OSD DEPUTY DIRECTOR OF DEFENSE RESEARCH & ENGINEERING SMALL BUSINESS INNOVATION RESEARCH PROGRAM

PROGRAM DESCRIPTION

Introduction

The Army Research Laboratory, the Army Research Institute, the Naval Sea Systems Command and the Air Force Research Laboratory, hereafter referred to as a DoD Component acting on behalf of the Office of the Director, Defense Research and Engineering, invites small business firms to submit proposals under this Small Business Innovation Research (SBIR) program solicitation. Firms with strong research and development capabilities in science or engineering in any of the topic areas described in this section and with the ability to commercialize the results are encouraged to participate. Subject to availability of funds, DoD Components will support high quality research and development proposals of innovative concepts to solve the listed defense-related scientific or engineering problems, especially those concepts that also have high potential for commercialization in the private sector.

Objectives of the DoD SBIR Program include stimulating technological innovation, strengthening the role of small business in meeting DoD research and development needs, fostering and encouraging participation by minority and disadvantaged persons in technological innovation, and increasing the commercial application of DoD-supported research and development results.

The DoD Program presented in this solicitation strives to encourage technology transfer with a focus on advanced development projects with a high probability of commercialization success, both in the government and private sector. The guidelines presented in the solicitation incorporate and exploit the flexibility of the SBA Policy Directive to encourage proposals based on scientific and technical approaches most likely to yield results important to DoD and the private sector.

Three Phase Program

Phase I is to determine, insofar as possible, the scientific or technical merit and feasibility of ideas submitted under the SBIR Program and will typically be one half-person year effort over a period not to exceed six months. Proposals should concentrate on that research and development which will significantly contribute to proving the scientific and technical feasibility of the proposed effort, the successful completion of which is a prerequisite for further DoD support in Phase II. The measure of Phase I success includes evaluations of the extent to which Phase II results would have the potential to yield a product or process of continuing importance to DoD and the private sector. Proposers are encouraged to consider whether the research and development they are proposing to DoD Components also has private sector potential, either for the proposed application or as a base for other.

Subsequent Phase II awards will be made to firms on the basis of results from the Phase I effort and the scientific and technical merit of the Phase II proposal. Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months (subject to negotiation). Phase II is the principal research and development effort and is expected to produce a well defined deliverable prototype or process. A more comprehensive proposal will be required for Phase II.

Under Phase III, the DoD may award non-SBIR funded follow-on contracts for products or processes, which meet the component mission needs. This solicitation is designed, in part, to encourage the conversion of federally sponsored research and development innovation into private sector applications. The small business is expected to use non-federal capital to pursue private sector applications of the research and development.

This solicitation is for Phase I proposals only. Any proposal submitted under prior SBIR solicitations will not be considered under this solicitation; however, offerors who were not awarded a contract in response to a particular topic under prior SBIR solicitations are free to update or modify and submit the same or modified proposal if it is responsive to any of the topics listed in this section.

For Phase II, no separate solicitation will be issued and no unsolicited proposals will be accepted. Only those firms that were awarded Phase I contracts, and have successfully completed their Phase I efforts, will be considered. DoD is not obligated to make any awards under Phase I, II, or III. DoD is not responsible for any money expended by the proposer before award of any contract. For specifics regarding the evaluation and award of Phase I or II contracts, please read the front section of this solicitation very carefully, as well as the Component's specific requirements contained in their respective sections. Each of the services and Defense Agencies have developed their own Phase II enhancement policy, which can also be found in their respective sections. The DDR&E topics will follow the Phase II enhancement policy corresponding to the topic author's service. That is, the Army Research Laboratory and the Army Research Institute will follow the Army Phase II enhancement policy, the Naval Sea Systems Command topics will follow the Navy policy, and the Air Force Research Laboratory topics will follow the Air Force policy. (Refer to their respective sections in this solicitation for details.)

The Fast Track provisions in section 4.0 of this solicitation apply as follows. Under the Fast Track policy, SBIR projects that attract matching cash from an outside investor for their Phase II effort have an opportunity to receive interim funding between Phases I and II, to be evaluated for Phase II under an expedited process, and to be selected for Phase II award provided they meet or exceed the technical thresholds and have met their Phase I technical goals, as discussed Section 4.5. Under the Fast Track Program, a company submits a Fast Track application, including statement of work and cost estimate, within 120 to 180 days of the award of a Phase I contract. Also submitted at this time is a commitment of third party funding for Phase II. Subsequently, the company must submit its Phase I Final Report and its Phase II proposal no later than 210 days after the effective date of Phase I, and must certify, within 45 days of being selected for Phase II award, that all matching funds have been transferred to the company.

Follow-On Funding

In addition to supporting scientific and engineering research and development, another important goal of the program is conversion of DoD-supported research and development into commercial products. Proposers are encouraged to obtain a contingent commitment for private follow-on funding prior to Phase II where it is felt that the research and development has commercial potential in the private sector. Proposers who feel that their research and development have the potential to meet private sector market needs, in addition to meeting DoD objectives, are encouraged to obtain non-federal follow-on funding for Phase III to pursue private sector development. The commitment should be obtained during the course of Phase I performance. This commitment may be contingent upon the DoD supported development meeting some specific technical objectives in Phase II which if met, would justify non-federal funding to pursue further development for commercial purposes in Phase III. The recipient will be permitted to obtain commercial rights to any invention made in either Phase I or Phase II, subject to the patent policies stated elsewhere in this solicitation.

