fluid at the inlets to multiple fluid passages. Validate design performance through analytical modeling or subscale demonstration of components as appropriate.

PHASE II: Demonstrate a working prototype of an evaporator sized to a 5-ton (60,000 BTU/hr) Environmental Control Unit. Experimentally validate the unit’s performance over a variety of refrigerant flow rates and inlet qualities, assuming an air side 80/67 °F dry bulb/wet bulb temperature and 2000 cfm. Complete a cost analysis of concepts established to ensure the selected technology is competitive with tube-fin manufacturing processes.

PHASE III: Optimize the concept design for manufacturability and heat transfer performance using the knowledge gained during Phases I and II. This heat exchanger must meet military unique requirements such as corrosion resistance, shock and vibration. Perform detailed design and fabrication of evaporator for transition into advanced environmental control systems demonstrations. Conduct extended testing to verify performance.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Increasing the effectiveness of two-phase heat exchangers provides an enabling technology to reduce size and weight, as well as improve the energy efficiency, of commercial HVAC systems.

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1. Cho H., Cho K., “Performance comparison of microchannel evaporators with refrigerant R-22,” Journal of Mechanical Science and Technology, 21 (11), pp. 1926-1934 (2007).

2. Qi, Z., Chen, J., Radermacher, R., “Investigating performance of new mini-channel evaporators”, Applied Thermal Engineering, 29 (17-18), pp. 3561-3567 (2009).

3. Qi Z., Zhao Y., Chen J., “Performance enhancement study of mobile air conditioning system using microchannel heat exchangers,” International Journal of Refrigeration, 33 (2), pp. 301-312 (2010).

4. Jha, V., Dessiatoun, S., Ohadi, M., Al Hajri E., “Experimental Characterization of Heat Transfer and Pressure Drop Inside a Tubular Evaporator Utilizing Advanced Microgrooved Surfaces,” Journal of Thermal Science and Engineering Applications 4 (4), 041009 (2012).

5. http://www.marcorsyscom.usmc.mil/sites/pdmeps/ECU.asp

KEYWORDS: Thermal Management; Heat Exchanger; Two-Phase Cooling; Evaporator; Condenser

N141-069 TITLE: Compact, Collapsible, or Conformal Antenna Design for Emerging High Power Radio Frequency (HPRF) Sources

TECHNOLOGY AREAS: Ground/Sea Vehicles, Battlespace, Weapons

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: Develop a wideband, small aperture antenna exhibiting > 10 dB gain for emerging HPRF sources over the mid-VHF to low L band frequency range, with increased capabilities in operational reconfiguration, frequency tuning, bandwidth, and field of view.

DESCRIPTION: One of the main challenges for HPRF radiation is the integration of antennae in the propagation environment (ground and sea surface in various sea state conditions) into the system design configuration. Current wideband antenna concepts are largely focused on omni-directional radiators derived from simple dipole antenna designs, sometimes with corner reflectors and other simple modifications. However, all of these efforts provide only minimal gain, with the state-of-the-art currently only 2-3 dB across the desired bandwidth. Furthermore, emerging architectures are limited in power handling capability to tens of Watts or perhaps kW. The antenna is a critical sub-system that has not evolved to handle the diversity of HPRF waveforms and the MW power levels required in directed energy applications. Effective delivery of HPRF is made even more challenging with the complexities that arise with integration of antenna structures onto unmanned platforms, munitions, or other air delivered employment concepts. In typical antenna design, the physical size plays an important role in the gain and power handling capability, which leads to extreme challenges when requiring a compact, conformal, and lightweight design for proper system integration. Another key consideration is the intended operating environment of the system, of greatest interest for this effort is a naval environment. The antenna must be able to withstand large temperature fluctuations, maritime weathering (salt, wind, rain), and continuous UV exposure. Typical high power systems experience catastrophic degradation in this environment if not addressed with proper environmental mitigation techniques (i.e. radomes, UV protected dielectrics, etc.). Innovative improvements to the antenna architecture and/or materials are needed to achieve the higher gains necessary for increased range and could prove to be the critical factor in transitioning HPRF technology to the warfighter. A novel, compact, moderate-gain antenna design for MW+ powers is required with improved directionality to keep pace with the miniaturization of emerging HPRF technologies.

PHASE I: Perform a technology review of existing antenna technologies to determine the design feasibility and potential implementations of an antenna with moderate gain (10-15 dB) and compact size (less than 0.25 m^3), capable of operations at peak powers of 100 MW to 1 GW with repetitive pulse operation at 100s of Hz, and a characteristic impedance between 50 to 150 Ohms. Research efforts should also be made to determine the current limitations of antenna technology at the MW power levels for the volume specified and determine if any of the low power architecture technological solutions can be applied to achieve higher gain and/or powers. A down select of existing antenna technology should be conducted with a focus on determining what technologies provide the most useful capability for short pulse, MW class power operation while meeting the volumetric requirements. These antennae will be driven by an assortment of high voltage based RF sources, with pulse lengths shorter than 1 μs while utilizing damped sinusoid waveforms. This variation in sources leads to a requirement for a flexible, center frequency tunable antenna with a bandwidth of at least 20-30%, if not much broader. Efficient methods for numerical computation of electromagnetic and antenna radiation, new materials, devices and radiating systems for miniaturization and performance enhancement of the wideband antenna should be included in this analysis. Flexibility across bands, manufacturability, and real-time frequency reconfigurable antennas are stressed. The completion of Phase I will include the development of novel antenna designs to meet the outlined requirements using computational electromagnetic modeling and simulation, building on the antenna development for commercial applications at lower powers derived from the technology review efforts. The conceptual designs, along with the design implementation and antenna performance models should be included as well as a cost analysis and material development so as to ascertain critical needs not yet fully developed or readily available given current technology.

PHASE II: Phase II will involve the design refinement, procurement, integration, assembly, and testing of a proof of concept prototype leveraging the Phase I effort. The Phase II prototype will have a gain (10-15 dB), a compact size (less than 0.5 m^3), and be capable of greater than 50 MW to 500 MW output at a rep-rate of 10s of Hz, and a characteristic impedance between 50 to 150 Ohms. The prototype should also be capable of operating in an outdoor environment. This prototype must demonstrate a clear path forward to a full scale prototype based on the selected technology. Data packages on all critical components will be submitted throughout the prototype development cycle and test results will be provided for regular review of progress. The development of actual hardware and empirical data collection is expected for this analysis. A refined design package should also be submitted that meets the solicitation objectives with moderate gain (10-15 dB), compact size (less than 0.25 m^3), and operations at peak powers of 100 MW to 1 GW with repetitive pulse operation at 100s of Hz.

PHASE III: The performer will apply the knowledge gained during Phase I and II to build and demonstrate a full scale prototype device capable of 10-15 dB gain, compact size (less than 0.25 m^3), and operations at peak powers of 100 MW to 1 GW with repetitive pulse operation at 100s of Hz, and a characteristic impedance between 50 to 150 Ohms. Data packages on all critical components and subcomponents will be submitted throughout the development cycle and test results will be submitted for regular review of progress. The prototype will represent a complete solution and include all system elements including the RF connectors, RF feed, RF transition, and antenna. The prototype should be ruggedized for, at a minimum, testing in a shipboard environment across a temperature range of -20 °C to > 70 °C, MIL-STD shock and vibration, and be environmentally enclosed.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Potential commercial applications include a variety of communications, sensor and medical applications requiring compact, high power RF systems.

