U.S. Air Force Laboratory Topics

TOPIC: OSD95-019 TITLE:Spastic Resistant Stick Controllers

POINT OF CONTACT: Armstrong Laboratory
AL/XPTT (Belva Williams)
2509 Kennedy Circle
Brooks AFB, TX 78235-5118
(210) 536-2103

TECHNOLOGY: Human-Systems Interfaces

OBJECTIVE: Stimulate the transition of stick controllers, which have been demonstrated to be resistant to sudden, spastic motion.

DESCRIPTION: At the Armstrong Laboratory, a technology with dual-use applications has evolved within the Air Force as a result of studies conducted to find stick controllers that pilots may use in unusual flight environments. A joint program between the Air Force and the Department of Veteran Affairs was conducted to apply this DOD technology to patients with neuromotor disabilities. An extensive data base now exists which demonstrates for pilots, normals, and patients with neuromotor disabilities, that substantial improvement in tracking performance can be obtained for a variety of task situations. This technology can be developed by a small business contractor to further improve on size, cost, and commercial availability of this technology for a wide number of applications. Within the Air Force, several Air Force patents are available for licensing. Proprietary data bases that can be developed for exclusive rights to the small business contractor for his marketing purposes are also available.

PHASE I: Phase I will result in engineering specifications for commercialization applications.

PHASE II: Phase II will result in fabrication, testing, and validation of spastic resistant stick controllers based on the commercial/military applications assessment.

DUAL-USE COMMERCIALIZATION: Some possible uses within the health care industry include: (1) wheelchair stick controllers, (2) input devices into computers (cursor control), and (3) other "spastic resistant" devices for use in the workplace to help employ individuals with some neuromotor disability. Applications outside the health care industry include: (4) video game "steady sticks" and (5) training aids for precision control tasks.

REFERENCES:
1. D. W. Repperger, "Active Force Reflection Devices In Teleoperation," IEEE Control Systems Magazine, January, 1991, pp. 52-56. Unclassified. Distribution Unlimited.
2. D. W. Repperger, E. L. Scarborough, and T. L. Chelette, "Construction of A Dual Axis Force Reflection Stick and Test Station," Al-TR-1992-0041, November, 1991. Unclassified. Distribution Unlimited.

TOPIC: OSD95-020 TITLE:Spontaneous Emission Filter

POINT OF CONTACT: Rome Laboratory
RL/XPX (William Gregory)
26 Electronic Parkway
Griffiss AFB, NY 13441-4514
(315) 330-3046

TECHNOLOGY: Telecommunications, Computers, and Electronic Devices

OBJECTIVE: Develop a semiconductor spontaneous emission filter device to improve DoD and commercial fiber-optic transmission systems for communications and computer interconnects.

DESCRIPTION: As defense and civilian message bandwidth continuously increases, dramatic increases in speed and decreases in cost for both DoD and commercial fiber optic communications and interconnect subsystems are continually required. Ultra-high bandwidth telecommunications or inter-computer interconnects utilizing fiber optic technology must deal with a signal/noise ratio determined in part by spontaneous emission noise produced by source or repeater laser devices in all-optical architecture. Cascaded stages of amplification amplify the spontaneous noise to the point where detection and regeneration are required. A spontaneous emission filter device would provide such amplification without the need for electronic regeneration. Performance increases and cost savings for both DoD and commercial systems could be very significant. The Digital Photonics Branch in the Surveillance & Photonics Directorate at Rome Laboratory has developed such a filter based on our observation that spontaneous emission in an in-plane GaAs laser does not quench lasing activity in a second crossed-cavity laser. Prototype filter devices have been fabricated at Cornell and tested in the Photonics Center at Rome Laboratory, and are now ready for SBIR pickup.

PHASE I: Should involve further development of filter designs based on the demonstrated Rome Lab prototype, iterative fabrication of devices, and evaluation.

PHASE II: Should involve development of actual pre-commercialization devices. Target commercial and DoD applications should drive device engineering. Packaging and cost issues should be fully addressed. Use of Photonics Center device design, evaluation, and fabrication resources, including access to the National Nanofabrication Facility, and research collaboration with Branch Personnel is encouraged in both phase I and II.