Contact with DoD

General informational questions pertaining to proposal instructions contained in this solicitation should be directed to the point of contact identified in the topic description section. Proposals should be mailed to the address identified for this purpose in the topic description section. Oral communications with DoD personnel regarding the technical content of this solicitation during the pre-solicitation phase are allowed, however, proposal evaluation is conducted only on the written submittal. Oral communications during the pre-solicitation period should be considered informal, and will not be factored into the selection for award of contracts. Oral communications subsequent to the pre-solicitation period, during the Phase I proposal preparation periods are <u>prohibited</u> for reasons of competitive fairness. Refer to the front section of the solicitation for the exact dates.

Proposal Submission

Proposals shall be submitted in response to a specific topic identified in the following topic description sections. Each topic has a point of contact to which the proposals shall be submitted. The topics listed are the only topics for which proposals will be accepted. Scientific and technical information assistance may be requested by using the DTIC SBIR Interactive Technical Information System (SITIS).

OSD DEPUTY DIRECTOR OF DEFENSE RESEARCH & ENGINEERING

FY 1999 Topic Descriptions

ARMY RESEARCH LABORATORY TOPICS

Technology Focus Area: Sensors

The Army Research Laboratory (ARL) consists of technical Directorates and Centers focusing on specific "fields of endeavor" of critical importance to the Army and DOD. ARL is a leader of basic research for the Army and the ARL primary locations are Adelphi and Aberdeen Proving Ground, Maryland.

Technology Focus Area: Sensors/ Electronic Devices

The DDR&E/Army Research Laboratory topics are:

OSD99-001 Microsensor Information Assurance

OSD99-002 Novel X-ray Detection for Large Field of View Very High Resolution Computed Tomography Inspection and Evaluation

OSD99-003 Improved Breakdown Properties in Large Area SiC Devices

Submission of Proposals for the above topics:

All proposals written in response to the above topics must be received by the date and time indicated in **section 6.2** of the introduction of this DOD solicitation. **All proposals (one original, with original signatures, and four copies) must be submitted to the ARL SBIR Program Manager at the following address:**

U.S. Army Research Laboratory
Technology Transfer Office
AMSRL-CS-TT (D.HUDSON)
2800 Powder Mill Road
Adelphi, Maryland 20783-1197

For more information or clarification about the above topics you may contact Mr. Dean Hudson on (301) 394-4808 or email: dhudson@arl.mil

OSD99-01 TITLE: Intersensor Information Assurance

DOD CRITICAL TECHNOLOGY: Sensors

OBJECTIVE: Develop methods of information assurance for battlefield intersensor networks.

DESCRIPTION: We anticipate that future battle commanders will deploy distributed arrays of networked sensors or sensor elements for remote sensing, surveillance, and/or area denial missions. Individual microsensors may consist of small arrays of individual sensing elements (acoustic, seismic, magnetic, etc.), or groups of different kinds of sensor elements, or both. Data from these sensor elements must be collected at a local central processing unit (CPU), which will attempt to detect, classify, and/or identify various battlefield targets of interest. Microsensors may also communicate with neighboring microsensors in order to improve their estimates of the target/s, and with gateways to more conventional information networks.

PHASE I: Intersensor communications, i.e., between microsensor elements and their associated CPU as well as between neighboring microsensors, will likely employ different transmission mechanisms and communication protocols than conventional computer networks, yet will be subject to similar constraints on information reliability. Specifically, individual microsensor performance should degrade gracefully as sensor elements are lost from intersensor network, or as neighboring sensors are compromised. A mechanism to quantify and evaluate this needs to be developed.

PHASE II: Hardware and/or software should be developed to demonstrate improved network performance in the kind of adverse environment/s discussed above.

PHASE III DUAL-USE COMMERCIALIZATION: It is anticipated that microsensors will be the "eyes and ears" of future battlefields. They must be able to communicate with individual soldiers, small units, and higher-eschelon C4I assets through self-forming, wireless networks. These networks will have specialized internal and external communication protocols and algorithms that are conceptually similar to, but functionally unlike, those for conventional computer networks. Tactical sensors and sensor networks must be secure and robust in the face of information warfare attacks; this is the essence of sensor information assurance. It is anticipated that the research described above could also be applied to commercial and industrial networks of microsensors used to monitor traffic, automated warehouses, and secure installation, perimeters and borders.

REFERENCES:

Paul Walczak (ed.), "Land Warfare Information Survivability Worshop: Volume 1", ARL-SR-79, 28 Jan 99. Note: This report includes Peter Neumann's "Practical Architectures for Survivable Systems and Networks", Final report, SRI project 1688, Contract DAKF-11-97-C-0020, SRI International, 1999, which contains almost 300 additional references. It should be available via DTIC in May or June 1999, or via the web at http://www.csl.sri.com/~neumann/arl-one.html

KEYWORDS: Information Assurance, Unattended Ground Stations, and Microsensors

OSD99-02 TITLE: Novel X-Ray Detection for Large Field of View (FOV) Very High Resolution Computed Tomography (CT) Inspection and Evaluation

OBJECTIVE: Develop x-ray detectors for very high spatial resolution computed tomography imaging and evaluation of large areas.