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KEYWORDS: High power radio frequency; high power microwave; directed energy weapons; antenna

N141-070 TITLE: In-node Processing for Low Power Target Detection, Classification, Localization, & Tracking

TECHNOLOGY AREAS: Sensors, Weapons

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OBJECTIVE: The objective is to develop sea floor based small, passive, low-power sensors and in-node processing to autonomously detect, classify and localize target vessels sufficiently to facilitate a fire control solution for an autonomous weapon.

DESCRIPTION: This SBIR solicits innovative solutions for short range small sensors (e.g. acoustic/ magnetic/ electric/ pressure/ seismic) and in-node processing capabilities that provide detection and localization in such a way as to facilitate a fire control solution for autonomous engagements. The Research & Development emphasis is to tactically exploit the environment to achieve improved detection, classification, localization and tracking (DCLT) or parts thereof for engagement of sea-born vessels. Sensing prototypes may include very short range proximity sensors where tracking is not possible and the sensor performance range limitation is adequate for a targeting solution. Sensing prototypes may also include longer range capability configurations, where the capacity to localize or track is necessary for a targeting solution for the given weapon. A nominal goal would be a packaged sensing capability, of volume 30 cubic feet prior to deployment, which provides a four nautical mile, shallow water barrier. For classification, innovative optical methods are of interest. The tracking capability would need to be in very low power firmware and would be required to perform against very quiet targets in high ambient noise environments. Modeling and simulation are an important part of the effort and shall be integrated appropriately with data analysis in the development and testing of the technology solution. This is to ensure the performance capability is able to tolerate environment variability, multiple targets, and a diverse set of surface and submerged targets, as needed, for effective weapon performance.

PHASE I: Develop an innovative concept for low-power small sensors and in-node processing for passive threat detection and localization that meets the requirements outlined in the description. Demonstrate the feasibility of the concept in meeting Navy needs and establish that the concept can be feasibly developed into a useful product for the Navy. Feasibility may be established through simulation, data analysis and analytical modeling. Phase I should establish that the technology is able to tolerate environment variability, multiple targets, a diverse set of surface and submerged targets, and engagement performance. Algorithm computational requirements must be addressed during Phase I and demonstrated to be capable of deployment in a real time power constrained system. Required Phase I deliverables will include a Phase II development plan that must address technical risk reduction and provides performance goals and key technical milestones.

PHASE II: Based on the results of Phase I and the Phase II development plan, develop a prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals defined in the Phase II development plan and the Navy requirements for the technology. Demonstrate system performance via thorough prototype evaluation through in-situ testing, combined with modeling and simulation methods over the required range of parameters and operational requirements. Use evaluation results to refine the prototype into an initial design that will meet classified Navy requirements provided during Phase II. Use algorithm and software modularity and open standards, that are not platform specific, and accepts/produces data according to a government specified format. Prepare a Phase III plan to transition the technology to Navy use.

PHASE III: Integrate the prototype according to the Phase III technology plan into the SHD-14-04 FNC EC to address MIW capability/capacity shortfalls in S&T Gap POM14-30 "USW On-Demand Battlespace Shaping."

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The ability for ports and waterways to be monitored for ship traffic; oil platform surveillance and protection; the ability for long duration at-sea monitoring of whale and fish traffic; long-term standoff seismic monitoring at sea.

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KEYWORDS: Detection, classification, localization and tracking (DCLT); in-node processing; autonomous engagement; fire control solution; passive sensing

N141-071 TITLE: Information Triage Engine: User-Composable Automation for the Dynamic Management of Text-Based Information

TECHNOLOGY AREAS: Information Systems, Human Systems

OBJECTIVE: Develop a scientifically-principled design specification with supporting prototype concepts for a set of advanced, user composable information management tools. Tools would enable warfighters to easily examine message traffic, email or other data streams of text based information. It would also enable warfighters to categorize, meta-tag, alert or otherwise manage information transactions based on natural language-like rules to support the execution of operations in the face of evolving missions with dynamic tasking requirements. Result will be a structured approach to user-composable automation that enables warfighters to manage information dynamically given real-time, emergent, missions and tasks.

DESCRIPTION: Many military domains require agile, time-critical decision making in order to maintain speed of command. These domains increasingly involve diverse and/or complex missions with dynamic information needs. Current information systems often get in the way of decision-making because they are data-centric, vice task-centric, and as a result require human decision-makers to manage large volumes of data before they can address command tasks. Warfighters are required to sort out what data is relevant to emergent tasks and mission demands. Tools are needed that allow decision-makers to rapidly configure (or compose) automation for managing the flow of data from multiple sources as needed to support emergent missions and tasks. The tools should support publish and subscribe (pub/sub), services oriented architecture. This effort will result in the natural language management of modular, reusable, and robust automation to be used with a variety of databases and information processing tools.

Given the demands of modern missions, automation must be easily composed by warfighters through natural behavior and language mechanisms that do not require advance programming skills. Warfighters need to be able to demonstrate the desired information management behaviors to the automation, and express them through natural language transactions and/or a graphical user interface. The desired Operator Machine Interfaces (OMIs) need to be task-centric and support the task needs of decision makers. The desired solution will result in an extensible strategy with supporting information services that: 1) facilitate rapid, behaviorally based, composition of information management in response to missions and tasks; 2) be applicable to a wide range of information feeds and data; 3) require minimal user training, 4) allow rapid insertion into DoD and Navy Information Technology, C2 and combat systems, and 5) demonstrate rapid end user adoption and utilization of the tools developed in accordance with the design schema. Resulting products will support improved operational (e.g. combat system; command and control (C2)) decision making and reduced workload by providing a dynamic, interaction-based mechanism for managing data based on mission and task information context. The desired tools are expected to enable command staff to more rapidly plan, re-plan and execute missions in the face of changing mission requirements and information needs. The desired solution would represent an approach to a reusable Information Triage Engine.

Desirable features would include:

• Natural interface (e.g. one which is behaviorally trained) for composing a workflow engine in response to task and mission demands.
• Rapidly composed through natural language and/or behaviors.
• Include mechanisms to support the dynamic tagging of information with appropriate meta-tags
• Incorporate mechanisms to support iterative tuning of information management engine processing rules.
• Consider mechanisms to refine automation to include negative (not) information, (e.g. to exclude certain categories of information) as well as other relational arguments.
• Support for automated derivation of meta-tags based on mission & task context and user activity.
• Demonstrate the generation of alerting rules for (proactively) alerting the user to relevant information and/or changing needs based on new/upcoming events or text (i.e. context shifts)
• Consider mechanized standardized information summaries. These might include template-based summaries for what information is/i not available in (and/or is being aggregated into) data stores; as well as context descriptors of time, location, and related mission(s) for which the information was collected.
• Demonstrate an ability to store user-composed automation as rule sets for discovery & reuse.

