Air Force SBIR/STTR Innovation

Air Force SBIR/STTR Innovation Story

SBIR Topic Number:
AF04-189

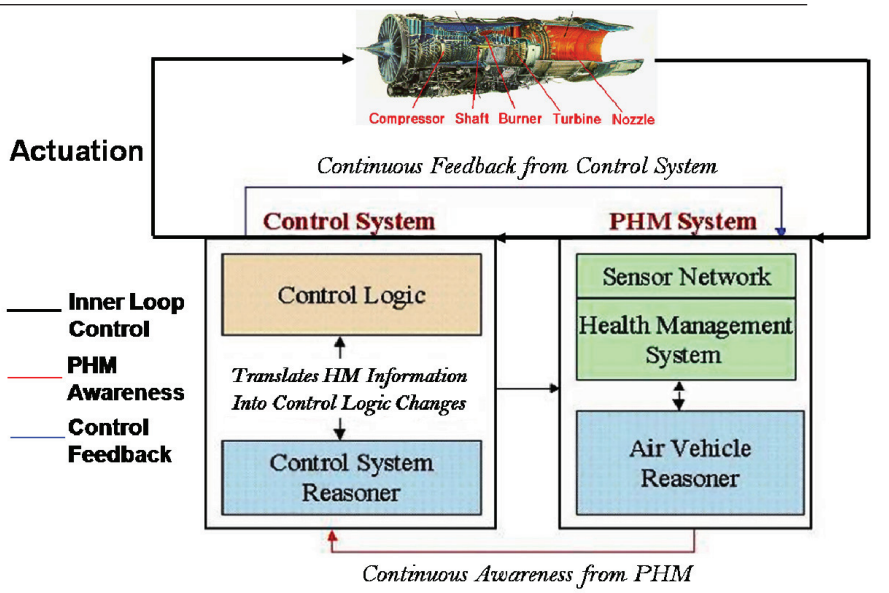
SBIR Title:
Propulsion Health Management—Future, Legacy, and Integrated Power System Technology

Contract Number:
FA8650-05-C-2607

SBIR Company Name:
Impact Technologies, LLC, Rochester, NY

Technical Project Office:
AFRL Propulsion Directorate, Wright-Patterson AFB, OH

This Air Force SBIR/STTR Innovation Story is an example of Air Force supported SBIR/STTR technology that met topic requirements and has outstanding potential for Air Force and DoD.



Automated Contingency and Life Management (ACLM) Overview

Automated Contingency and Life Management for Integrated Propulsion and Power Systems

- ACLM strives to meet Air Force requirements for optimal asset management by adaptively improving system performance, improving engine health assessment, increasing propulsion system life, and reducing ownership costs.
- Impact Technologies' ACLM concept uses PHM diagnoses and prognoses as input to their Adaptive Intelligent Control (AIC) module which, in turn, provides supervisory level commands to the propulsion system to optimize performance and mitigate the effects of anomalous operation.
- This ACLM technology is being targeted for the growing unmanned air vehicle (UAV) market as well as manned aircraft propulsion and power systems
- The ACLM technology has been successfully transitioned into subsequent Phase III programs and provides the main adaptive system management component of Impact's Integrated Vehicle Health Management system for the unmanned vehicle market.
- Other potential applications include commercial and general aviation, land and marine propulsion, fluid power transmission, and robotic applications.

AFRL/RZ 10-0180

Air Force Requirement

The Air Force has a requirement to advance the current state-of-the-art of propulsion health management (PHM) by direct monitoring and management of propulsion and electrical power supply systems in order to improve performance, provide more accurate assessments of system health, and increase the life of the propulsion and power supply systems. However, currently available diagnostics and fault protection do not provide an accurate assessment of system health. To evolve to the Air Force goal of condition-based maintenance, it is desirable to develop flexible model-based systems for diagnostics, information fusion, and active component control; plus virtual sensing, calculation of useful remaining service life, and accurate scheduling of maintenance events capabilities. This issue will become even more important in future fly-by-wire systems. Development of PHM technology encompassing both the engine control and electrical power systems meets a clear Air Force need that is currently present, and will continue in all future advanced aircraft propulsion and power systems.

SBIR Technology

Impact Technologies, LLC, in collaboration with Honeywell Aerospace, has developed a prototype Automated Contingency and Life Management (ACLM) system for aircraft propulsion and power systems. By fusing two symbiotic fields – PHM and Adaptive Intelligent Control (AIC)--the ACLM system automatically responds to changing system health by detecting degradations/failures in real-time and mitigating their effects through updates to control schemes. As shown schematically on the previous page, the ACLM concept combines PHM diagnosis and prognosis used as input for the AIC module. The AIC module then provides supervisory level commands to the propulsion system.

This combined architecture is both modular and hierarchical leading to localized, embedded intelligence at the component level, which contributes to provide overall system health knowledge. The PHM technique uses multiple algorithms to isolate faults, thus facilitating an improved confidence in fault prediction. The Phase II program included the development of PHM algorithms for the aircraft engine lubrication system, gearbox, and power generation systems, as applicable to Honeywell's F124 engine. Program efforts also yielded an information fusion and prognosis module that incorporates diagnostic information from various engine components to provide prognostic information about the propulsion and power system. The AIC module uses this information to plan and control the performance and operation of the propulsion and power system. ACLM's flexible, scalable architecture consists of reusable elements, thus enabling the addition of new algorithms and the extension of ACLM and PHM functionality to other propulsion and power system components.

Potential Air Force Application

The ACLM system is directly applicable to Air Force propulsion and power systems resident in both manned and unmanned air vehicles (UAVs). The automation aspect of the ACLM technology lends itself particularly well to UAVs. Without a pilot in the cockpit, intelligent, adaptive systems like ACLM must be developed and integrated to fill this information void. UAV numbers in service are growing significantly as they assume more roles traditionally handled by manned aircraft. Improving their reliability and availability will play an increasingly important role as their portions of operations and sustainment budgets increase. The ACLM system also provides substantial benefits to manned aircraft propulsion and power systems. The ACLM system's combination of advanced PHM along with engine and power system controls enables optimal automated mission planning and execution based on real-time system health information. This can lead to reduced overall cost of ownership via improved performance, reliability, maintainability, availability, and survivability of safety-critical engines, generators, gearboxes, and other power train components.

Company Impact

The versatile nature of the ACLM modules allow the system's applicability to expand beyond DoD aerospace propulsion and power systems making it suitable for ground and sea vehicles in a variety of other commercial or DoD applications. Impact has utilized Phase III funding to leverage this technology into its integrated vehicle health management system, fielded to the unmanned system community, and is receiving significant attention from both DoD and commercial interests. The success of this program and its technology has played, and will continue to play, a key role in both providing market separation over competitors and winning subsequent programs for automated health management solutions.

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