DESCRIPTION: X-ray computed tomography (CT) is used for the nondestructive evaluation (NDE) of complex and advanced materials and components of civilian and military structures. X-ray CT imaging is applied in the automobile, aerospace, and nuclear waste industries, and is also applied to inspecting missile and rocket components (i.e., propellant, motors/motor casings, and nozzles). Medium energy x-ray CT using 300KeV-450KeV x-ray sources can attain spatial resolution of about 250 microns. Low energy x-ray CT using 160KeV microfocus x-ray sources can attain spatial resolution of about 25 microns or better. However, large factors of geometric magnification are necessary to attain this resolution, so only small areas on the order of a few or several millimeters, not inches, can be inspected. Secondly, 160KeV tubes can only penetrate relatively low atomic number (low Z), low density materials. Conventional and microfocus x-ray tubes are typically manufactured with certain focal spot sizes, which cannot be changed. However, there is much more flexibility in designing and developing x-ray detector systems. There is a need to develop x-ray detector systems for use with medium energy conventional tubes to provide better spatial resolution than currently attainable. This will allow inspection of significantly larger materials or components with better spatial resolution. Detectors with this capability could immediately be applied in the previously mentioned areas as well as three dimensional mapping and evaluation of mechanical/ballistic damage in armor material systems. Current CT imaging techniques have been successfully used to fully map ballistic damage in armor assemblies, including ceramics and composites. CT imaging has also been used for pre-impact characterization of armor target assemblies, including metal matrix composites with embedded ceramic plates. However, it is integration of pre and post impact characterization that will result in the best understanding of evolution of damage in a ballistic impact. X-ray detector systems capable of increased resolution over large areas will provide important, possibly critical, information on the ballistic behavior of armor material systems.

PHASE I: Develop a prototype x-ray detector system of very high (i.e., better than 200 micron) spatial resolution for medium energy x-ray CT imaging. The detector should provide this resolution over a field-of-view of at least 2-3 inches without using large geometric magnification factors.

PHASE II: Develop and demonstrate a x-ray detector system with improved spatial resolution for advanced CT imaging to detect defects in and assess structural integrity of armor material systems and components, including pre-and post mechanical/ballistic testing characterization of armor target assemblies.

PHASE III DUAL-USE COMMERCIALIZATION: The x-ray detector system will significantly enhance the inspection and evaluation of Army and commercial armor material systems by providing capability of very high resolution and relatively large area advanced x-ray CT imaging. This will be applicable to a variety of armor systems, including those using metals, ceramics, metallic/nonmetallic composites, and metal foams. Metal foams with high fraction of porosity are becoming a new class of engineering materials. Application for metal foams include commercial armored vehicles, blast protection in wall structures, and blast protection underneath vehicles for landmines. Certainly, metal foams could be used in military armor systems as well.

REFERENCES:

1. ST Neel; RN Yancey; DS Eliasen; DH Phillips; "NDE X-ray Computed Tomography Applications Research", Report Number WL-TR-95-4010, Materials Directorate, Wright Laboratory, Air Force Materials Command, Wright-Patterson AFB, OH, 1994.
2. MJ Dennis; "Industrial Computed Tomography", Methods of Nondestructive Evaluation, pp.358-386
3. C Bueno; MD Barker; RC Barry; RA Betz; SM Jaffey; B Staff; "High Resolution Digital Radiography and 3D Computed Tomography of Composite Materials", Proceedings of the Moving Forward With 50 Years of Leadership in Advanced Materials Conference, Vol. 39. I, pp. 766-778, Anaheim, CA. 1994.
4. RH Ossi; GE Georgeson; RD Rempt; "X-Ray Computed Tomography for Emerging Aerospace Materials and Processes Development", Interim Progress Report, Sept. 1991-May 1993, Boeing Defense and Space Group, WA, 1993.
5. JH Stanley; "Physical and Mathematical Basis of CT Imaging", American Society for Testing and Materials (ASTM), ASTM CT Standardization Committee, ASTM Tutorial: Section 3, 1986.

KEYWORDS: armor, x-ray computed tomography, nondestructive evaluation, ballistic damage, mechanical damage, and x-ray detector

OSD99-03 TITLE: Improved Breakdown Properties in Large Area SiC Devices

DoD CRITICAL TECHNOLOGY: Electronics

OBJECTIVE: Develop a method to increase the power handling capability of SiC devices by eliminating, or at least reducing, the decrease in the breakdown voltage as the size of the SiC devices increase. This will, for example, enable people to make single thyristors that can handle the current in inverter circuits used to operate electric motors in the more electric combat vehicle rather than using a larger number of devices connected in parallel as is currently done.

DESCRIPTION: There is a strong interest in the Army to replace many mechanical controls with electronic controls in their future combat systems; the interest is sufficient for it to be incorporated into a Science and Technology Objective (STO). One example is the drive system where replacing the mechanical with an electric drive would increase the flexibility in the design, enhance the performance, reduce the weight and volume, provide more stealth, improve reliability, and reduce the production costs. A key element in the electric drive is the SiC gate turn-off (GTO) thyristor that not only can handle large amounts of power, but also can operate efficiently at higher temperatures so it can be cooled by engine oil. Great strides have been made in making devices, but being able to use it effectively has been stymied by the problem of the breakdown voltage decreasing as the size of the device increases. This means that, in order to retain the required large breakdown voltage and at the same time handle the large amounts of current that are required, a number of smaller thyristors have to be combined in parallel. This is both cumbersome and demanding as all the thyristors have to have very similar characteristics. People have suggested that this problem can be solved through improved material quality through the reduction of crystalline defects such as dislocations and micropipes and/or improved processing by replacing etched mesa structures with junction edge termination geometry. Any other creative approach would also be considered.

PHASE I: Demonstrate that the approach selected shows a quantitative improvement in increasing the breakdown voltage in larger area devices.

PHASE II: Quantify the approach selected and identify its strengths and weaknesses. Incorporate the process into manufacturing of a SiC power device.

PHASE II DUAL-USE APPLICATION: SiC thyristor based circuits could be used in power electronic applications such as those in turbine engines, propulsion systems, systems and automotive and aerospace electronics.

