U.S. Army Laboratory Topics

TOPIC: OSD95-001 TITLE:Flexible Automated Finishing of Non-Axisymmetric Precision Optics

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CRITICAL OR KEY TECHNOLOGY: Precision optics are utilized in almost all US military weapons systems. Visible and Infrared-transmissive optical elements are used in night vision equipment, telescopic sights, laser rangefinder/designators, and seeker missiles. The need for new types of precision optics will further increase with the development of optical data processing and memories. The capabilities and affordability of these systems are bounded by the limits of optical manufacturing. This presently restricts optical design to spherical and plano component shapes. Affordable non-axisymmetric optics would open up new possibilities for electro-optical system front ends, displays optical computers and even conventional optical sights.

OBJECTIVE: Develop process and machinery to enable the flexible automated finishing of non-axisymmetric (cylinders, toroids) optics, that is, smoothing to 10 Angstroms RMS surface roughness and figuring to 1/10 wave.

DESCRIPTION: Deterministic microgrinding processes have been applied to flexible automated fabrication of spherical and plano optical surfaces. This has been accomplished at the Center for Optics Manufacturing (COM) in Rochester, NY. The extension of these techniques to the fabrication of non-axisymmetric optics will require new computer-controlled fabrication technology for final smoothing and precision figuring. This program will develop and prototype a system to perform this function. Both phases of this effort must be coordinated with the COM and participate in its concurrent engineering process. Following is a description of the effort by phase:

Phase I: (one year) A concept for non-axisymmetric optical finishing will be developed. The processes and system will be amenable to the optics shop environment, affordable to a small optics supplier, and environmentally friendly. A design and execution plan for Phase II will be included in the final report.

Phase II: (two years) The finishing machine for non-axisymmetric optics will be built and tested. Cylindrical and toroidal optical elements made from optical glass materials will be finished. SPC data will be collected on production runs to determine accuracy and repeatability. Cycle times will be measured. This information will be used to predict the cost for non-axisymmetric optical components made by this method. A design for a commercial version of the machine will be included in the final report.

DUAL-USE COMMERCIALIZATION: This program will make new classes of optics available to the designers and manufacturers of optical systems, both military and civilian. This will revolutionize future designs for robotic vision, television cameras, HDTV, laser scanners, laser rangefinders, telescopic sights, night vision, optical computers, optical memories, displays, virtual reality, missile seekers, and medical equipment.

REFERENCES:
1. "Computer-Aided Optics Manufacturing", Optics & Photonics News, pp. 15-19, June 1994.
2. "Doing More With Less" Optics and Photonics News, pp 21-27, June 1994
3. "Magnetorheological Finishing", Optics and Photonics News, P.16, December 1993
4. "Microgrinding Makes Ultrasmooth Optics Fast", Laser Focus World, July 1992
5. "Elements and Devices Based on Magnetorheological Effect" Journal of Intelligent Material Systems and Structures, Volume 4, Jan 93.

TOPIC: OSD95-002 TITLE: Intelligent Information Presentation for a Helmet Mounted Display in a Synthetic Environment

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OBJECTIVE: To develop an innovative and intelligent information presentation for a Helmet Mounted Display (HMD) as aircraft flight regimes change.

DESCRIPTION: Future methods of providing appropriate and timely information to the rotorcraft pilot via an HMD will require significant improvements to meet mission and pilotage requirements. Categories of information already envisioned for the HMD display include flight, navigation, system, obstacle avoidance, virtual switching and warnings, weapons status, and target acquisition. Research has shown that this volume of data leads to pilot information overload. Advances in intelligent information presentation as well as prioritization and filtering of flight mode information need to be achieved to obtain an essential high level of performance during low altitude night operations. As the rotorcraft moves from hover and low speed flight, to cruise and maneuver modes of flight operation, the symbologies displayed should intelligently and automatically make the same timely transitions. Manual mode selection of display information in use today was developed in the late 1970s. Manual mode selection does not take advantage of data bus and electronic cockpit monitoring systems that could provide automatic and intelligent information updates. Manual mode switching increases pilot workload and often results in unnecessary display icons that clutter the pilot's synthetic environment. Current technology does not provide the intelligent information presentation requirements necessary in future aircraft. Reduced pilot workload, safer flight envelopes, the encouragement of low-cost HMD development and use in the civil sector, and simpler pilot-vehicle interface with reduced switchology are all goals of this SBIR.

