Department of the Navy SBIR/STTR Transition Program

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Topic # N18B-T029

Optimization of Fatigue Test Signal Compression Using The Wavelet Transform

ATA Engineering, Inc

WHO

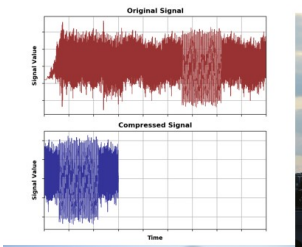
SYSCOM: NAVAIR

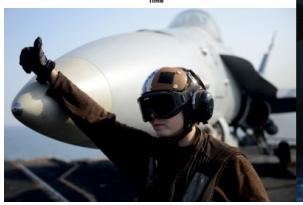
Sponsoring Program: PMA-299 H-60 Multi-Mission Helicopters

Transition Target: MH-60R and MH-60S helicopters

TPOC:
(301)342-9359

Other transition opportunities: ATA's damage squeezing technology is applicable to any defense or aerospace system that requires fatigue testing. Prime contractors developing military rotorcraft for Future Vertical Lift (FVL), such as Bell Helicopter and Sikorsky, are prospective users, as are designers of commercial aircraft and automotive components. Because fatigue is a critical concern for a broad range of defense and aerospace systems, as well as industries ranging from automotive and robotics to power generation and mineral extraction, ATA's damage squeezing technology has wide applicability.





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Notes: ATA's signal editing software will fill a need for accelerated fatigue testing of aircraft subject to demanding fatigue regimes. The software will improve workflows in the design, analysis, testing, and sustainment of such vehicles and will thus be of interest to many stakeholders across the Navy and DoD.

WHAT

Operational Need and Improvement: The U.S. Navy seeks an improved signal compression methodology for generating optimally compressed fatigue test signals that, compared to the full-length signals, produce equivalent amounts of fatigue damage in predictably reduced amounts of time. ATA's damage squeezing technology offers a number of advantages over current methods, including removing arbitrary criteria and empirical guidelines and adding support for multiaxial, variable-amplitude loading of complex, dynamic structures.

Specifications Required: The Navy is targeting a less than 50% reduction in fatigue test duration for an acceptably small change in damage induced, noting that the level of achievable signal compression is highly dependent on the makeup of the original spectrum and the number of fatigue-critical locations used to constrain the signal compression process.

Technology Developed: ATA developed a systematic tool for compressing fatigue test signals that allows for faster fatigue tests without sacrificing accuracy or reliability. The methodology generates shorter-duration fatigue test signals that exhibit the same critical fatigue characteristics as the original signals, such that the accelerated tests produce field-representative failures in predictably less time. Users applying this accelerated test environment could potentially cut a year off a multi-year fatigue test program. ATA successfully demonstrated the methodology for uniaxial, quasi-static loading conditions, achieving as high as 94% signal compression with much less than 1% change in damage. The compressed signals used to conduct accelerated tests produced fatigue cracks in predictably less time compared to baseline tests—an average test time of 25 minutes (accelerated) compared to 8 hours (baseline).

Warfighter Value: As high-performance military vehicles increase in speed and maneuverability and as general economic pressures to control defense expenditures continue to grow, the need for improved fatigue life prediction and testing strategies is becoming increasingly urgent. ATA's methodology provides an efficient and reliable means for conducting accelerated fatigue tests on dynamic structures, thereby reducing the time and cost associated with full-scale fatigue testing. The wavelet-based methodology provides advantages directly to the warfighter by allowing new aircraft to be fielded more quickly, reducing downtime, and providing greater certainty of a component's fatigue life.

WHEN

Contract Number: N68335-20-C-0151 **Ending on:** January 3, 2023

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Biaxial fatigue testing with non-proportional loading	Low	>50% compression, <5% damage error, predictable cracking behavior	4	December 2021
Multiaxial fatigue testing with quasi-static loading	Med	>50% compression, <5% damage error, predictable cracking behavior	5	September 2022
Multiaxial fatigue testing with dynamic loading	Med	>50% compression, <5% damage error, predictable cracking behavior	6	November 2022
Algorithm automation and commercialization prep	Low	Removal of heuristics, IMAT™ compatible code, user guide	6	January 2023

HOW

Projected Business Model: ATA, known for delivering innovative simulation and testing solutions to DoD agencies and their contractors, plans to commercialize the outcomes of this project through two supplemental channels. The first is our engineering consulting services; ATA's core business is to provide high-value engineering consulting to our customers in the aerospace, defense, and commercial aviation industries, and we plan to equip and train our engineers with the signal editing tool so that they may apply it in solving our customers' fatigue problems. The second is algorithm licensing: because of the broad applicability of this technology, third-party engineering software and test equipment vendors are expected to have interest in incorporating the method into their products.

Company Objectives: As an advanced engineering services company, ATA is focused on providing superior and innovative analysis- and test-driven design solutions and exceptional support to our aerospace engineering clients, with frequent infusion of new analysis methods. ATA's objective in continuing development of the wavelet-based damage squeezing method is to further that mission by expanding our capabilities portfolio to provide unique benefits in this area. The signal editing technology will allow us to better support current customers including the US defense and aerospace agencies and their prime contractors, as well as those in other fatigue-critical industries.

Potential Commercial Applications: Experimental assessment of the fatigue life of critical system components is necessary in design and sustainment for a multitude of commercial applications. The damage squeezing methodology will greatly reduce the cost and schedule requirements associated with conducting full-scale and component-level fatigue testing by generating optimally compressed test signals that produce characteristic failure modes in a fraction of the time. The technology can be broadly applied to compress either quasi-static or dynamic test signals, making it a versatile tool that promises to dramatically reduce schedule and cost requirements for DoD and commercial component and airframe fatigue test programs. Successful implementation of this innovative technology will have far-reaching benefits across multiple industries, including the aerospace, defense, automotive, shipbuilding, energy, and entertainment industries.

Contact: Heather Wilkens, Ph.D., Manager, Business Development
heather.wilkens@ata-e.com 858.480.2043