PHASE I: Phase I will address an approach for managing a stream of text-based messages from at least one application/database. Develop one or more use cases for how your proposed system will assist a decision maker in the dynamic management of information. Identify relevant literature from cognitive decision making and human supervisory control of automation to develop requirements for decision support needed for the proposed technology. Design a concept prototype tool with wireframe design elements to demonstrate interactions between human supervisor and anomaly detection technology. Define operational and technical metrics that will permit the demonstration of the utility of the approach in Phase II. Propose notional elements for an extensible decision support mechanisms by which warfighters might compose automation for these elements that could then be dynamically adapted to support mission execution and re-planning tasks. Design and prototype a basic proof-of-concept decision support prototype capability that would demonstrate improved speed of command required to perform re-planning. Demonstrate through storyboards or a working prototype how users would create, select and modify composable automation as needed, including select from available algorithms and technologies. Define and analyze the requirements for determining mission and task management requirements, and mission context for a specific information triage task. Show how automation would be managed for reuse by future users and with other applications/databases. Phase I deliverables should include a Final Phase I report that includes a detailed description of the approach taken, as well as a detailed proposed approach for Phase II development.

PHASE II: Develop, demonstrate, and refine the Phase I concept prototype. Validate utility in human performance based evaluations. Demonstrate applicability to an operational domain appropriate for the planned commercialization strategy (e.g. command and control). The effectiveness of the system shall be demonstrated by satisfying the utility metrics defined in Phase I, as well as additional metrics that may be developed in Phase II. Develop a formal plan for transition and commercialization.

1. Mature, demonstrate, and refine a concept prototype illustrating the decision support concept.
2. Phase II demonstration to address information orchestration across multiple applications/databases. Databases may include e-mail, naval message traffic, social media, etc.
3. Validate the decision support concept and quantify its impact on decision making tasks with controlled human performance study with dynamically changing mission/task requirements with empirical, user-based performance data appropriate to the anticipated transition end-user.
4. Demonstrate that the schema can accommodate a variety of different decision making tasks.
5. Develop a transition strategy for insertion of the technology developed into a US Navy Program of Record (e.g. BYG-1, GCCS-M) or a commercially developed system.

Phase II deliverables will include a Final Phase II report that includes a detailed description of the approach taken and results obtained in Tasks 1-5, and formal transition agreements or commitments for external investments as part of a Phase III development effort.

PHASE III: Refine the prototype and make its principal features complete in preparation for transition and commercialization. In addition to the DoD, there will be an increasing demand for supervision of autonomous systems in the commercial sector, such as the process control domain and commercial mining industries, and in federal and state agencies such as law enforcement, emergency management, and border protection. These domains could benefit significantly from the application of the solution developed in this effort. In operational command centers, it is expected that the developed tools would serve to create user composable automation for critical mission events that would be applicable to Fleet command centers and shipboard combat centers supporting anti-submarine warfare, or Area Access Denial missions.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: There is an ever increasing demand for user-composable, readily extensible, automation that enables the dynamic management of information. Tools for detecting, editing and responding to the concurrence of data from disparate sources is endemic to modern life. The desired technology will have ready application to streaming web data accessed through computers and personal electronic devices. The desired technology would have ready application to next generation office automation providing productivity gains to individuals and across organizations. Composable automation algorithms would create a new form of autonomous systems for information management. Further, these tools would become key enablers to the supervision of autonomous systems in the commercial sector, such as in the process control domain and commercial mining industries, and in federal and state agencies such as law enforcement, emergency management, and border protection. Multiple application domains could benefit significantly from the application of the solution developed in this effort.

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KEYWORDS: Dynamic decision making, natural language, command and control, context modeling, information management

N141-072 TITLE: Deflagration Efficiencies in Metals

TECHNOLOGY AREAS: Materials/Processes, Weapons

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OBJECTIVE: The objective is to develop and define the properties affecting impact driven oxidative combustion of Aluminum (Al) and Tungsten (W) powder neat and as composites.

DESCRIPTION: Today’s ordnance fills often contain substantial quantities of Al and W micron size powders to enhance blast and momentum effects. These metal powders demonstrate high efficiencies in propulsion compositions, but do not provide similar combustion efficiencies during detonation or impact driven events. Innovative processing technology is sought to better define the scope and limitations of metal particle combustion efficiencies and to identify the material properties that can be manipulated to enhance measured energy release. Methodologies that provide Al or W metal composites resulting in high combustion (50-80%) efficiency within a 0.5-15 ms time frame are of interest. The improvements in combustion efficiency of micron sized metal composites should be stable with time and environmental exposure. Any processes must be fully described and should be sufficiently adaptable and scalable for production of well characterized materials.

During deflagration, Al contributes only 10 to 25% of its potential energy output, and W provides no measured enhancements. Recent Army Research Lab publications indicate shear phenomena in nanostructured W may provide a pathway to higher combustion efficiencies. Doping Al with various metals results in lowered ignition temperatures, a potential route to enhanced energy release mechanisms. Other combinations of work–harden technologies (mechanochemistry) may provide insight into the ignition and growth process for these metals.

PHASE I: This topic in Phase I strives to: (1) Identify properties and mechanisms that increase energy release rates and combustion efficiencies of shock/impact initiated of aluminum and tungsten; (2) Develop and define concepts which will increase combustion efficiencies of aluminum and tungsten; (3) Provide experimental and test data supporting hypotheses.

PHASE II: Based on the Phase I effort, demonstrate and validate the concept identified for improving the impact initiated combustion efficiency of aluminum and tungsten both neat and in formulations to be identified. Deliver samples of the prototype solutions to the government for test and evaluation in a government laboratory. Work under Phase II might be classified.

PHASE III: Utilizing the concept successfully demonstrated in Phase II, warhead components (cases or preformed fragments) will be manufactured and delivered to government laboratories and/or system integrators for evaluation in weapon applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Pressed metallic powder formulations have a range of uses beyond those relevant to the military. The ability to more readily combust Aluminum or Tungsten in commercial pyrotechnic devices could lead to their use in place of more expensive or more sensitive materials.

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KEYWORDS: Reactive Materials; Energy Release Mechanisms; Impact Initiated Combustion;Metal Composites; Tungsten; Aluminum

N141-073 TITLE: Multi-Stage, Multi-Phase, High Efficiency, Intelligent, Electrical Energy Conversion Unit for Navy and USMC

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors, Electronics

OBJECTIVE: Develop an electrical energy conversion unit for sea vehicles and expeditionary systems that has a volumetric power density of 500 kW/m^3, a frequency of 50-100 kHz, 97% efficiency with a minimum efficiency of 94%, and is 2-man portable.

DESCRIPTION: The Navy and USMC are embarking on an aggressive power and energy program for applications in surface and underwater vehicles as well as expeditionary systems. Limited by either shipboard space and weight or portability, the Navy and USMC require innovative technology solutions to increase electrical energy conversion efficiency and density in order to reduce volume, weight, and cost.

As of 2011, demonstrated state-of-the-art converter technology was capable of 210-230 kW/m^3, though this excludes the thermal management unit. The frequency range was 10-20 kHz with roughly 94% efficiency. For this program, the objective is to develop an electrical energy conversion unit for sea vehicles and expeditionary systems that has a volumetric power density of 500 kW/m^3 including cooling, a frequency up to 50-100 kHz, maximum 97% efficiency with a minimum efficiency of 94%, and is 2-man portable.