KEYWORDS: Silicon Carbide, Breakdown Voltage, Thyristor, Dislocations, Micropipes, and Junction edge termination

REFERENCES:

1. J.W. Palmour, R. Singh, L.A. Lipkin, and D.G. Waltz, "4H SiC High temperature Power Devices," Trans. 3^{rd} HiTEC Conf., Albuquerque, NM, June, 1996, Vol.2,p XVI-9-14
2. A.K. Agarwal, JB Casady, LB Rowland, S Seshadri, RR Siergiej, WF Valek, and CD Brandt, "700-V Asymmetrical 4h-SiC Gate Turn-off Thyristors," IEEE Electron Device Lett. 18, 518 (1997)
3. PG Neudeck and JA Powell, "Effects of Micropipes on the Breakdown Voltage of SiC Devices,"IEEE Electron Dev. Lett. 15, 63 (1994)

4. SV Rendakova, IP Nikitina, AS Tregubova, and VA Dmitriev, ‘‘Micropipe and Dislocation Density Refunction in 6H-SiC and 4H-SiC Structures Grown by Liquid Phase Epitaxy,’’ J Electron. Mat. 27, 292 (1998)

ARMY RESEARCH INSTITUTE TOPIC

The U.S. Army Research Institute (ARI) is a directorate of the Total Army Personnel Command and is the Army's principal agency for soldier-oriented research and development in personnel and training. ARI is made up of a number of Research Units and is headquartered in Alexandria, VA. **Any questions and all proposals regarding the following topic, OSD99-04, should be addressed to:**

ARI RWARU
ATTN:TAPC-ARI-IR
William R. Howse
Building 5100
FORT RUCKER, AL 36362-5354
PHONE: 334-255-3686

OSD99-04 TITLE: Adaptive Instructional Systems

DOD CRITICAL TECHNOLOGY: Human Systems (Personnel Performance and Training)

OBJECTIVE: Develop an approach to design and implementation of computer-based training systems that dynamically adapt instructional methodology to individual differences in learning style and rate, capitalize on student strengths and match content and structure of training events to the student's conceptual structure.

DESCRIPTION: As military systems have become more complex so have their training requirements. Force reductions further necessitate increased training to maintain readiness and proficiency, which in turn increases pressure on, limited training resources. Military training programs tend toward temporally driven schedules which are incompatible with proficiency based progression. This produces a tendency toward outcome proficiency criteria derived from the mean or minimum obtainable level in a fixed time window. This results in unnecessarily high elimination rates and remedial instruction loops. The remediation loops increase manpower requirements and complicate training planning. Training eliminations entail wasted investment in recruiting and training those personnel.

Adaptive training methodologies have the potential to accommodate individual differences within required time limits to avoid instructional failures, ensure minimal proficiency outcome and the opportunity for maximizing the outcome proficiency for each individual. Current advances in conceptual modeling and in artificial intelligence technologies may provide the basic components of machine based instruction that adapts to and evolves with the individual student through the skill acquisition process.

PHASE I: Develop a technical approach to conceptual modeling of student and instructor behaviors and inferred cognitive processes as they evolve through the process of learning a complex skill, specifically, hovering a helicopter. Develop a technical approach for implementing these models within a computer based instruction module that teaches this task in a low-cost flight simulator.

PHASE II: Implement the approach developed in Phase I in a demonstration conducted on the ARI Intelligent Flight Trainer. Generalize the principles of the approach for application to other aspects of initial flight training and to other skill acquisition instruction modules.

PHASE III DUAL USE APPLICATIONS: The specific implementation of the demonstrated adaptive instruction system may be refined and used in initial entry training of rotary wing pilots. It is likewise adaptable to other occupational skill training programs such as advanced aircraft transitions, air traffic control and aviation maintenance. In addition, the technical approach will be applicable to instructional systems that are more heavily loaded on cognitive skills such as command and control and staff officer training. They are equally applicable in industrial and academic settings.

KEYWORDS: Training Technology, Artificial Intelligence, Intelligent Tutoring, Automated Instruction, Adaptive Training

REFERENCES:

1. Dohme, Jack. (1995) "The Military Quest for Flight Training Effectiveness". In: W.E. Larsen, R.J. Randle, Jr., and L.N. Popish (Eds.), *Vertical Flight Training*, (pp. 103-123). NASA Reference Publication 1373.
2. Gutstein, E. (1992) "Using Expert Computer Knowledge to Design a Self-Improving Intelligent Tutoring System". In: C. Frasson (Ed.) *Intelligent Tutoring Systems*, New York: Springer-Verlag.
3. Wolf, Randall P. and Delugach, Harry S. (1996), ``Knowledge Acquisition via the Integration of Repertory Grids and Conceptual Graphs,'' *Auxiliary Proceedings, 4th Intl. Conf. on Conceptual Structures*, P.W. Eklund, G. Ellis and G. Mann, eds., University of New South Wales, Sydney, Australia

NAVAL SEA SYSTEMS COMMAND TOPICS

Technology Area: Condition Based Maintenance Technology

The Naval Sea Systems Command has identified the following five topics:

OSD99-05 Development of Metrics and a Process for Mechanical Diagnostic Technique Qualification and Validation

OSD99-06 Prognostic Enhancements To Diagnostic Systems

OSD99-07 In-Situ Corrosion Detection and Mitigation for Inaccessible Areas

OSD99-08 Integrated Mechanical Load and Condition Assessment for Mechanical Components

The Program Executive Office for Aircraft Carriers (PEO Carriers) develops, acquires and supports operationally superior and affordable aircraft carriers for the Navy. The Navy goal is to significantly reduce the cost of ownership of aircraft carriers. Currently, maintenance costs represent approximately one-third of the total life cycle cost of the carrier itself, not including the embarked air wing. PEO Carriers is looking for innovative solutions to achieve large reductions in maintenance costs. One potential area of interest is condition based maintenance (CBM). DDR&E has identified four technical topics in the CBM technology area for the FY 99.2 solicitation. CBM capabilities are critical to meeting DoD platform, infrastructure, and logistical needs. Continued progress in CBM is essential to ensure increased affordability, performance, and longevity in DoD systems.

