Topic: N161-009

Metis Design Corporation

Damage Detection in Complex Fastened Joints

Metis Design Corporation (MDC) is a recognized worldwide leader in the field of structural health monitoring. MDC has developed a unique approach for monitoring of fastened joints by developing an ultrasonic transducer that is integrated into rivets after they have been installed on a structure. The method effectively turns a row of fasteners into its own phased array, with the ability to scan for fatigue cracks or corrosion in any layer of the fastened stack-up. The main advantage of this approach is that it does not impact typical rivet installation, which would add risk and further certification requirements. This technology is initially targeted towards the CH-53K rotorcraft, but MDC seeks interest from other platforms with riveted joints who would benefit from condition-based maintenance enabling technologies.

Technology Category Alignment:

Fixed Wing Vehicles (includes UAS)
Rotary Wing Vehicles
Test, Evaluation, Validation, and Verification
Maintainability/Sustainability

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SYSCOM: NAVAIR
Contract: N68335-18-C-0195

Corporate Brochure: https://navystp.com/vtm/open_file?type=brochure&id=N68335-18-C-0195

Department of the Navy SBIR/STTR Transition Program

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NAVAIR 2018-681

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Damage Detection in Complex Fastened Joints
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WHO

SYSCOM: NAVAIR

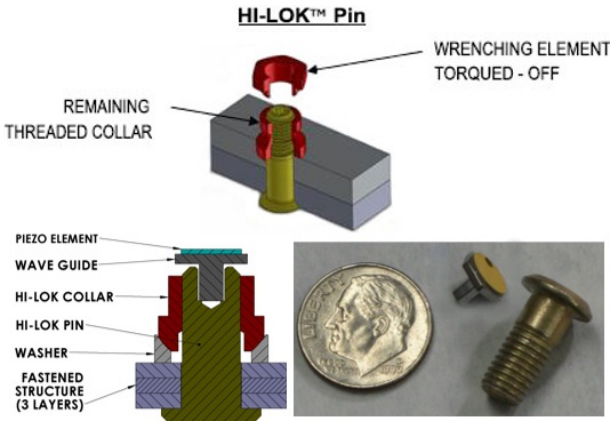
Sponsoring Program: H-53 Heavy Lift Helicopter (PMA-261)

Transition Target: CH-53K King Stallion

TPOC:
(301)757-1832

Other transition opportunities: Any DoD platform that uses Hi-Shear style rivets (HI-LOK, Hi-LITE or HI-TIGUE)

Notes: Piezoelectric Phased-Array Sensors Bond into Installed Hi-Shear Fasteners



WHAT

Operational Need and Improvement: Multiple materials joined together with fasteners provide for some of the most challenging locations for damage detection, while also often being the most prone to damage and are failure critical. Even conventional non-destructive inspection (NDI) tools have difficulty detecting cracks and corrosion that can be hidden under the fastener head or between layers without a time-consuming disassembly. New structural health monitoring (SHM) approaches are necessary to detect damage in these fastened joints quickly and reliably without the need for removing the fastener.

Specifications Required: The SHM method must be able to detect small fatigue cracks and corrosion without removing the fastener, and must be able to survive and maintain the certified resolution through the aircraft life-cycle without degradation in performance. MIL-STD-810, MIL-STD-461 and MIL-HDBK-1823A standards apply.

Technology Developed: Metis Design Corporation (MDC) had developed a piezoelectric sensor that mounts inside an already-installed rivet, essentially turning a line of fasteners into an ultrasonic phased-array. Excited guided waves through each layer of the joined structure travel to other nearby rivets which receive the wave energy. Very small changes to the structure caused by flaws near the rivet effectively results in boundary condition differences that can be detected through signal processing. These sensors are compatible with a distributed data acquisition architecture previously developed by MDC, which natively communicates with rotorcraft health and usage monitoring systems (HUMS) hardware.

Warfighter Value: This novel sensor will shorten inspection times for fastened joints, resulting in reduced operating costs and improvements in asset availability. The benefits of HUMS for rotorcraft have already been well documented by the Navy for platforms like the MH-60R/S and CH-53E, and this type of sensor would just augment those capaiblities already afforded to dynamic components, and extend them to monitoring static fastened joints.

WHEN

Contract Number: N68335-18-C-0195 **Ending on:** January 15, 2019

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Demonstration of performance on NAVAIR designed fatigue articles	Med	Size of crack detected	TRL4	August 2018
Redesign of wiring scheme	Low	Robust wiring (or wireless) to acquistion hardware	TRL4	TBD
Customization of acquisition hardware	Low	Connection from HUMS to sensor	TRL4	TBD
Airworthiness testing	Med	Testing survival in representative environments	TRL5	TBD
Additional probability of detection evaluation	Med	Testing of complete system	TRL5	TBD

HOW

Projected Business Model: Metis Design Corporation has already exclusively licensed many of their piezoelectric-based SHM technologies to United Technologies Aerospace Systems (UTAS), including distributed data acquisition network that natively communicates with their HUMS hardware. Once successfully demonstrated through the Phase II effort, we would work to incorporate this new sensor into the existing licensing agreement with UTAS for them to fabricate and sell it to augment current detection capabilities.

Company Objectives: We are seeking additional transition opportunities, specifically programs of record who would be interested in using this technology on their platform. Those could be explored through Phase II.5 or Phase III contracts.

Potential Commercial Applications: These types of fasteners, namely those with Hi-Shear style rivets (HI-LOK, Hi-LITE or HI-TIGUE), are also the standard for commercial fixed-wing aircraft and rotorcraft, thus would be equally applicable to their commercial counterparts.

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