PHASE I: Perform a feasibility study and develop physics-based models in order to produce a converter design capable of meeting the following:

For this program, the objective is to develop an electrical energy conversion unit for sea vehicles and expeditionary systems that has a volumetric power density of 500 kW/m^3 including cooling, a frequency up to 50-100 kHz, maximum 97% efficiency with a minimum efficiency of 94% efficiency, and is 2-man portable.

Additional Requirements:
1. Ability to convert AC-DC, DC-AC, DC-DC, AC-AC
2. An adjustable speed drive capability for different electric machine configurations/topologies
3. Multi-stage power electronic system with thermal management included, and without external power source
4. Control of the electric machine forward and reverse without using external resistive loads
5. Real-time non-invasive prognostic/diagnostic capability of each phase of the electric machine and power electronics

PHASE II: Develop a prototype based on Phase I work for demonstration and validation. The prototype should be delivered at the end of Phase II. The design should be at TRL 3 or 4 at the end of this phase.

PHASE III: Integrate the Phase II developed converter into the P&E-FY14-01 FNC program for transition to the ESO acquisition program.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The desired electrical power converter has direct applications in power conversion, machine drive, and transportation traction, making it broadly applicable to the commercial world.

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KEYWORDS: Electrical Converter; Efficiency; Energy Security; Enhanced Performance; Thermal Performance; Power Electronics

N141-074 TITLE: Robust Matrices for 2700F Ceramic Matrix Composites

TECHNOLOGY AREAS: Air Platform, Materials/Processes

OBJECTIVE: Develop mature physics and thermo-chemical-based foundation needed to underlay the development of advanced matrices with improved environmental robustness that can mitigate the effects of coating loss (viz. CMC exposure to moisture-induced volatilization or corrosive deposits), or matrix cracking (leading to oxidative embrittlement of the CMC) in high temperature gas turbine hot section components.

DESCRIPTION: Implementation of SiC-based ceramic matrix composites (CMCs), in propulsion engines of interest to the US Navy, is now a tangible reality, representing the most fundamental change in design and manufacturing practices for gas turbines since the introduction of single crystal super-alloys. However, application of SiC-based CMCs in combustion environments requires the use of protective environmental barrier coatings (EBCs) to prevent volatilization of the protective silica scale from water vapor present in propulsion gases, as well as attack from ingested ash, sand etc. (calcium-magnesium-alumino-silicate (CMAS) attack). The EBC only provides protection while present on the surface. Cracking and spallation of the coating leaves the underlying SiC vulnerable to oxidation/volatilization as well as other forms of damage. There is need for robust matrices, chemically tailored to re-grow protective scales and to heal cracks extending into the CMC itself. To date, CMC matrices and EBCs have been developed heuristically. While both the thermo-mechanical performance of CMCs and the thermo-chemical behavior of EBCs have been addressed, the latter arguably to a lesser degree, an integrated, science-based perspective that can underpin the development of such systems approach has yet to emerge. The Integrated Computational Materials Engineering (ICME) strategy must include modeling approaches that can describe the relevant thermo-mechanical and thermo-chemical behavior of ceramic matrices, as well as the overall system and its constituents, combined with experimental approaches to generate requisite information for model validation. The capability to design and manufacture robust, self-healing matrices would be invaluable for extending the durability of critical gas turbine engine hot section components. This will lead to improved life management of these high value components and a concomitant reduction in their sustainment costs.

PHASE I: Using ICME functionalities, establish models to predict the effect of composition on phase stability and key properties in ceramic matrices such as thermomechanical and thermochemical behavior, as well as thermodynamics and kinetic to predict system evolution due to inter-diffusion between constituents, phase transformations or interactions with the environment. The models should lead to application of self-healing environmental barrier coatings that can withstand the rigors of aggressive environments (such as 2400 deg F). The ICME effort needs to be combined with experimental approaches to generate requisite information for model validation.

PHASE II: Apply validated models, developed in Phase I, to the synthesis of advanced matrices and coatings, initially as monolithic materials and later in sub-systems and complete EBC/CMC systems. In coordination with an appropriate original equipment manufacturer, establish and execute a test plan that will provide sufficient data for preliminary assessment of design allowables for critical and relevant design requirements.

PHASE III: Adoption of models/optimized matrix by an original equipment manufacturer (OEM) for further maturation to manufacture robust self-healing matrix CMC components that can operate in complex environments with less maintenance, lower overall life cycle cost, and improved operational capabilities. The small business and the engine OEM would work towards further maturation of the knowledge and/or process to fabricate CMC engine components for military and commercial platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: There is increasing need for commercial airlines to reduce fuel consumption for better profitability and reduced emissions, as well as establish technology that will allow the design and manufacture of more robust commercial engines.

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KEYWORDS: Ceramic matrix composites, environmental barrier coatings, oxidation, thermo-chemical model, mechanical property model, gas turbine engine

N141-075 TITLE: Pattern of Life Calculation from Big Graphs

TECHNOLOGY AREAS: Information Systems, Human Systems

OBJECTIVE: The research objective is to mature big graph data analytics to model patterns of life and automatically detect changes indicative of anomalous events . A capability that scales linearly with graph complexity is needed.

DESCRIPTION: Sailors and Marines are responsible for conducting missions such as assaults, embassy protection, non-combatant evacuation, and disaster relief. Mission planning involves understanding normal patterns of life (POL) so anomalies can be recognized. For example, observed changes in imagery over time has been used to derive POL for areas of interest. This type of data can be expressible as a vector of terms enabling expected and estimates of change to be calculable as Euclidian distances from mean values. Relevant POL modeling, however, needs to consider far richer data sets that include information on the content and frequency of interaction of nodes. Relevant data sets must also include open source (e.g. social media), cyber (transactional) and messaging (theme and concept spread) in addition to considering the relationship between movement, people and places. This data, even when time/place bounded, results in very large graphs.

A new capability to enable POL calculation, based on large graph theory, is needed. While Euclidian distance calculation scales linearly with nodes, graph analytics do not. Spurred by social networking data, big graph approximate analytics are maturing towards linearity with nodes. These developments empower answers to questions such as who a person may know or personal preferences. POL calculations must consider more diverse data sets and richer graph representations, calling for even more efficient distance calculations.

Network analysis provides powerful means of studying structural connections [1]. Of interest for this topic, is POL for situation awareness. Military and intelligence operators typically rely on their own data sources and analysis for determination of threat activities. Much of the data reported is of events unfolding or that have already taken place; that is important for response; situation assessment; and historical base-lining. However, this data doesn't provide normal POL that could serve as early indicators of change. This topic will explore analytics of nontraditional open source data fused with conventional data that can provide insight into anomalous activities.

Nontraditional data sources can provide insight into real time activity [2]. Examples of data include open source text, satellite imagery available through search engines, video feeds of vehicle traffic flow, video feeds from public areas available on the Internet, public utility patterns (electricity, water, etc.), weather station reports and many more. It should be noted that combining multiple diverse information sources into a unified graph that can be mapped to POL indicators presents challenges. For instance, how do we assess quality of sources? How do we normalize data types? How do we form graph structures?