The topics were initiated by the Naval Sea Systems Command's technical offices that manage the research and development in these areas. The topics listed are the only topics for which proposals will be accepted.

PEO Carriers is seeking small businesses with a strong research and development capability and an understanding of the CBM capabilities. PEO Carriers invites the small business community to **send proposals (original plus 3 copies) directly to the following address**:

Mailing Address for Proposals and Technical Point of Contact:

Program Executive Office for Aircraft Carriers
Attn: PMS 378R, Ms. Gemma M. Meloni
Airport Plaza I
2711 Jefferson Davis Why
Arlington, VA 22202
Tel (703) 872-3249
Fax (703) 416-0327
E Mail melonigm@navsea.navy.mil

In addition, please electronically submit your appendices A, B and E through the Navy SBIR website at http:\\www.onr.navy.mil\SBIR.

Inquires of a general nature or questions concerning the administration of the SBIR program should be addressed to:

Office of Naval Research
Attn: NAVY SBIR PROGRAM, CODE 362, Mr. John Williams
800 No. Quincy Street, RM 633
Arlington, VA 22217
Tel (703) 696-0342
Fax (703) 696-4884
E Mail williajr@onr.navy.mil

OSD99-05 TITLE: Development of Metrics and a Process for Mechanical Diagnostic Technique Qualification and Validation

SCIENCE/TECHNOLOGY AREA: Modeling and Simulation

OBJECTIVE: Develop an approach, process and metrics to impartially evaluate performance and effectiveness of mechanical diagnostic techniques based on a particular Condition Based Maintenance (CBM) application.

DESCRIPTION: In an effort to reduce the total cost of ownership, while increasing readiness and reliability, the U.S. Navy has implemented condition based maintenance and monitoring systems on shipboard equipment/systems. In this age of open/modular systems, more and more third party software vendors are attempting to integrate their equipment/system specific diagnostic/prognostic systems into an existing core capability. Verification of these diagnostic and prognostic solutions is a key element of robust, reliable systems especially as these systems are developed in an open architecture comprised of solutions offered by a variety of technology vendors. Real-world validation is expensive and time consuming. An effective process and measures of effectiveness and performance need to be developed based on an evolving database of in-service data, simulations, and test bed data, all adequately quality assured and configuration managed to assure reliability. The primary goals of this task are to design processes, techniques and metrics for determining if a technology or near-COTS product should be considered for integration into currently deployed and future Naval equipment automated diagnostic systems that support the basic concepts of Reliability Centered Maintenance (RCM) and Condition Based Monitoring and Maintenance philosophies. The processes and metrics developed must be amenable to cost-effective assessment of a given technique against a variety of applications and for a given application against a variety of techniques. The process must account for different approaches to address the same diagnostic problem (e.g., oil analysis vs. vibration vs. thermography for bearing fault detection) without penalty other than that associated with the cost of implementation of one technique in a given application. The process must account for the specific application for which a particular technique is being considered. It must recognize that some techniques will perform better in some applications than others, but that failure to perform in one application is not reason to reject from all applications. The process must also outline an approach to gather and maintain data sets useful for development and test. These data sets must be adequately controlled, useful, and available to a broad range of developers and end-users.

PHASE I: Outline and specify the requirements for mechanical diagnostic technologies in a variety of applications aboard a future aircraft carrier. Identify the critical performance measures that differentiate acceptable from non-acceptable performance (e.g., false alarm rate, miss rate, hardware reliability) applicable to those equipment types. Define an approach to implement techniques to measure any diagnostic technique against those performance measures and to develop and maintain a library of data sets and simulations to support development and testing of candidate techniques.

PHASE II: Implement the approach defined in Phase I for a variety of machinery applications of interest to future aircraft carriers. Establish an initial data repository and library of applicable data sets for those machinery applications. Exercise the process and data library in controlled application.

PHASE III: Develop a software tool for use by military or commercial program managers to exercise a proposed diagnostic technique against a particular application requirement. The tool should user-friendly and easily updateable, potentially linked directly with the data repository via the Internet.

COMMERCIAL POTENTIAL: CBM is an important opportunity in both the military and commercial sectors. As open architecture systems evolve enabled by standards like MIMOSA, the need to reliably and fairly compare alternative techniques for a given application will become a critical issue for owners and operators of any system considering implementation of CBM.

REFERENCES:
1. Nickerson, G. William; Michael Van Dyke; and Carl S. Byington; "Qualification and Validation of Diagnostic Techniques Using Fleet Data", ASNE Condition Based Maintenance Symposium, June 1998.
2. Hadden, Ph.D., George D, George Vachtsevanos, Bonnie Holte Bennett, Ph.D., Joe Van Dyke P.E., "Machinery Diagnostics and Prognostics/Condition Based Maintenance: A Progress Report", Failure Analysis: A Foundation for Diagnostics and Prognostics Development, Proceedings of the 53rd Meeting of the Society for Machinery Failure Prevention Technology, April 1999.
3. Essawy, Magdi A. and Saleh Zein-sabatto, "Measures of Effectiveness and Measures of Performance for Machine Monitoring and Diagnosis Systems", Maintenance and Reliability Conference, May 1999.