Phase I: Using several design principles, identify and evaluate innovative flight and mission information mode switching concepts necessary for representative aviation missions. Then, using a baseline which is representative of current technology, select several candidate intelligent information prioritization/filtering techniques to demonstrate the potential increase in pilotage and mission effectiveness.

Phase II: Preliminary evaluations of intelligent information presentation concepts for an HMD will be performed in both ground and in-flight simulation to verify improvement potential. Complete definition of intelligent moding characteristics of the most promising configuration will be verified in flight tests on helicopters with HMD systems.

DUAL USE COMMERCIALIZATION: This automatic moding HMD technology will have multiple applications in civil sectors in the area of emergency services including police, ambulance, forestry, and fire protection. Civilian resources are increasingly being tasked to monitor and assist in border surveillance, neighborhood surveillance, fire emergencies, highway patrols, forest protection, police reinforcement, and rescue service. Rotorcraft play a unique role meeting the civilian sector needs in all of these areas. These activities represent a growing market for rotorcraft; especially, in high population density areas. It is these high density areas where safety of flight issues are magnified and where intelligent flight moding will be most useful.

TOPIC: OSD95-003 TITLE: Thermal Imaging for Medical Diagnosis

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TECHNOLOGY: Second Generation Scanning Thermal Imaging

OBJECTIVE: Investigate and develop innovative designs and packaging of high sensitivity Second Generation thermal imaging for non-intrusive medical diagnosis. Sensitivities in the tens of milli-kelvin degrees range have been demonstrated in the latest developments in military systems based upon PV mercury cadmium telluride focal plane array technology. The goal is to establish the feasibility of using passive infrared imaging to detect and diagnose medical conditions, such as cancer and circulatory problems.

DESCRIPTION: The Army is in engineering development of advanced thermal imaging systems for integration into large weapons platforms, e.g., tanks, helicopters, gun systems, and missiles, which require large optics, power sources, processing, etc. The sensitivity available in this technology, when packaged in a small volume and used close up to a subject, could be used to detect very small temperature differences on a body's surface that are due to physiological problems. Such a device could then be used as a passive, non-intrusive diagnostic tool for doctors.

Phase I: Develop a design for a medical thermal imager, using focal plane array technology, which can be used by medical professionals in hospitals or offices to detect and diagnose medical disorders.

Phase II: Fabricate and demonstrate a diagnostic tool based upon Second Generation thermal imaging.

DUAL-USE COMMERCIALIZATION: A medical diagnostic tool, such as described above, not only has enormous civilian application, but can also be of significant benefit to military casualty diagnosis on the battlefield. Employment of this technology in combat field or shipboard hospitals could improve the timeliness for determination of the nature and location of wounds by passive, real time means.

REFERENCES:
1. Van Derlaske, Bohan, Graves, "Second Generation FLIR Horizontal Technology Integration", Proceedings of National IRIS, Eglin AFB, FL, 24-26 May 1994.
2. Van Derlaske, "Horizontal Technology Integration (HTI) of 2nd Generation Thermal Imaging", Proceedings of the Night Operations Symposium XI, Las Vegas, NV, 7-10 February 1994.
3. Hall, "Technology Applications for Next Generation Night Vision Equipment", Proceedings of SPIE OE/Laser Conference, Los Angeles, CA, 26 January 1994.

TOPIC: OSD95-004 TITLE: Inexpensive Intrusion Detectors

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TECHNOLOGY: Staring, Uncooled Thermal Imaging

OBJECTIVE: Develop and demonstrate a small, lightweight, low power, uncooled thermal imager that will be affordable for the home security market.

DESCRIPTION: Uncooled thermal imaging, based upon staring pyroelectric detector array, has been demonstrated for low to medium performance target acquisition applications. The cost of such devices is relatively inexpensive in military affordable terms and the technology has been transferred to the automobile industry for night driving aids. Innovative designs and device concepts are required in order to demonstrate significantly greater improvements that would enable the fabrication of devices at a cost that made them inexpensive enough for mass production home protection systems.

Phase I: Investigate cost reduction designs for uncooled thermal imagers and innovative device designs to significantly lower the cost of these devices.