The technical challenges of this topic are as follows: 1) automating collection of data for big graph formation; 2) data enrichment and fusion 3) construction and maintenance of a dynamic big graph representation [3]; 4) calculation of relevant static and dynamic POL metrics from very large and diverse graphs [4]; 5) setting filters for event detection relevant to user needs (i.e. location, time and tasking); 6) providing means to optimize data collections over time by monitoring and adjusting data sources, (i.e. user data needs and haves); and, 7) identifying analytic methods to scale processing. Practical system building needs to be considered as well as metrics to measure development success.

Creative solutions are desired. Public data gathering should be done on a 'not to interfere' basis with providers and should comply with policies for use of the data acquired. Data used, and modeling methods, should be relevant to potential customer for product transition, such as a government agency, program of record or commercial market place. Use of open standards is encouraged to reduce costs and improve system interoperability.

PHASE I: Develop processes and techniques to characterize the content, as it relates to patterns of life, of big graphs over time. The data behind graphs should contain information extracted from diverse data sources. Key technical risks should be identified as well as key technical parameters that measure progress against the risk areas. Results from analysis and concept feasibility tests should be documented in a technical report or paper at a selected conference. The final Phase I brief/demonstration should show risk reduction to the development of a fully responsive Phase II product as well as plans for Phase I Option and Phase II.

PHASE II: Produce a prototype system that is capable of detecting changes to features describing patterns of life rapidly from dynamic large graphs populated by multiple data types and providing mission relevant early threat indicators all enabled by big graph analytics. The prototype system should be able to automatically process, display and alert on activity discoveries relevant to the specific user location and mission interests. The system should support data acquisition, large graph data storage and analytics and alert dissemination. It is desired that context and pedigree of information be maintained for operator review. At this point the performer should focus on a proof-of-concept of capability using data sources that are of interest to a transition program. It is possible that some data sources of interest may be classified secret such as multi-intelligence data (IMINT, HUMINT, MASINT, ELINT).

PHASE III: Produce a system capable of deployment and operational evaluation. The system should address POL indicators that are of value to transition program or commercial application. Machine based processing steps and inferences about patterns of life should be accessible by operator and presented in human understandable form. The software and hardware should be modified to operate in accordance with guidelines provided by transition sponsor.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The capability specified by this topic is highly relevant to non-government organizations involved in disaster relief who need to track life disruptions and return to normalcy over time.

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http://www.technologyreview.com/news/425090/the-new-big-data/

KEYWORDS: Big Graph Analytics; Patterns of Life; Activity Detection, Dynamic Analysis; Change Detection; Analytics; Graphs; Scalability

N141-076 TITLE: Attention-Based Vision for Autonomous Vehicles

TECHNOLOGY AREAS: Ground/Sea Vehicles

OBJECTIVE: To develop an attention-based vision system that will facilitate a higher-level reasoning in ground autonomous systems by enabling these systems to actively identify, observe, and focus on regions or objects of interest within complex scenes without losing situational awareness.

DESCRIPTION: Autonomous ground systems continue to promise a revolutionary technology that will enable smaller units to expand their area of operation while maintaining the same control over the battlespace by enhancing sustainment, Intelligence, Surveillance and Reconnaissance (ISR), and maneuver for distributed operations. However, in most cases this promise remains largely unfulfilled with unmanned ground systems still relying heavily on human intervention in all but the most routine mission assignments. The biggest impediment to date has been the failure for these systems to actively perceive the world as a series of semantically labeled objects, events, and situations required for the generation and adaption of goals, priorities, and plans. Computational limitations coupled with the sheer complexity of the tactical environment have resulted in highly specialized solutions that are brittle and not scalable from one situation to the next.

Achieving more autonomous capabilities will require the development of a software framework that is able to effectively and efficiently process electro-optical and possibly multi-modal sensor data to identify, observe, and focus on regions or objects of interest within complex scenes. This framework will need to understand the task objectives and the context of situations as they arise to intelligently select what and where to focus its attention without losing situational awareness. It must be able to detect the temporal continuity of perceived objects despite motion of the sensor suite and/or motion of objects in the world, and will need to be able to predict the motion of objects to anticipate where to look and account for occlusion or discontinuities within an image sequence.

PHASE I: Develop a conceptual design for a framework for an attention-based vision system that is capable of efficiently processing multi-modal sensor data to identify, observe, and focus on objects or regions of interest within complex scenes and deliver a report on the desired approach for development in Phase II. The Phase I report will include: development of the reference model architecture and performance specification and prediction for an attention-based vision framework and, the analysis of the potential component technologies to populate this framework using sensor data captured from the ONR 30 autonomous ground vehicle test-beds. Sensor data may include Red-Green-Blue (RGB) and Long wave infrared (LWIR) images and associated stereo disparity as well as automotive Light Detection and Ranging (LIDAR) and Radio Detection and Ranging (RADAR). Phase I option, if awarded, could address preparation for building the prototype in Phase II.

PHASE II: Prototype an attention-based vision framework based on reference model and performance specification defined in Phase I. This prototype framework will be loosely integrated into the ONR 30 Autonomy baseline system architecture to facilitate the rapid assessment of candidate solutions and evaluation of component technologies. At the conclusion of Phase II, the prototype solution will be demonstrated on ONR 30 autonomous ground vehicle test-beds to validate the performance in a relevant environment.

PHASE III: Conduct the system engineering to fully integrate candidate solution with the ONR 30 Autonomy test-bed platforms and associated system architecture (or other equivalent autonomous system) and conduct the optimization of component algorithms. Conduct full system demonstration in a relevant environment and if successful transition to future desired RSJPO Program of Records “Autonomous Mobility Applique System” or “Common Robotics System-Applique (CRS-A)”. If S&T needs still exist, they will be considered for transition into the ONR 30 Core Autonomy portfolio for maturation to TRL 6.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Farming and Mining industries continue to advance and leverage unmanned and autonomous systems for recurring tasks in relatively controlled environments. As these capabilities grow, safety will become more of a concern and the ability to identify, observe, and track objects in the environment will reduce risk of injury or accident. The automotive industry continues to significantly reduce cost of sensors through widespread integration onto new vehicles for safety and automation such as rear warning sensors, adaptive cruise control, and automated parking. As the industry moves toward driverless cars in the next 5 years or so, safety and increased ability to sense and perceive the environment through low cost sensors will be of paramount importance.

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2. Munoz, D., “Inference Machines, Parsing Scenes via Iterated Predictions,” CMU-RI-TR-13-XX.

3. Albus, J. S., "A Model of Computation and Representation in the Brain," Information Sciences, Vol. 180, Issue 9, pp. 1519-1554, January 2010.

4. E. Dickmanns et al., “The Seeing Passenger Car ‘VaMoRs-P'", in: International Symposium on Intelligent Vehicles ‘94, Paris, October 24–26, 1994.

KEYWORDS: Unmanned Systems; Machine Vision; Autonomy; Robotics; Perception; Focus

N141-077 TITLE: Low-Light, Low Cost Passive Terrain Sensing

TECHNOLOGY AREAS: Air Platform, Sensors

OBJECTIVE: Develop a stereo imaging passive terrain mapping system explicitly for use in low-light conditions using low-resolution, low cost, and low signal-to-noise sensors.