KEY WORDS: Condition-Based Maintenance, CBM, Qualification and Validation, Data Repository

OSD99-06 TITLE: Prognostic Enhancements To Diagnostic Systems

SCIENCE/TECHNOLOGY AREA: Modeling and Simulation

OBJECTIVE: To develop prognostic algorithms and computer software applications that will readily support backfit into existing Naval platforms employing both SMART and conventional Command, Control, and Communications (C3); Human-System Interfaces (HIS), and sensor technologies as well as extensibility into new acquisition Naval platforms.

DESCRIPTION: This project will provide strategies for developing "add-on", "plug 'n play" type software modules that can be integrated and/or interfaced to existing system and equipment diagnostic software deployed on Navy ships and aircraft to estimate the time to failure and/or time to maintenance action for specific high value pieces of machinery. A number of options for enhancing existing diagnostic software will be addressed and evaluated. Options will include (1) data fusion drawing performance and intrinsic health data from shipboard and aircraft Condition Based Maintenance (CBM) databases; (2) executing external, independent artificial intelligence (ie: neural nets, fuzzy logic, genetic algorithms) algorithms on real-time and CBM database data through open software interface standards,; (3) incorporating mechanical components reliability design equations and algorithms in performance curve analyses and existing Boolean rule based diagnostics; and, (4) adapting data mining algorithms to sort and capture prognostic indicators from existing shipboard and aircraft CBM databases.

PHASE I: Select promising prognostic and HSI concepts that can be integrated or interface with existing shipboard CBM systems architectures. Perform preliminary investigations to determine the most likely supporting open systems interface specifications that can be adapted to support demonstration of the selected prognostic and HSI concept in conjunction with existing shipboard CBM databases. Develop a software design document and interface control document for demonstrating the selected prognostic and HSI concept.

PHASE II: Program and optimize the prognostic and HSI software modules in accordance the Phase I documentation utilizing machinery CBM database data for three types of equipment found aboard Navy ships and/or aircraft. Install and demonstrate the effectiveness of the software modules in both a land-based and shipboard environment in prognosticating potential failures and corrective maintenance actions.

PHASE III: Prepare plug-in software modules for individual shipboard, aircraft, and power generation, and chemical processing equipment with installation documentation for use with commercial and military Condition Assessment and Health Monitoring systems.

COMMERCIAL POTENTIAL: These software modules will be directly transferable to any machinery health monitoring application in the electrical power industries, commercial ship industry, commercial air travel industry, and chemical processing industry.

REFERENCES:

1. Carl S. Byington, Susan E. George, G. William Nickerson, Prognostic Issues for Rotorcraft Health and Usage and Monitoring Systems, Proceedings of a Joint Conference, A Critical Link: Diagnosis To Prognosis, 51st Meeting of the MFPT Society 12th Diennial RSAFP Conference, MFPT Society, April 1997, p, 93-102;

2. T. G Edwards and G. D Hadden, An Autonomous Diagnostic/Prognostic System for Shipboard Chilled Water Plants, Proceedings of a Joint Conference, A Critical Link: Diagnosis To Prognosis, 51st Meeting of the MFPT Society 12th Diennial RSAFP Conference, MFPT Society, April 1997, p, 139-150.

3. Lynn Yarosh et al, A Management Approach to Condition Based Maintenance for CVX, NSWC Crane Technology Management Symposium, November 1997.

KEY WORDS: Prognosis, Diagnostics, Machinery, Condition, Maintenance

OSD99-07 TITLE: In-Situ Corrosion Detection and Mitigation for Inaccessible Areas

SCIENCE/TECHNOLOGY AREA: Materials and Processes

OBJECTIVE: To develop the technology, manufacturing method, and associated hardware and software, to non-intrusively apply an in-situ Impressed Current Cathodic Protection (ICCP) system to detect and subsequently mitigate corrosion at hidden or hard-to-access sites in shipboard seawater systems.

DESCRIPTION: One of the most deleterious problems for shipboard seawater systems is corrosion in hidden or hard-to-access areas. Examples of corrosion which occurs in these systems include corrosion at crevices such as those created by flange joints and valve seats, erosion-corrosion in valves, pumps, or other areas of turbulent flow (elbows, tees) in piping, and galvanic corrosion caused by the use of dissimilar metals. These types of corrosion negatively impact both the total cost of ownership (TOC) and operational readiness. For non-critical systems, TOC is affected by the need to repeatedly perform repairs or replace components or piping sections. For critical systems where access is not possible or practical, costly non-destructive evaluations (NDE) are performed in an attempt to detect corrosion prior to the occurrence of a failure. NDE is often ineffective since the corrosion is typically localized and/or associated with complex geometries. Operational readiness is affected since corrosion in hard-to-access areas often progresses to the point of system failure prior to detection.

This topic seeks to provide a method with the ability to detect and then remotely stop corrosion while maintaining the structural integrity of the hidden area, without the need for disassembly. ICCP has been used extensively and successfully to suppress corrosion of external hulls, piers, and other submerged structures. However, it has not been applied to the mitigation of corrosion in hidden or inaccessible areas of complex seawater handling systems such as those on Navy ships. This topic seeks a technology capable of delivering ICCP to hidden areas, which are susceptible to corrosion, for detection and mitigation of that corrosion. Such a technology will allow the Navy to meet its requirements of reduced manning, increased operational readiness, and reduction in the total cost of ownership.

PHASE I: Demonstrate the technical and economic feasibility of a technology that will enable mitigation/prevention of localized corrosion, through in-situ application of ICCP to hidden areas. The proposed technology should be adaptable to a wide variety of hidden corrosion sites such as those found in Navy piping systems.

PHASE II: Optimize manufacturing methods, measurement devices, methods, and computer responses for the proposed technology. Build a prototype system, with dedicated hardware/ software that could be monitored through a variety of methods, including manual, automated, and/or wireless transmission. On multiple test sites, measure the corrosion currents and provide impressed current cathodic protection as applicable.

