Department of the Navy SBIR/STTR Transition Program

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NAVAIR 2020-20

Topic # N161-009

Innovative Sensing Fasteners for Aircraft Fatigue Monitoring

Physics Renaissance LLC

WHO

SYSCOM: NAVAIR

Sponsoring Program: PMA-261 (H-53 Heavy Lift Helicopter)

Transition Target: CH-53K King Stallion

TPOC:
(301)757-4660

Other transition opportunities: The first units will be delivered to the U.S. Naval Air Warfare Center. Transitions will be sought with DoD and commercial aviation, aerospace, naval, and ground systems and equipment OEMs and suppliers that have a need to monitor critical structures for the onset of fatigue induced cracking and wear. Other uses include in-situ monitoring of critical infrastructures such as metal bridges, building structures, turbines, and other systems where visual inspection is not practical.

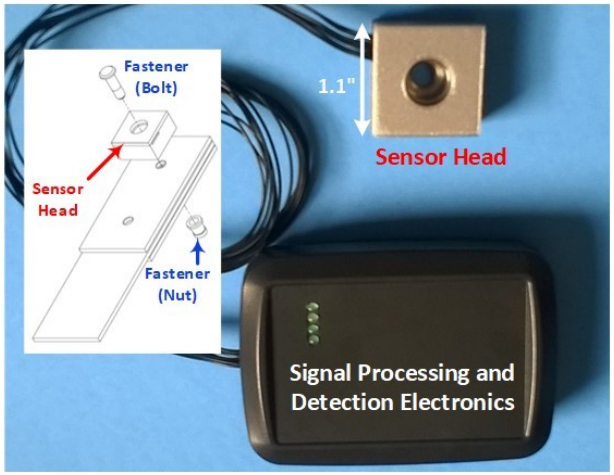

Image Courtesy of Physics Renaissance LLC.

Notes: The picture shows the reusable prototype crack detector designed for NAVAIR. The current one inch square sensor/washer supports an one quarter inch fastener and allows full fastener torque. Size satisfies protruding head rivet layout spacing and geometry. The signal processing and detection electronics package currently provides integration with the analysis software.

WHAT

Operational Need and Improvement: The primary damage modes in layered joints on aircraft is fatigue cracking that originates at fastener through-holes. If fatigue cracks are undetected, they have the potential to cause a joint failure that could result in catastrophic system failure. Currently, crack detection often requires time consuming and costly disassembly of structures followed by in-hole inspections of joints that require specialized equipment and personnel. The Naval Air Warfare Center needs this technology to provide in-situ fatigue monitoring during current and future aircraft testing. The technology also needs to be certified for use with aircraft HUMS for Condition Based Maintenance (CBM).

Specifications Required: The self-sensing fastener will be integrated into the assembly of an aircraft with minimal impact to weight, structural strength, and durability of the parent joints. It also should be capable of interfacing with existing Health and Usage Monitoring Systems (HUMS) currently being utilized aboard H-53E/K, H-60R/S, and H-1. The goal is to perform a full system airworthiness qualification on board a Navy or Marine aircraft, which will include test and evaluation per MIL-STD-810, MIL-STD-464, and MIL-STD-461.

Technology Developed: Physics Renaissance has developed an autonomous in-situ sensor that has the ability to detect fatigue induced cracks and defects in metal structures. Sensor has been demonstrated to detect early onset of cracks <0.050" long and is usable for layered structures i.e. buried cracks. It is designed to meet FAA spacing and geometry constraints and is designed for quick and easy assembly. This sensor does not require special adhesives and is reusable. The supporting electronics is designed to integrate with existing HUMS.

Warfighter Value: The greatest benefit is monitoring of problematic areas on an entire fleet of aircraft to ensure the safety of our warfighters and to better maintain the aircraft, which are expensive assets to the country. Also, the Naval Air Warfare Center needs this technology to provide in-situ fatigue monitoring during current and future aircraft testing. Sustained competitive advantage is provided as this technology provides early indications of damage to structure which reduces time consuming structure disassembly to inspect for fatigue damage, reduces scheduled down time, and faster return to service. The goal is to integrate and transition this technology into government and prime contractor systems for facilitating Condition Based Maintenance.

WHEN

Contract Number: N68335-18-C-0196

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Proof of Concept Demonstration Unit (End of Phase I)	Low	Created a hand held crack detection system, and successfully demonstrated to TPOC	3	December 2016
Laboratory Bench Model/ Gate Review Tests (End of Phase II Base)	Low	Successfully completed 18 structurally representative jointed coupon fatigue tests; Demonstrated detection onset of cracks < 0.050	4	June 2019
Brassboard Model/Reliability Tests (End of Phase II Base)	Low	Demonstrate Brassboard Model/Perform Reliability Tests	4	December 2019
Complete Working Model (End of Phase II)	Med	Complete working model, Environmental testing	5	December 2020
Transition to NAVAIR Test Stand	Med	Integrated into Test Stand and demonstrated functionality in real test environment	6	December 2021
Phase III (Planned)	Med	Successful development; Flight certified	7	TBD

HOW

Projected Business Model: We intend to develop the manufacturing base to sell the crack detector technology to the government, prime contractors, fastener warehouses, and test equipment suppliers. The intellectual property may also be made available for purchase and/or license agreements.

Company Objectives: Physics Renaissance specializes in developing innovative advanced sensor technologies to address problems critical to the fields of vehicle testing, health monitoring, smart sensors and condition based maintenance solutions. Our goal is to expand the crack detection technology developed for NAVAIR to include the ability to detect the onset of corrosion and corrosion induced fatigue. Our company also has extensive experience in high velocity impact dynamics, high speed electronics, development of hardware and software for classification algorithms, and is proficient in analog/digital circuit design and schematic/PCB layouts, designs and development of complex electro-mechanical sensors and sensor systems for shock and vibration monitoring, environmental monitoring, and vehicle health monitoring systems. The company has been established and will continue to provide innovative sensor solutions to difficult war fighter problems, and technological requirements for DOD, NASA and the commercial sector.

Potential Commercial Applications: Our technology can be applied across a multitude of commercial applications including commercial rotary and fixed wing aircraft, Unmanned Aerial Vehicles, satellites, experimental vehicles, automobiles, transport vehicles, ships, submarines, bridges, buildings, satellite and space vehicles or any structural components which require crack or corrosion detection.

Contact: Dr. Philip Reiner CEO/Owner pjrphysicist10000@gmail.com (256) 200-9583 or Andy Jenkins VP ME andy1@hiwaay.net (256) 652-3564 or Soon Kwon VP EE soondkwon@hotmail.com (256)-251-1158 ,