DESCRIPTION: Terrain sensing and mapping based on stereo imagery, whether from single or multiple cameras, generally relies on having good signal-to-noise characteristics. Military operations necessitate that terrain sensing systems operate primarily at night under low-light conditions where image intensifiers (I2) or infrared (IR) sensors are generally limited to low resolution, low signal-to-noise, or both. This has resulted in the majority of terrain sensing systems now being active (emitting), such as millimeter-wave radar, scanning Laser Detection and Ranging (LADAR), or flash LADAR, all of which pose a signature risk in threat environments. This effort would explore the limits of passive terrain sensing and mapping under low-light conditions using sensors such as I2, fused Electro-optical-infrared (EO-IR) or some alternative, preferably low cost solution. This effort will also stress the limits of machine vision ranging algorithms in low signal-to-noise environments. Terrain and obstacles likely to be encountered by a helicopter Unmanned Aerial Vehicle (UAV) in both rural and urban settings should be emphasized; e.g., hills, trees, water, buildings, towers, wires, etc.

PHASE I: Perform and document a tradeoff analysis of existing sensors for range, field-of-view, resolution, frame rate, weight, and power. Identify design points within the study appropriate to micro, small and full-scale helicopter UAVs, i.e., system weight equal to approximately 0.25 lb, 2.5 lb, and 25 lb, respectively. A horizontal and vertical field-of-view of 60 degrees is desirable. Identify and design a concept using the low-light sensors coupled with machine vision algorithms. Demonstrate a breadboard implementation of the resulting design that can produce accurate real-time terrain data.

PHASE II: Using results of the Phase I effort, build a prototype system and demonstrate it on a helicopter UAV provided as Government-furnished equipment. This prototype demonstration and validation will be achieved by working closely with Government researchers to integrate the sensor.

PHASE III: Upon successful results at the end of Phase II, the company will be expected to support the Navy in continuing the transition of the developed low-light terrain sensing technology. The business will produce a sensor system for evaluation to determine its effectiveness in an operationally relevant environment and will provide support for test and validation to certify and qualify the new technology in navy systems. Other potential applications include the ONR AACUS program and Army Autonomous Technologies for Unmanned Air Systems (ATUAS) program. These programs seek to expand the operations of future autonomous helicopters including operations in complex, cluttered environments.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This system could be used in a broad range of helicopter UAV missions requiring autonomous operations in complex urban environments. In addition, manned helicopters operating in the same environment could benefit from such a sensor to prevent controlled flight into terrain (CFIT).

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4. Theodore, "Comparison Between Passive and Active Terrain Sensing for Autonomous Landing Site Selection" presented at the 2007 AHS International Specialists' Meeting, Unmanned Rotorcraft: Design, Control and Testing, January 2007.

KEYWORDS: Terrain; mapping; low-light; sensor; electro-optic; helicopter

N141-078 TITLE: <u>Develop a Methodology for Cyber-Electronic Warfare Battle Damage Assessment (BDA) using Game Theory</u>

TECHNOLOGY AREAS: Information Systems, Battlespace

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: This SBIR topic proposes the use of game theoretic modeling to quantify the contribution of information related capabilities (Computer Network Attack (CNA), Computer Network Exploitation (CNE), and Electronic Attack (EA)) to the warfighting outcome. The model should enable comparative analysis between information related capabilities and traditional kinetic fires (artillery, mortars, & close air support) during mission planning.

DESCRIPTION: Future Marine Corps Air Ground Task Force (MAGTF) operations will be characterized by smaller, more agile units operating in a distributed environment facing a broad array of friendly and enemy networked communication and computer-based systems. To be effective in this complex battlespace, Marines at all echelons will be required to leverage technology to create a collaborative environment to coordinate ground and airborne non-kinetic capabilities, synchronized with traditional fires. To adequately integrate these fires, metrics are required to make trade-offs between Cyber/EW systems and air and ground weapons systems. The purpose of this research is to develop a methodology based on game theoretical models to quantify the value of cyber exploits and electronic attack within the context of relevant mission threads to rapidly inform decisions made on the battlefield.

PHASE I: Conduct a full factorial design of experiment (DOE) to identify input variables and response variables that adequately describe the cyber terrain for full spectrum MAGTF operations. Using those input variables and response variables, create a game theoretic framework for tactical decision making that can assess the relative value of Cyber/EW applications to the warfighting outcome. Researchers should reference the 2012 paper by Schramm, Alderson, Carlyle, and Dmitrov to guide their work. The deliverable for this phase is an academic paper detailing the results of the DOE and how those inputs and response variables are integrated into the development of the game theoretic model. This work will be at the UNCLASS level.

PHASE II: During Phase II, the research team will conduct a validation and verification (V&V) of the model developed in Phase I using three relevant tactical mission thread provided by the principle investigator. The deliverable for this phase is a detailed report on the V&V process and an explanation of any model modifications that were required based on the testing. This work will be classified at the TS//SI//NOFORN level.

PHASE III: Apply the game theoretic model validated in Phase II during a field test of the products developed for the FNT 13-03 FNC. The model should enable pre-mission Cyber/EW arsenal assessment and real-time tactical decision-making based on emerging threats detected in the Electromagnetic Environment (EME). The deliverable for this phase is a detailed assessment of the FNC based on the output from the game theoretic framework recorded during testing. The report should also include a methodology to apply game theory to both the Marine Corps Planning Process (MCPP) and decisions made within the Cyber/Electronic Warfare Coordination Cell (CEWCC) during tactical operations. This work will be classified at the TS//SI//NOFORN level.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The methodologies developed in this SBIR topic will enable warfighters to populate and select Cyber/EW applications from an application mall within a tactical cloud architecture. The game theoretic framework will enable rapid comparative analysis between available applications required for specific mission sets. Currently, the private sector is quickly moving towards the usage of cloud architectures to increase collaboration. This type of collaboration and rapid assessment will be very useful for the MAGTF to conduct cyberspace operations at the tactical edge.

REFERENCES:
1. Fudenberg, D. and Tirole, J. (1991) Game Theory, Cambridge: MIT Press.

2. Schramm, H., Alderson, D., Carlyle, M., and Dimitrov, N. (2012) A Game Theoretic Model of Strategic Conflict in Cyberspace, Naval Postgraduate School.

3. Washburn, A. and Kress, M. (2009) Combat Modeling, New York, NY: Springer Press.

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KEYWORDS: Game Theory, Operations Research, Analytic Baseline, Cyber/Electronic Warfare, Tactical Cloud Architectures

N141-079 TITLE: BFTN(e) Multi-Layer Spatial Multiplexer (MLSM) for RF Networking

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: Battle Force Tactical Network, ACAT III, for PMW/A 170 Program Office

OBJECTIVE: A Spatial Multiplexer will enable Spatially Divided Multiple Access (SDMA) transmit-receive paired nodes to correlate half-rate sub-streams dynamically, facilitating flexible channel modulation across up to 4 wideband High Frequencey (HF), 4 wideband Very High Frequencey (VHF) or 4 wideband Ultra High Frequency (UHF) radio pathways. This advancement in RF Network transport of TCP/IP will enable spatial filtering between transmit/receive pairs so that each SDMA which is also known as Multiple Inputs/Multiple Outputs for Multiple User (MIMO-MU) can nodally each have dynamically layered delivery options.