PHASE III: Statistically demonstrate the effectiveness of the technology for mitigation of localized corrosion in hidden areas. Manufacture the technology and optimized equipment. Assemble and transport equipment to a U.S. Navy shipyard to be designated and make a test installation on a Navy ship in overhaul or major availability. Train ship's force personnel to use the technology. Monitor and provide logistics support for a period of up to three years.

COMMERCIAL POTENTIAL: Strong potential for use throughout the world shipping industry, chemical industries, commercial power industry, off-shore oil industry, and anywhere crevice corrosion is a problem in hidden areas.

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OSD99-08 TITLE: Integrated Mechanical Load and Condition Assessment for Mechanical Components

OBJECTIVE: Develop technology to reduce the cost of integrating smart sensors with machinery and processes.

SCIENCE/TECHNOLOGY AREA: Sensors

DESCRIPTION: The cost to implement condition-based maintenance (CBM) technology widely on Navy weapons platforms will be dramatically impacted by the level of integration and penetration of the same technology into industrial and commercial markets. It is anticipated that integration of smart sensors with distributed processing capability needs to extend to the machine and machine component level. It is envisioned that the ultimate affordability will be achieved when smart machine components are widely available to build smart machines that are used to build smart weapons platforms. Today, sensors and machine components such as bearings, gearboxes and motors are designed and manufactured separately. This topic solicits innovative proposals to develop smart machine components that can show cost/performance advantages over current technology.

PHASE I: Research the Navy's critical machinery and document need. Classify critical machinery components into common and machine specific categories. Develop a smart machine component concept for those components with the greatest potential for payoff. Determine the critical technology development needs to demonstrate an economic advantage over current technology.

PHASE II: Develop the technology needs identified in Phase I. Produce a prototype smart machine component. Demonstrate how it integrates with a smart machine and ship wide CBM system. Conduct detailed cost/benefits analysis.

PHASE III: Implement the developed technology in commercial machine component manufacturing. Market these components widely to smart machinery opportunities such as turbines, generators, pumps, compressors, motors, etc. Produce large quantities to enable the reduction of cost of implementation of CBM aboard Naval ships and industrial manufacturing facilities.

COMMERCIAL POTENTIAL: CBM is an emerging market with tremendous potential in the US Navy, petro-chemical, pulp and paper, construction equipment, aerospace and consumer appliance markets. Smart machine components would be cost effective building blocks of the systems of the future.

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KEY WORDS:
Condition-Based Maintenance, CBM, Smart Sensors, Smart Machine Components

AIR FORCE RESEARCH LABORATORY TOPICS

Technology Area: Electronics

The mission of the Air Force Research Laboratory (AFRL) is to lead the discovery, development, and transition of affordable, integrated technologies for our air and space forces -- to keep our Air Force "the best in the world." Our mission is executed by our nine technology directorates, located throughout the United States. The following topics are focused on the technology area of electronics. Two of the topics are in the Munitions Directorate and the third is in the Sensors Directorate.

The AFRL Munitions Directorate, located at Eglin AFB FL, develops conventional munitions technologies to provide the Air Force with a strong technology base upon which future air-delivered munitions can be developed to neutralize potential threats to the United States. Their mission is to develop, integrate, and transition science and technology for air-launched munitions for defeating ground fixed, mobile/relocatable, air, and space targets to assure the pre-eminence of U.S. air and space forces. The following topics are managed by the Munitions Directorate:

OSD-009 "Electrophoretic Processing of Electronic Polymer Materials"
OSD-010 "Phase Tunable Spatial Light Modulator"

Mailed or hand carried proposals in response to the above topics, #OSD-009 and OSD-010, must be delivered to the SBIR focal point at the following address:

AFRL/MNOB
Attn: Dick Bixby
101 W Eglin Boulevard Suite 140
Eglin AFB FL 32542-6810
E-MAIL: bixby@eglin.af.mil
(850) 882-8591, ext. 1281

The AFRL Sensors Directorate specializes in the research and technology development needed for superior US air and space reconnaissance, surveillance, precision engagement, and electronic warfare systems. Their primary areas of technology investment include radio frequency sensors and countermeasures; electro-optical sensors and countermeasures; and automatic target recognition and sensor fusion. The following topic is managed by the Sensors Directorate: OSD99-11 "Silicon Carbide Power Transistors for High Power Transmitter"

Mailed or hand carried proposals in response to the above topic, #OSD-011, must be delivered to the SBIR focal point at the following address:

AFRL/SNOX
Atten: Marleen Fannin
Building 620, 2241 Avionics Circle
Wright-Patterson AFB, OH 45433-7318
E-MAIL:fanninbm@sensors.wpafb.af.mil
(937)255-5285, ext.4117

The following are the Air Force Research Laboratory topics.

OSD99-09 TITLE: Electrophoretic Processing of Electronic Polymer Materials

DoD CRITICAL TECHNOLOGY: Electronics

OBJECTIVE: To develop electrophoretic processing techniques for fabrication of bulk conductive, superconductive, and ferromagnetic polymers.

DESCRIPTION: Electrophoretic deposition (or electrophoresis) has inherent versatility unlike that of more commonly used techniques for advanced polymer fabrication. Electrophoresis is a process that involves movement or buildup of suspended particles (electrophores) through a fluid under the action of an applied electromotive force. In this way, tiny clusters of active polymer molecules can be combined as fundamental building blocks in order to form a desired bulk polymer material. Electrophoresis has potential application in fabrication of a variety of electronic polymers. There is a considerable amount of published information pertaining to the use of electrophoresis to form dielectric coatings on capacitor plates and printed circuit board cores. It may be feasible to extend the technology to conductive or superconductive polymer fabrication and for ferromagnetic polymer processing.