Phase II: Fabricate and demonstrate an uncooled thermal imaging device which can be projected to be affordable for the mass home security systems market.

DUAL-USE COMMERCIALIZATION: Imaging devices that are affordable for home protection would be applicable to many security missions in the services; base intrusion, armory security, military police, remote sentries, robots, etc.

REFERENCES:
1. Royal, Miller, "Uncooled Thermal Imaging Systems", Proceedings of SPIE, Orlando, FL, 5-8 April 1994.

TOPIC: OSD95-005 TITLE: Fluid-Filled O-Ring for Maintaining a Seal Under Low Temperature Conditions

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TECHNOLOGY: Engineering Sciences

OBJECTIVE: Extend capabilities of fluid-filled O-ring to include high temperature applications.

DESCRIPTION: Recently, a patent was issued to an Army engineer on a fluid-filled O-ring for maintaining a seal under low temperature conditions. O-rings serve the critical function of sealing devices in containers, components, pressure vessels, pipes, structures and machines in which pressurized fluids or gases are prevented from leaking out. The degree of sealing depends on how well the O-ring cross section can deform and deflect from the circular shape to an oval section thus filling up any gap around it and resting tightly against the two walls of the two concentric

components. Unfortunately, most elastomeric O-ring seals loose their resilience (flexibility) at low temperature and are not effective sealers. In fact, the disaster of Space Shuttle Challenger happened because the unusual low temperature of the launch site stiffened the solid rocket booster O-ring seal and reduced its sealing capacity leading to the accident. The objective of the new elastomeric O-ring design is to provide an improved O-ring seal for subzero temperatures that does not stiffen when introduced to a low temperature and cause a situation of imperfect sealing.

This technology, developed by the Army, demonstrated the feasibility of making an O-ring that can seal at low temperatures. To make this technology commercially viable, further development of the O-rings is needed to accommodate high-temperature applications, such as for a standard internal combustion engine.

Phase I: Develop a preliminary O-ring designed for low-temperature uses using one standard material for the O-ring and perform preliminary tests to determine high-temperature tolerance for a standard-type, commonly used industry sealing device.

Phase II: Develop a prototype or series of prototypes for high-temperature applications common in industry and test in a simulated industrial application. Develop application specifications for the one type of 0-ring material.

DUAL-USE COMMERCIALIZATION: These fluid-filled O-rings have very high potential for private industry uses for components that are used to contain fluids or gas and that are subject to cold environmental effects. Such components include those using automotive technology, pressure vessels, pipes, and pumps. Military uses include much of the same and may also include high-power engines and launchers.

TOPIC: OSD95-006TITLE:Biosensor Technology and Miniaturization

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OBJECTIVE: The objective of the project is to fabricate a prototype hand-held biosensor able to detect toxins, bacteria, and/or viruses. Sub-objectives to meet the main goal are: investigate the potential of new detection approaches or modify established ones; fabricate a Phase I deliverable for testing at ERDEC; continue to miniaturize and test the Phase I design in Phase II with emphasis on ease-of-use (automation), low power consumption, rapid response, and high sensitivity; deliver the final product to ERDEC.

DESCRIPTION: Sensor types that are currently being investigated at ERDEC are the Light Addressable Potentiometric Sensor (LAPS), the Surface Plasmon Resonance (SPR) Sensor, Electrochemiluminescence Sensor, and the Fiber Optic Waveguide (FOWG). Other technologies have been considered in the past or are under review such as bioelectrochemistry and other optical methods. The Army requires miniaturized (hand-held) biosensors that can operate continuously for at least 24 hours and that can rapidly and unambiguously identify bioagents of concern. All approaches being considered involve antibody based assays although DNA probes and receptor based detection are also being investigated and are applicable for this solicitation.

Phase I: The phase I project will involve an experimental program to either downsize or otherwise modify a particular well-developed sensor technology (ie. LAPS, SPR, FOWG, ECL) or to demonstrate the feasibility of using another technology in a miniaturized sensor design. The contractor will concentrate on detection methods and designs that use low power consumption and enable the system to be hand-held. Any approach must detect a model biomolecule of interest to the Government at response and sensitivity levels within current detection requirements. A prototype will be one of the deliverables at the end of the effort.