DUAL USE COMMERCIALIZATION: These devices have the potential to revolutionize both DoD fiber-optic communications and internetting systems, as well as the Nation's installed base of fiber-optic communications.

REFERENCES:
1. "A Laser Optical Amplifier with an Integrated Spontaneous Emission Filter", M. Parker et al, NASA Laser Tech Briefs, Vol. 2, No. 4, Fall 1994, in print.
2. Surveillance & Photonics Directorate WWW Home Page, via URL, "http://www.rl.af.mil:8008/

TOPIC: OSD95-021 TITLE:Optical Pattern Recognition for Validation and Security Verification

POINT OF CONTACT: Rome Laboratory
RL/XPX (William Gregory)
26 Electronic Parkway
Griffiss AFB, NY 13441-4514
(315) 330-3046

TECHNOLOGY: Lasers, Optics & Power Systems, Human-Systems Interfaces

OBJECTIVE: In recent years, crime problems such as counterfeiting of currency and credit cards has increased to alarming proportions. Counterfeit parts such as computer chips and machine tools are arriving in America in great numbers. With the rapid advances in computers, CCD technology, image processing hardware and software, printers, scanners, and copiers, it is becoming increasingly simple to reproduce pictures, logos, symbols, money bills or patterns. This has stimulated an interest in research, development, and publications in security technology. In the growing area of biometrics identification, optical techniques are being used in developing products for retinal scanning, hand geometry, vein recognition, and fingerprint identification. In the military realm, access to secure areas and sensitive information through passes or ID's is an important application. The means currently used to secure things, such as holograms on credit cards, and PIN numbers on a magnetic strip on credit cards, are today easily read by scanners, CCD cameras, etc.

DESCRIPTION: If the information were encoded in the form of optical phase it would be very difficult to read by ordinary means. This is because all physical detectors are only sensitive to the intensity of the read-out light. The phase information is lost in the process of going from complex amplitude to intensity. However, optical correlators are sensitive to this information, and can make binary decision based on this phase information on whether the information card or pass is valid and whether the person using the card is the rightful user. The same technique could be used to irretrievable attach a phase mask to a computer chip. Several techniques have been proposed to use this fact that the phase information is invisible to standard detectors in an encryption scheme that is virtually impossible to copy or counterfeit (ref 1.2).

PHASE I: Develop a feasibility study and a preliminary design and demonstration plan for phase II.

PHASE II: Develop, build, and test a brass-board model of an optical security system embodying phase-encoding as the encryption means in conjunction with some form of biometrics measurements.

DUAL USE COMMERCIALIZATION POTENTIAL: The commercial market is desperately in need of a simple, inexpensive scheme to stem the $2 billion fraud rampant in this sector. In addition, there are ample military uses in entry into secure or sensitive areas, and the verification of parts, such as computer chips purchased by the government. It is very likely that phase-encoded encryption schemes could solve both these problems.

REFERENCES:

1. B. Javidi, J.L. Horner, J.F. Walkup, OPTICS & PHOTONICS NEWS, Sept. 94, pp. 13-19.
2. B. Miller, IEEE Spectrum, February 1993.
3. J. Horner, B. Javidi, J. Walkup, Patent Pending, "Optical Pattern System For Verifying The Authenticity Of A Person, Product, Or Thing," Docket #21069, filed 9/14/93.

TOPIC: OSD95-022 TITLE:High-Speed Electronic Imaging and Storage

POINT OF CONTACT: Wright Laboratory

WL/DOR (Gerry Cassidy)
2130 Eighth Street, Suite 1
Building 45
Wright-Patterson AFB, OH 45433-7542
(513) 255-4119

TECHNOLOGY: Electronics, Optics

OBJECTIVES: Investigate state-of-the-art developments in high-speed electronic imaging.

