Department of the Navy SBIR/STTR Transition Program

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Topic # N101-095

Multiplexed Fiber Optic Sensor System for SHM of Ships: Integration & Validation

Intelligent Fiber Optic Systems Corporation

WHO

SYSCOM: ONR

Sponsoring Program: Not specified

Transition Target: Littoral Combat Ships (LCS) & Landing Craft Air Cushion (LCAC)

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Other transition opportunities: A strain monitoring system of this nature could be installed in many DoD platforms (including destroyers, cruiser, amphibious ships, submarines, fighter, patrol and transport aircraft), which have key structural components (such as pressurized bulkheads, rudders, propellers, superstructures and wing attachment point) that could benefit from strain or loads monitoring.

http://www.navy.mil/management/photodb/webphoto/web_180327-N-AT135-018.JPG

Notes: A demonstration was given at NSWC Carderock with 60 sensors attached to cantilever beam and 5 0x9D x3 0x9D aluminum plate sampled at 6 kHz sampling rate.

WHAT

Operational Need and Improvement: A highly reliable, non-intrusive system for monitoring loads in Naval structures (ships and submarines) as well as next generation weapon systems is critically needed. Strain monitoring is a proven method for assessing the performance of a structure and for determining the remaining fatigue life left on the structure. However, present strain monitoring systems suffer from various limitations.

Specifications Required: The system should be reliable and durable in a sea environment, capable of monitoring a minimum span of 400 ft, the sensors should have a small footprint so as to be cost effective and non-intrusive, with good dynamic range and sensitive, reconfigurable, adaptive and scalable up to 500 sensors, with good frequency response. Other attributes include electromagnetic interference (EMI) resistance and have minimal wiring and maintenance requirements (no batteries, no switches).

Techniques that use fiber optic sensors or wireless MEMS sensor nodes are two examples that could offer the opportunity to overcome all these limitations. Overall objectives for this program are simplicity, reliability, scalability and affordability.

Technology Developed: IFOS developed a multisource Fiber Bragg Grating (FBG) sensor system supporting 128 FBG sensors per node over a range of 1500 microstrain or 256 sensors per node across 500 microstrain, which enables measurement of dynamic strain (loading) and temperature at many points along an optical fiber as a basis for structural health monitoring or condition-based maintenance.

Warfighter Value: Significant cost savings could be achieved by the installation of such a system and therefore, performing maintenance at longer time intervals or only when the system indicates that it is required.

WHEN

Contract Number: N68335-17-C-0170 **Ending on:** January 2, 2019

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Finalize specs & interrogator design.	Low	Design document completed	4	2nd QTR FY18
Perform hardware upgrades on current interrogator & construct new system	Med	Interrogator hardware lab tested	4	4th QTR FY18
Perform software enhancement and upgrades	Med	Interrogator software lab tested	4	1st QTR FY19
Develop sensor arrays for testing on Navy structures	Low	Sensor arrays completed	4	4th QTR FY18
Install sensors & perform grillage tests	Med	Sensors recorded dynamic strains throughout tests	5	1st QTR FY19
Install sensors & perform LCAC tests	High	Sensors recorded dynamic strains throughout tests	6	1st QTR FY19

HOW

Projected Business Model: Intelligent Fiber Optic Systems Corporation (IFOS) is a silicon valley based pioneer of advanced sensing system solutions and products using fiber optics for the measurement of physical, chemical and biological parameters derived from the interaction of light with matter. Pressures to 1 kBar, temperatures to 1000°C, angular rates, strains as small as sub micro strain and as large as 10,000 micro-strain and a number of other parameters can be measured accurately at MHz sampling rates simultaneously across large numbers of sensors in the extreme environments of space, energy and the human body. IFOS fiber optic interrogators and fiber optic gyroscopes are made to withstand the harsh environment of space and are used for structural health monitoring, prognostics, NDT and other applications requiring access to difficult areas, electromagnetic interference immunity, low size, weight and power packaging.

Company Objectives: IFOS seeks to meet with Program Managers and Prime Contractors in order to install IFOS sensors system on platforms such as LCAC, LCS and Expeditionary Fast Transport (EPF) ships. In addition, IFOS optical fiber sensing systems measure temperature, static load, dynamic strain and acoustic emission monitoring and NDT of critical infrastructural assets in oil & gas boreholes, directional drilling, wind turbines, nuclear plants, smart grid, high-voltage cables and many other energy applications. IFOS also sells sensorized medical devices for biopsy and surgery under the MEDIFOS™ trade name.

Potential Commercial Applications: The commercial shipping industry would benefit significantly from a system of this nature as well. The same problems that we experience in our Naval platforms (ships, subs and aircraft) are experienced by equivalent commercial platforms, e.g., wide spread area fatigue damage has been determined to be a major source of problem for commercial aviation. In addition, racing yachts, and other transportation applications (including next-generation high-speed transits) can significantly benefit from the IFOS technology and products.

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