Phase II: The phase II objective will be to optimize the design concepts explored in Phase I, to produce improved prototypes, and to incorporate a variety of assays of interest to the Government. By the end-of-effort, the contractor will provide a final sensor system that meets the requirements laid out in the General section above.

DUAL-USE COMMERCIALIZATION: The work described in this topic has applications for detecting a variety of substances of interest to clinical and environmental markets.

TOPIC: OSD95-007 TITLE:Innovative Approaches to Vaccine Delivery

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TECHNOLOGIES: C13 Chemical and Biological Systems

OBJECTIVE: To demonstrate the feasibility of delivering vaccines which would provide protection for multiple years by means other than the traditional needle and syringe.

DESCRIPTION: Most vaccines require multiple boosters and are given parenterally by needle and syringe. The procedure is tedious for mass immunizations and not without risk due to needle stick injuries. Desirable are vaccines which require a single administration either orally or by some other means amenable for mass immunizations, including administration of polynucleotide vaccines. Of principal interest are viral diseases (e.g. vaccinia, hantaviruses, tick-borne encephalitis virus, equine encephalitis viruses), bacterial diseases (e.g. anthrax, plaque), and toxins (e.g. botulinum toxin, staphylococcal enterotoxins).

Phase I: Demonstrate feasibility in laboratory animals using a vaccine against agents listed above.

Phase II: Preclinical trials to support IND submission.

DUAL-USE COMMERCIALIZATION: Specifically, vaccines to agents mentioned above could be marketed around the world especially to foreign travelers and in countries with endemic disease. The technology developed would be applicable to any vaccine and thus of major interest to groups such as the Children's Vaccine Initiative.

TOPIC: OSD95-008TITLE:Flame Resistant Textiles Using Microencapsulated Flame Retardants

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TECHNOLOGY: Advanced Materials and Processing

OBJECTIVE: Investigate the use of microencapsulated flame retardants to improve the flame resistance of textiles used for tentage, clothing and individual equipment.

DESCRIPTION: Flame resistance remains one of the most difficult characteristics to achieve with new textiles, while being extremely important for our soldier's safety. Many advances have been recently made using

microencapsulated substances for improved product performance. This effort will concentrate on using this technology to replace or improve current textile flame retardant treatments.

Phase I: The technical feasibility of using microencapsulation for flame resistant textiles will be established. Potential flame retardants will be identified, the most effective microencapsulation technique determined, and methods of incorporating the microcapsules onto various textile products proposed. The target fabrics shall include breathable, coated and laminated fabrics currently used for tentage, clothing and individual equipment and new textile products previously excluded due to their lack of flame retardance. The study will result in a trade-off analysis comparing performance, safety and manufacturing issues of the proposed solutions to existing products.

Phase II: The most promising concepts of phase I will be expanded and laboratory trials conducted. Laboratory strike-offs of potential products will be tested and compared to existing fabrics. Full-scale manufacturing issues will be resolved and pilot production runs completed. Adequate material will be supplied to enable full-scale fabrication and testing of representative tentage, clothing and individual equipment.

DUAL-USE COMMERCIALIZATION: This technology has wide-reaching commercial application wherever flame resistant textiles are required such as camping tents, clothing, sleeping bags, draperies, carpeting, and aircraft interiors.

REFERENCES:

1. "Microscopic Parcels Deliver the Goods," Chemical Engineering, March 1993.

TOPIC: OSD95-009TITLE:Optical Vibration Monitors in Gas Turbine Engines for Prognostic and Diagnostic Applications

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TECHNOLOGY: Advanced Propulsion Technologies

OBJECTIVE: Develop optical vibration monitors for inspection of gas turbine engines.

DESCRIPTION: Optical vibration monitors are used in the LV100 engine to determine the condition of the blades. This application is limited to laboratory testing only. Recent advancements in the optics and the electronic instrumentation should make such a system economical for field application to inspect production engines. If provided, such systems can be used to determine the condition of the rotor blades in the engine. This information will be available for scheduling maintenance and minimize the engine down time.

Phase I: Conduct the market survey and determine the state-of-the-art technology. Design a cost effective system for application in a production engine.

Phase II: Procure the system and demonstrate in an engine.

DUAL-USE COMMERCIALIZATION: If such a prognostic and diagnostic system can be made simpler and cost effective it can become a standard tool for maintenance of production gas turbine engines.