DESCRIPTION: The Wright Laboratory, Armament Directorate has been a leader in the development of applications for electronic imaging instrumentation technology. One of the highest requirements for the weapons research, development and test communities is a high resolution replacement for high speed film cameras. The key elements are the image sensor (million pixels, 1000 plus frames per second), the signal processor (gigaword per second, 8 to 12 bits per sample) and data storage (1000 to 10000 megawords in 1 cubic foot or less). We are currently developing a solid state image sensor for this process and have been performing research to address other areas. Numerous dual use applications are apparent. Among these applications are: automotive crash testing; aircraft and engine testing; machine vision for manufacturing; web inspection (textiles, paper); rolled goods inspection (steel, aluminum); sports medicine and human performance monitoring. More important are applications where the high speed imager is the transducer input to another device combining technologies the Armament Directorate is investigating in optical computing, spectroscopy, and signal processing. Among these secondary applications are: optical compilers and correlators; medical radiology and diagnostics; optical storage and retrieval (holographic memory); optical spectrometers for process control and environmental monitoring, and illegal dump

deletion; multispectral cameras for drug detection, crop and forest management, law enforcement, and treaty verification; DNA mapping and cell histology/cytology/pathology.

PHASE I: It is envisioned that Phrase I will consist of analysis and design of a system using high speed imaging techniques from the sensor, signal processing, or recording areas. The design should have both commercial and military pay-off.

PHASE II: Phase II would consist of prototype fabrication and test. A commercialization plan is required for both Phase I and Phase II.

DUAL-USE COMMERCIALIZATION: Technology development in the high speed video area is key to all the desktop graphics input devices being developed. It is also key to the development of high resolution medical imaging devices such as MRI, CAT, and PET scanners. In addition, high speed imaging has application in automotive, commercial aircraft, and industrial testing.

REFERENCES:

1. McCurin, Schooley, and Sims, "Signal Processing for Low Light Level, High Precision CCD Imaging", SPIE Vol 1448, "Camera and Input Scanner Systems" (1991).

TOPIC: OSD95-023 TITLE:Multidisciplinary Design Optimization (MDO)

POINT OF CONTACT: Wright Laboratory

WL/DOR (Gerry Cassidy)
2130 Eighth Street, Suite 1
Building 45
Wright-Patterson AFB, OH 45433-7542
(513) 255-4119

TECHNOLOGY: Design Automation (computer aided design, concurrent engineering, simulation and modeling; including the computational aspects of fluid dynamics, electromagnetics, advanced structures, structural dynamics and other automated design processes).

OBJECTIVE: Develop Multidisciplinary optimization tools for the design of Airframe Structures with the emphasis on integration of structures, aerodynamics and controls disciplines.

DESCRIPTION: Airframe design optimization requires the integration of engineering disciplines: structures, aerodynamics and controls; mathematical disciplines: optimization, sensitivity analysis, implicit and explicit integration schemes; computer science related disciplines: executive and higher order languages, data bases and other software development issues. Over the last ten years the Flight Dynamics Directorate of Wright Laboratory has developed a prototype structural optimization system called "ASTROS" (Automated Structural Optimization System), and has publicized it through training workshops and distribution to industry, government laboratories and universities. ASTROS, at present, runs on most of the modern work stations (IBM RS6000, SGI, SUN, Hewlett-Packard, Dec Alpha, VAX, to name a few), and mainframes (CRAY-YMP-C90, Convex, etc.). Although "ASTROS" is a comprehensive self-contained structural optimization system, its architecture allows easy enhancements and additions of new engineering modules. The latter feature of ASTROS offers great opportunities for small businesses to develop a secondary market through the development of enhancements as well as new modules to expand the scope of the multidisciplinary optimization system. Any expansion related to airframe and other aircraft subsystems optimization can be potential topic for the STTR solicitation. The following area is cited as an example for the expansion of MDO.

Computational Fluid Dynamics: The steady and unsteady aerodynamic modules of current MDO systems are based on panel methods because of their simplicity and versatility in handling the full range of flight conditions. Nevertheless, the general consensus is that these methods are inadequate to model the complex flight conditions of

modern aircraft, including high-angle-of-attack, transonic and hypersonic ranges. The purpose of this solicitation is to investigate potential approaches for bringing the results of modern computational fluid dynamics research into the MDO environment. This is not intended for research in CFD per se but to devise schemes to factor CFD results into the design optimization environment.

