

Department of the Navy SBIR/STTR Transition Program

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Topic # N193-A01

Navy Artificial Intelligence Maintenance System (AIMS)

Data Fusion & Neural Networks, LLC

WHO

SYSCOM: NAVAIR

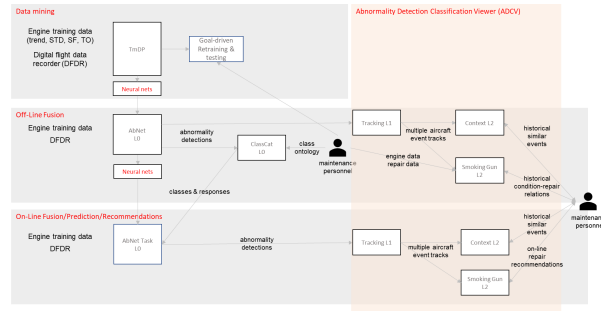
Sponsoring Program: PMA 265

Transition Target: KC- 130; F-18

TPOC:

(301)757-2504

Other transition opportunities: Fleet Readiness Centers (FRC)



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WHAT

Operational Need and Improvement: AIMS provides Condition-Based Maintenance (CBM) for any instrumented system. Abnormality detection neural networks (NNs) detect abnormally correlated behaviors over time and provide the abnormality signatures to the categorization NNs. The trust NNs score how similar the on-line test signature is to validation data. The valid abnormal event categorizations approved by the user will trigger repairs/responses. The new (i.e., unknown-unknowns) abnormality detection signatures will be automatically named and flagged for later user resolution.

Specifications Required: AIMS detects unknown abnormal behaviors, recognizes repair conditions, and provides recognition trust to recommend repairs. AIMS evolves with use by deciding when to retrain, what to retrain on, what to test on, and with user feedback when to promote on-line. Off-line train NNs to learn the correlated Patterns of Life behaviors in historical aviation State of Health (SOH) and detect unknown abnormal behaviors. AIMS gives default names and tracks similar abnormality detections. AIMS trains categorization and trust NNs for each abnormal signature class and finds the correlations of historical abnormal events to the overlapping repair data using Smoking Gun. The user confirms high confidence correlations of abnormal SOH events and/or pilot debriefs with recommended repairs.

Technology Developed: AIMS grows its neural architecture to be the smallest possible to meet user requirements for each data set. Smoking Gun discovers repairs correlations for user approval. Trusted repair conditions trigger repairs. AIMS gets better with use as it automatically retrains. Phase II prototyping has verified this functionality. Our goal is to transition AIMS prototype for government and commercial use.

Warfighter Value: AIMS reduces maintenance labor costs by >10% by reducing unneeded maintenance by detecting when maintenance is needed before a catastrophic fault. The savings versus preventative maintenance is measured by increase in availability. The C-130 Reliability and Maintainability Information System (REMIS) reports for the last 4 years indicate approximately 2000 repair records per tail number per year. Approximately a fourth of these are for preventative checks that would be saved by AIMS. Each record represents an average of 20 man-hours of total labor, so the savings is ~10K labor hours per year per C-130. AIMS eliminates the labor hours required to continually re-compute the engine parameter test limits and improves its performance as it is used.

WHEN

Contract Number: N68335-20-F-0590 **Ending on:** November 15, 2021

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Phase II AIMS Prototype TRL 4:	Low	AIMS Demonstration on C130 Data	TRL 4	November 2021
Phase II AIMS Enhancement	Med	Demonstration on Navy System Data	TRL 6	May 2023
Phase III AIMS Operationalization	Med	Demonstration on Navy Ops System	TRL 7	May 2024

HOW

Projected Business Model: Plan is to operationalize AIMS within DoD and to commercialize. The business plan is to have the user purchase AIMS (CBM) software licenses. DF&NN has TRL 7 ANOM machine learning tools that detect unknown unexpected abnormal SOH, trains on historical abnormal behaviors, automatically clusters, labels, and trains characterization NNs, and provides a characterization trust score when the NNs are applied to new operational data. We have Certification to Field (CTF) at National Space Defense Center (NSDC) and have installed at 3rd Space Experimentation Squadron (SES), 3 SOPS at Schriever AFB and installed in Thought Cloud at Kirtland AFB. We have sold licenses for our intelligent system software to Aerospace Corporation.

Company Objectives: GCPM originally developed for the C-130 using Warner Robins Digital Flight Data Recorder (DFDR), Engine Trend, Pilot Debrief, and Reliability and Maintainability Information System (REMIS) Repair Data. Phase II will affordably deliver the AIMS prototype based on the Goal-Driven Condition-Based Predictive Maintenance prototype that has been tested on five years of USAF C-130 aircraft engine, pilot debrief, and maintenance/repair data. Risk is reduced due to 40 years experience delivering machine learning systems. AIMS will be fully compliant with NIST (e.g. Zero Trust Architecture 800-207), support Cybersecurity Maturity Model Certification implementation, and be ready for installation in enclaved system architectures. We will work with our program sponsor to identify integration connections, systems, and/or databases during the Phase 2/3.

Potential Commercial Applications: The AIMS product will be sufficiently flexible through data & goal-driven processing for low cost application of nearly all instrumented (e.g. aircraft, rotorcraft, machinery, etc.) data sets and databases. AIMS will upload and synchronize individual data/databases to a cloud-based containerized AIMS instance with REST APIs that aggregates fleet-wide data. AIMS will be commercialized as part of our ANOM toolbox which will enable DoD and commercial operators and developers to have automated GCPM tools that will adapt to changing environments.

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