DESCRIPTION: Present designs of BFTN are underutilizing the power of "wireless" networking using multiple transmitters and receivers to establish meshed high-bandwidth TCP/IP communications (Collegiately referred to as MIMO-MU) in an Anti-Acess Area Denial (A2AD) or Satellite Communication (SATCOM) denied event. These events are predicted to last as many as 9 months without abatement and can significant impinge warfighter operations until BFTN is enhanced to advantage the user with the high-bandwidth they need. A principal challenge with these high-bandwidth RF Network layers is to dynamically route IP data traffic across a number of RF communication pathways that are "sub-netted" to allow hopping from one transport path to another and still retain TCP delivery verifications. The MLSM project endeavors to build upon academic research work conceptually architecting spatial combining and reuse of RF channels in order to layer RF Networks into cohesive multi-node MIMO-MU wireless delivery systems. The endeavor will assert testable design criteria to this cognitive research and establish design limitations commensurate to MIMO-MU Networking over RF; to produce a common routable topology across multiple sub-networks within the technical and operational requirements of US Navy Fleet operations. As the result of this project, MLSM will be tested and demonstrated in a test bed environment that closely mimics a Navy trial program such as the Fleet Experiments (FLEX) or similar Program of Record funded evaluations. If successful, the MLSM will enable expedited implementation of the BFTN(e) capability to the US Navy Fleet and assure their TCP/IP inter-networked communication even in the most stringent Radio jammed environments.

PHASE I: The offering company or organization will design a common approach to multiplex and load balance TCP/IP traffic across eight RF Networking circuits based on Exhibit 1: Concept Diagram for Spatial Multiplexing eight (8) channels of HF/UHF/VHF. This exhibit can be viewed on the SITIS website for the duration of the solicitation opening. As a Phase I deliverable, a scientific and technical report will be required that will fully document how the design will be constructed, as well as, contain sufficient underpinning research, both direct and indirect, to authenticate the achieved performance results of such a design.

Exhibit 1: Concept Diagram for Spatial Multiplexing 8 channels of HF/UHF/VHF

PHASE II: Utilizing design from Phase I effort, develop a bench-top prototype that would be used to validate required performance in a laboratory environment. A Program of Record sponsored field trial will authenticated the performance levels postulated during Phase I and demonstrated during the Benchtop test. Phase II deliverables, over and above the required monthly status/progress reports and the final report, will include the following, as a minimum:
1) Complete preliminary and final prototype design documents/drawings to the system and subsystem level.
2) A preliminary design review (PDR) and critical design review (CDR), and all supporting documentation for these reviews, will be provided to government stakeholders at the 50 and 75 percent point of the base effort. A Technology Readiness Review (TRR) and all supporting documentation for this review, will be provided to government stakeholders at the 50 percent point of the option effort, if awarded.
3) Formal test procedures and test plans with subsequent test inspection/reports authenticating the achieved performance results of the prototype design.
4) Preliminary demonstration of bench-top prototype design will be required within the last 30 days of the base effort, and if option effort is awarded, a fully operational demonstration will be required no later than the end of the option period. Each demonstration will consist of spatial multiplexing, load-balancing and re-routing performance levels in a laboratory emulation of three at-sea Carrier Strike Groups with simultaneously inter-operating RF Networks.
5) Bench-top prototype must be delivered to the government at the completion of the base effort, if option is not awarded. If option is awarded, prototype will be retained by company for further refinement and testing, and re-delivered to the government at the end of the option period.

PHASE III: Transition of this work effort to full production under the BFTN Program of Record (POR) will be accomplished once the MLSM design is validated and interface requirement documentation is approved for installation. Productionization of the solution will commence once installation handbooks and user maintenance manuals are completed and accepted by the SPAWAR Integrated Logistics System (ILS) organization.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: RF Networking is a common approach to achieve user mobility. However long-range communications in the at-sea environment still has a significant dependence on SATCOM and/or HF radio point to point voice communications. Accentuating their present

Radio communications system with this MLSM offers an ability to multiplex TCP/IP output to multiple radios aboard a cargo vessel or yacht and utilize highbandwidth RF Networking as a result.

REFERENCES:
1) A. Paulraj, R. Nabar and D. Gore " Introduction to Space-Time Wireless Communications," Stanford University Textbook, Cambridge Publishers, 2003, ISBN 978-0-521-06593-1

2) Hujun Yin, and Hui Liu "Performance of Space-Division Multiple-Access (SDMA) With Scheduling," IEEE Transactions on Wireless Communications, VOL. 1, NO. 4, October 2002

3) Exhibit 1: Concept Diagram for Spatial Multiplexing 8 channels of HF/UHF/VHF (uploaded in SITIS 12/2/13).

KEYWORDS: BFTN; RF Networking; MIMO-MU; Load-Balancing; HF/UHF/VHF; wireless routing; Jamming, TCP/IP

N141-080 TITLE: Innovative and Cost-Effective Thermal Protection Systems for Navy Reentry Bodies

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Strategic Weapons Systems: Trident II D5 (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.

OBJECTIVE: Define and demonstrate cost and weight effective materials for Navy Thermal Protection System applications.

DESCRIPTION: Navy reentry bodies are subject to intense aerodynamic heating rates and surface ablation during descent. A Thermal Protection System (TPS) is used on the outer surface of the body to control ablation and minimize the amount of heat transmitted to the underlying structure. Current Navy TPS technology is based on the family of char-forming carbon/phenolic (C/Ph) materials and was developed in the 1960's. These materials are effective, but a TPS based on C/Ph can be heavy and thick. It is known that a variety of char-forming (thermo-set and thermo-plastic) and non-char forming materials have become available for fire/flame resistant applications since the development of the current Navy system. High performance structural and non-structural insulation materials have also become available, and there may also be utility in evaluating nano-material solutions.

This topic seeks innovative solutions for improving the performance of the Navy Reentry TPS over the current C/Ph system. Navy TPS are deployed in Submarine Launched Missile Systems and cost, weight effectiveness are the primary performance metrics. However, proposed solutions must be also be free of light metal contaminants; and must be maintenance-free.

Proposed solutions must be fabricated from US Domestic sourced materials.

PHASE I: Define and develop TPS concepts for improved performance over current Carbon/Phenolic TPS materials. Example thermal loads for Reentry Bodies are given in Ref. [1], as are heat loads for typical ground test evaluations, survivability requirements and performance of current systems. Phase I effort will perform thermal analyses of proposed concept, and predict TPS performance against survivability requirements during flight. Define criteria for Phase II success.

PHASE II: Fabricate and test prototype TPS concept for laboratory and/or ground testing. Define scale-up manufacturing process (if necessary), develop production and life-cycle costs. Finalize Phase II design in response to ground test results, and produce additional materials to support material characterization.

PHASE III: Assuming successful demonstration in Phase II, TPS concept will be transitioned to Reentry Bodies for Navy Strategic Systems or Conventional Strike Hypersonic Boost Glide Vehicles.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Light weight, cost effective TPS's have potential use in Commercial Space vehicles. In addition, these type TPS materials have potential application as fire/flame protection materials for military/commercial aircraft interiors, and as under-hood, or crew compartment, fire protection for commercial/military vehicles.