PHASE I: Within the above area, develop requirements and criteria for establishing critical performance and operation bounds and identify the key parameters for optimization.

PHASE II: Utilizing the results of Phase I, develop efficient computational modules for integration into existing or future multidisciplinary optimization systems.

DUAL-USE COMMERCIALIZATION: Such an MDO system can be readily used for the design of all types of military and civilian aircraft, automobile and engine components, off shore platforms and other marine structures, and civil engineering structures such as buildings and bridges.

REFERENCES:

1. Johnson, E. H., and Venkayya, V. B., "Automated STRuctural Optimization System (ASTROS)," AFWAL-TR-88-3028, Volume I - Theoretical Manual, December 1988.
2. Neill, D. J., and Herendeen, D. L., "ASTROS Enhancements," WL-TR-93-3025, Volume I - ASTROS User's Manual, March 1993.

TOPIC: OSD95-024 TITLE:Multiple Degree of Freedom Measurement (MDFM) System

POINT OF CONTACT: Wright Laboratory

WL/DOR (Gerry Cassidy)
2130 Eighth Street, Suite 1
Building 45
Wright-Patterson AFB, OH 45433-7542
(513) 255-4119

TECHNOLOGY: Human-Systems Interfaces

OBJECTIVE: Investigate commercial applications of MFDM system in a commercial machine tool environment. The system has application as an accessory to coordinate measuring machines used in virtually every type of industrial setting.

DESCRIPTION: The MFDM program, ManTech contract F33615-89-C-5716, developed a laser-based system capable of measuring five geometric error components per axis simultaneously. The systems were found to have an accuracy of 1 micron for straightness measurement, and 0.5 arcsec for pitch and yaw measurement. The development work accomplished resulted in a prototype system demonstration at University of Michigan, the prime contractor. However, the original research focused solely on the system's potential use as a calibration device. No work has been accomplished to implement this system as a performance enhancer for coordinate measurement machines (CMMs). Independent market analysis indicates a strong industry need for this type of device.

PHASE I: Further investigate the potential applications of the MFDM system. Develop preliminary design criteria to bring existing design prototypes to implement as appropriate, and develop and demonstrate commercial prototype.

PHASE II: Demonstrate updated prototype of the system for selected dual use technology areas. Implement beta sites to test the prototype, and document additional changes necessary to fully implement in a commercial setting.

DUAL USE COMMERCIALIZATION: The MFDM system has the potential for application in any industry area that uses a CMM - virtually every manufacturer in the world. This product could be a valuable tool for teaching factories and manufacturing extension centers as well.

TOPIC: OSD95-025 TITLE:Advanced Tooling Manufacture for Composite Structures (ATMCS)

POINT OF CONTACT: Wright Laboratory
WL/DOR (Gerry Cassidy)
2130 Eighth Street, Suite 1
Building 45
Wright-Patterson AFB, OH 45433-7542
(513) 255-4119

TECHNOLOGY: Human-Systems Interface

OBJECTIVE: Investigate applications of existing ATMCS expert system in other domains - metal forming, extruded plastic, etc.

DESCRIPTION: The ATMCS system, developed under ManTech contract F33615-89-C-5715, is an expert system that automates and greatly reduces the time required to design the tooling required to manufacture composite structures. The results show a 95% reduction in time, and the potential for cost savings using this system are enormous for the aircraft industry. The development work accomplished resulted in an implemented system at Northrop Aircraft, the prime contractor, and at several beta sites within the composites supplier subtier.

PHASE I: Investigate the potential commercial applications of ATMCS. Develop preliminary design criteria for additional knowledge bases, identify relevant parameters, and begin development of necessary additions to existing software.

PHASE II: Develop a prototype of the system for selected dual use technology areas. Implement beta sites to test the prototype, and document additional changes necessary to fully implement in a commercial setting.

DUAL-USE COMMERCIALIZATION: The ATMCS system has the potential for application in other industries that require tooling design. Some examples include metal forming, extrusion, and plastics molding. It could have use in any number of commercial manufacturing enterprises. The existing software shell would require tailoring, and a new knowledge base would need to be developed listing and relating the key parameters for each new technology area. This product could be a valuable tool for teaching factories and manufacturing extension centers as well.