PHASE I: Phase I of this effort would involve demonstration of electrophoretic processing approaches for fabrication of bulk ferromagnetic polymers exhibiting magnetic permeability greater than 6 and bulk conductive polymers having conductivity well in excess of 1000 siemens. Detailed electronic and electromagnetic characterization of the new polymers would be required to verify achievement of unique material properties.

PHASE II: Phase II would address development of new electronic components useful for advanced future Air Force weapon fuzes, including low loss transmission lines for detonators and inductive couples for wireless connection of separately sealed, testable fuze modules.

PHASE III DUAL USE APPLICATIONS: This technology will find military usage in inductively coupled modular fuzes, connectors, and transmission lines. Additional applications include lightweight motors, electrical appliances, portable magnetic resonance imaging/medical examination devices, electronic test equipment, wireless communications devices, power transmission and distribution systems, and electric vehicles.

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ADD401667 – Polymer Coating by Electrophoretic Deposition

KEYWORDS: Electrophoresis, ferromagnetic polymer, electrophoretic deposition, superconductive polymer, conductive polymer, modular fuze

OSD99-10 TITLE: Phase Tunable Spatial Light Modulator

CATEGORY: Exploratory Development

OBJECTIVE: The objective is to identify an innovative concept for a pure phase Spatial light modulator.

DESCRIPTION: The research is to result in a fast (1K frames per second), high-resolution (256x256 or greater), gray scale (8 bits of controllable dynamic range), and affordable spatial light modulator (SLM) for application in phase-only optical correlators. The ideal SML should provide 360 degrees of pure phase modulation and can be compatible with a fast framing CCD array, i.e. it should operate at greater than 1kHz and have resolutions of 256 x 256 or greater. Most important is the need for full 360 degrees ($-\pi$ to π) gray-scale modulation across the visible spectrum with low noise levels, as well as pixel size of 20 microns or less and fill factor of 80 percent or greater. Proposals may involve the development of new materials and/or novel integrated device structures. Possible approaches might include liquid-crystal phase modulators or pixel-level addressable MEMS arrays. Appropriate drive electronics should be included in the design and integration of the system. Particular attention should be paid to keeping the overall package small and low cost.

PHASE I: The structure of the modulator is to be designed, materials are to be specified, the array fabrication process is to be established, and any subcomponent or materials testing necessary should be accomplished. Electronic drive circuits are to be designed. A proof-of-principle demonstration is to be carried out to show viability of the concept.

PHASE II: The complete prototype working devices are to be fabricated and demonstrated in Phase II. In particular, the number of bits of phase control, the linearity, the range of phase control, and the optical flatness should be established through rigorous testing. One complete prototype copy of the external drive electronics and three working modulator arrays should be delivered.

PHASE III DUAL USE APPLICATIONS: Optical modulators are critical elements in a multitude of commercial and military systems including: cameras, CCD video cameras, computer and video displays, simulators, photolithography, optical interconnects, telecommunications, security devices, and noninvasive medical procedures. There are almost no limits to the applications for modulators described here. This research is intended to introduce breakthrough technologies (new capabilities, enhanced performance, and reduced system size and weight) that significantly reduce future system cost. Spatial light modulators are used in optical processing, telecommunications, computing, and in display applications. In optical processing, they are used in such applications as optical correlators and real-time processors for synthetic aperture radars. In telecommunications they are used to route communications signals, optically connect electronic boards, and provide massively parallel transmission of data. Spatial light modulators are also often used as display devices in everything from consumer electronics to miniature head-up projectors to flight simulators.

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KEYWORDS: Spatial light modulators, phase modulators , liquid crystal modulators, MEMS, optical processing, optical correlation

OSD99-11 TITLE: Silicon Carbide Power Transistors for High Power Transmitter

DOD KEY TECHNOLOGY AREA: Electronics Technology

OBJECTIVE: Develop Silicon Carbide power transistors that will enable high power pulsed transmitters to achieve a stable output signal.

DESCRIPTION: Silicon Carbide power transistors are being used in the design of high power, high temperature applications. Current Silicon power transistors have a maximum operating temperature of below 150 degrees C and a maximum power of 300 Watts. Silicon Carbide power transistors on the other hand, can operate at temperatures on the order of 400 degrees C and a maximum power of 650 Watts. Therefore, Silicon Carbide power transistors can develop about twice the power of Silicon power transistors. Additionally, Silicon Carbide transistors are more efficient, which means that more power can be generated for the same cooling and power requirements as Silicon power transistors. When these power transistors are used in pulsed transmitter operations, output signal stability becomes an issue. In order to obtain a stable output signal, particular attention must be paid to design of both the power supply and the pulsed transmitter. The process development of SiC devices and circuits is evolving. Although the SiC materials have excellent high temperature operation, additional work remains to be completed on developing compatible metal contact systems and packaging/interconnect technologies that efficiently operate at high temperatures. These process and packaging issues should be addressed as part of the subject effort.

PHASE I: This topic focuses on the design of Silicon Carbide power transistors. The design should lead to improved device fabrication processes and packaging techniques. To optimize high temperature operation, compatible metal contact systems and packaging/interconnect techniques should be considered.

PHASE II: Construct and demonstrate the operation of a prototype pulsed transmitter with Silicon Carbide power transistors.

PHASE III DUAL USE APPLICATIONS: In both airborne and space applications where space is limited, pulsed transmitters using Silicon Carbide transistors will allow for smaller transmitter designs with high output power.

KEY WORDS: Silicon carbide, Power transistors, Pulsed transmitter, High temperatures, Output signal stability, Airborne and space applications

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