REFERENCES:
1. Barczi, K. A., Buchanan, A. L., Jensen,D. L., and Brunsvold, R., "Ablation Testing of a Non-Rayon Carbon Phenolic Heatshield Material in Preparation of Fielding a Flight Test Vehicle.", AIAA Missiles Sciences Conference, 7-9 November, 2000, Monterey, California.

2. Nam, J.-D., and Seferis, J.C.,"Generalized Composite Degradation Kinetics for Polymeric Systems under Isothermal and Non Isothermal Conditions", J.Poly.Sci, Part B: Physics, Vol. 30, 455-463 (1992).

3. Chen, Y.-K., and Milos, F.S., "Nonequilibrium Ablation of Phenolic Impregnated Carbon Ablator", Journal of Spacecraft and Rockets, Vol. 49, 894-904 (2012).

4. Tate, J.S., Kabakov, D., and Koo, J.,"Carbon/Phenolic Nanocomposites for Ablative Applications", SAMPE Journal, Vol. 47, 36-43 (2011).

KEYWORDS: Thermal protection; strategic; reentry; heatshield; ablation; composite; insulator

N141-081 TITLE: <u>Signals of Opportunity as a Covert Alternative Fix Source for Submarines While Submerged</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors, Electronics

ACQUISITION PROGRAM: Strategic Weapons Systems: Trident II D5 (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.

OBJECTIVE: This SBIR will develop an innovative alternative technology position fix system that would be entirely passive (i.e., no transmission of energy or the exposure of a mast antenna) for use on a submarine while submerged using available signals of opportunity.

DESCRIPTION: The development of an accurate, totally covert, non-inertial navigation system for underwater navigation is a long standing problem. Currently, submarines rely on GPS or bathymetry as a position fix source for reset of their inertial navigators. Each of these systems either require the exposure of a mast antenna or the transmission of acoustic energy to the bottom. There has been significant Signals of Opportunity development for in air applications. There is very little published on any underwater Signals of Opportunity for position fixes. This SBIR would investigate the feasibility of a new technology alternative position fix system that would be entirely passive (i.e., no transmission of energy or the exposure of a mast antenna). This new system would use external signals, both man-made and natural, to provide a position fix, while submerged, for inertial navigation reset to near GPS quality, i.e., 3-D position error less than 5 meters 1-sigma. The receiver on the underwater platform needs to be able to be made small < 1 m3 volume although 0.027 m3 would be the goal. Both ranging and velocity aiding signals may be considered

PHASE I: 1) Determine what available Signals of Opportunity are available underwater and at what depth they are available. 2) Develop an alternate fix source for a submarine using Signals of Opportunity. 3) Develop metrics and a strategy for measuring the effectiveness of the proposed approach. 4) Produce a detailed research report outlining the design and architecture of the system, as well as the advantages and disadvantages of the proposed approach.

PHASE II: 1) Based on the results from Phase I, develop a fully functioning prototype solution. 2) Provide test and evaluation results that demonstrate the effectiveness of the overall system. 3) Develop a final report completely describing the design and architecture.

PHASE III: Further engineering design efforts will continue to develop the Signals of Opportunity design to incorporate the "ilities" (manufacturability, reliability, operability, etc.) and integration into the Navigation Subsystem.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology could be used in any commercial equipment that needs position or velocity in areas where GPS is not always available, such as subway systems or unmanned underwater vehicles (UUV).

REFERENCES:

1.) Ryan J. Eggert, "Evaluating the Navigation Potential of the National Television System Committee Broadcast Signal", Master's thesis, Air Force Institute of Technology, Wright-Patterson AFB OH, March 2004.

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KEYWORDS: Signals; Opportunity; SoOP; Navigation; Submarine; GPS

N141-082 TITLE: <u>Non-Linear Behavior Models for Design of Carbon-Carbon Composite Components</u>

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Strategic Weapons Systems: Trident II D5 (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.

OBJECTIVE: To develop improved non-linear materials behavior models for the design of Carbon/Carbon thermal protection components.

DESCRIPTION: Thermal protection systems (TPS) for current and future Navy hypersonic reentry bodies include flight critical components fabricated from 2D and 3D woven carbon-carbon (C/C) composite materials. TPS component designs are validated by Finite Element Analysis (FEA) during pre-flight Preliminary and Critical Design Reviews (PDR & CDR). These C/C materials are orthotropic in nature and exhibit extreme non-linear behavior across a very wide temperature range of 70-5000F, and above. Use of linear elastic behavior models results in over prediction of material stress state, and possibly over conservative designs. Efficient design with these materials requires that onset and development of material non-linearity be accounted for. For 3D C/C, this has historically been accomplished by use of a material behavior model (UMAT) that enables the FEA code to calculate the material stress/strain at all points within the component at discrete points during reentry. While the UMAT model is relevant to 3D C/C composites in general, the utilization in a reentry environment requires applicability to problems with distributed external pressure loads, and severe transient thermal loads. Damage and non-linearity are primarily driven by these transient thermal loads.

The UMAT material model contains coefficients derived from characterization tests. Historically, this was not a concern as the C/C material was derived from constituent materials with a stable manufacturing base; the composite material was well characterized and much data was available by which these coefficients were obtained. However, this is no longer the case; fibers and matrix materials become obsolete almost as soon as they are selected, and pre-flight PDR/CDR design validation for current generation TPS materials is often required before full characterization data and material model coefficients become available. Furthermore, output of the material model is limited to stress/strain state and gives no indication as to the onset or extent of non-linearity (damage) within the material or critical failure mode within the cell structure of the material.

This topic seeks to take advantage of recent improvements in computational power/resources in developing new/improved methods for thermo-mechanical design validation of new/emerging 2D and 3D C/C TPS components.

PHASE I: Conceptualize approach for improved design methodology for non-linear FEA of 2D and 3D C/C. Evaluate methods which take into account onset and development of material non-linearity under transient and multi-directional thermo-mechanical stress state developed during reentry. Evaluate methods at to provision of insight into onset and evolution of damage, and dominant failure mode. Evaluate methods which can automate or ease the development of material coefficients from limited new data sets from candidate replacement materials. Methods which integrate with the commercial ABAQUS finite element method are preferred. Evaluate preliminary approach and perform partial functionality using current materials/test data. Define criteria for Phase II success.

PHASE II: Continue to develop and refine methodology for C/C component design taking into account onset and development of material non-linearity under thermo-mechanically induced tension, compression or shear loads. Demonstrate extraction of material coefficients using reduced material data sets from replacement materials. Evaluate fidelity of response against test data from complex thermo-mechanical load conditions. Evaluate the concept for applicability in a Nosetip reentry environment. Deliver code/models to Navy for evaluation.

PHASE III: Transition non-linear material design methodology for potential use in a multitude of military and commercial applications. If successful, this methodology would transition into a future Navy Program of Record. Package and market methodology for commercial applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: 3D reinforced composite materials have many potential uses in space, air transport, and automotive applications. Improved methods for design validation of these materials would be very attractive. Examples include: Missile NoseTips, Missile Launch Abort Systems, Throttling Divert and Attitude Control Systems (T-DACS), and Thermal Protection Systems for hypersonic vehicles.

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