TOPIC: OSD95-026 TITLE:Intelligent Machining Workstation (IMW)

POINT OF CONTACT: Wright Laboratory
WL/DOR (Gerry Cassidy)
2130 Eighth Street, Suite 1
Building 45
Wright-Patterson AFB, OH 45433-7542
(513) 255-4119

TECHNOLOGY: Human-Systems Interfaces

OBJECTIVE: Investigate military and commercial applications of IMW process planning and execution system in a modular machine tool environment. The system has application is such areas as metal cutting, concurrent engineering design, aerospace, automotive, telecommunications, industrial machinery, and machine tools.

DESCRIPTION: The IMW program, ManTech contract F33615-86-C-5038, developed a prototype set of software modules and novel tooling designed to perform unattended metal cutting planning and execution. The results showed use of this system resulted in a more efficient operation. This modular system can be used in total, or tailored to fit the needs of any size manufacturer. The development work accomplished resulted in a prototype system demonstration at Cincinnati Milacron, the prime contractor. No commercial activity was ever pursued after contract completion.

PHASE I: Investigate the potential commercial applications of IMW products. Develop preliminary design criteria to bring prototypes to current state of the art, upgrade existing prototype, and conduct market analysis to determine appropriate commercial areas and changes needed to existing product.

PHASE II: Demonstrate update prototype of the system for selected dual use technology areas. Implement beta sites to test the prototype, and document additional changes necessary to fully implement in a commercial setting.

DUAL-USE COMMERCIALIZATION: The IMW system has the potential for application in any industry area that uses machine tooling. Some examples include such areas as metal cutting, concurrent engineering design, aerospace, automotive, telecommunications, industrial machinery, and machine tools. The software and hardware could be offered as a package or as modular units, and could be used in any size manufacturer, form large primes to small manufacturing enterprises. This product could be a valuable tool for teaching factories and manufacturing extension centers as well.

TOPIC: OSD95-027 TITLE:Measurement Techniques for Surfaces under Dynamic Contact

POINT OF CONTACT: Wright Laboratory
WL/DOR (Gerry Cassidy)
2130 Eighth Street, Suite 1
Building 45
Wright-Patterson AFB, OH 45433-7542
(513) 255-4119

TECHNOLOGY: Interfacial Sensors, Data Retrieval

OBJECTIVE: Measure tire footprint slip velocities (relative to ground) and contact stress/pressures of tires rolling on a dynamometer or over a flat, paved track under steady-state or transient conditions. A measurement system designed for dynamometer installation shall not adversely affect the structural integrity of the dynamometer. Tires will be subjected to a wide range of loading conditions, including, but not limited to, braking (ABS (automatic braking system) or steady) and cornering (transient or steady).

DESCRIPTION: Measurement system shall be applicable to both automotive and aircraft tires for input into durability and safety design improvement studies. Wear and handling characteristics, which are directly related to tire footprint quantities, change significantly as speed increases. Sensor technology state of the art (pin sensors) currently are capable of measuring pressure and slip in the contact region at low tire speeds (0.06 mph). Pin slip sensor technology, in its infancy, has already shown some limitations for low speed applications, but no promise for high speed applications. Pin pressure sensor technology (which is somewhat more developed) performance will be degraded in high speed dynamometer applications, due to vibrations and centrifugal effects.

PHASE I: Develop design and determine feasibility of:

1) slip sensor for low speed dynamometer and flat track use
2) contact stress and slip sensor types for high speed dynamometer and flat track use

PHASE II: Develop and deliver full scale final product. Install, test and validate on a WL/FIVMA dynamometer.

DUAL-USE COMMERCIALIZATION: The measuring system has commercial application to both the aircraft and automotive tire industries, as well as the military aircraft and automotive tire industries.

REFERENCES:

1. "The Tire-Pavement Interface", ASTM STP 929, edited by Pottinger & Yager, 1986.
2. "Mechanics of Pneumatic Tires", DOT HS 805 952, edited by Samuel Clark, 1981.