Air Force SBIR/STTR

Innovation

Air Force SBIR/STTR Innovation Story

SBIR Topic Number:
AF02-182

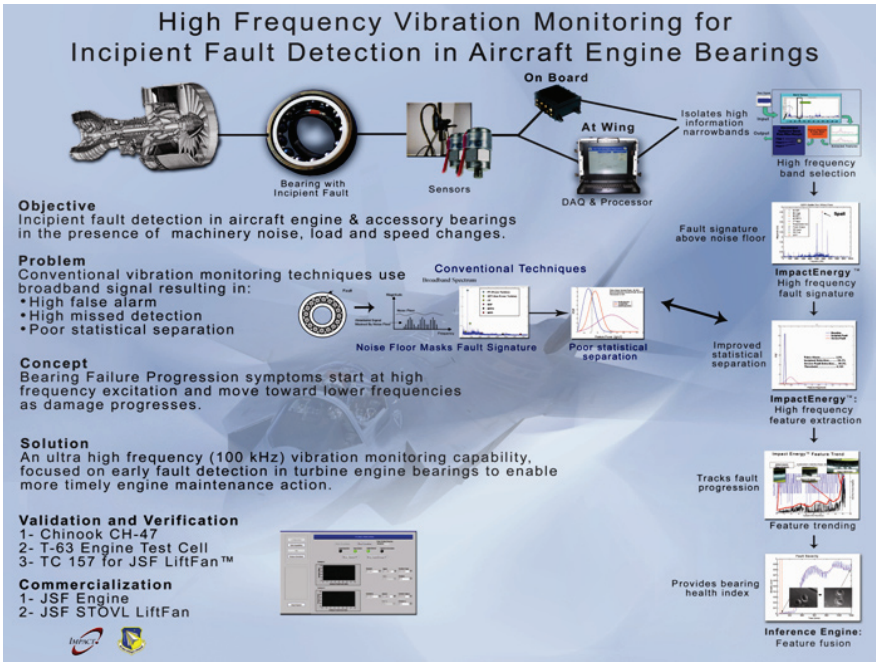
SBIR Title:
Advanced Vibration Monitoring Diagnostics and Prognostics Techniques

Contract Number:
F33615-03-C-2364

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.



High Frequency Vibration Monitoring System

Advanced Ultra-High Frequency Vibration Monitoring for Improved Turbine Engine Diagnostics and Prognostics

- The Air Force has a requirement to improve turbine engine vibration monitoring in order to provide more accurate health assessments of their engines.
- Impact Technologies' system predicts the current health of a critical set of aircraft engine and accessory components, namely bearings, gears and shafts.
- This Phase II SBIR, originally sponsored by JSF (F-35), is being targeted for implementation on maintenance test cells, as well as at-wing and on-board applications.
- Other potential applications include the General Electric F-136 engine, the Rolls Royce F-135 LiftFan™ engine, and the Army's Fire Scout, UH-60 and Vigilante platforms.

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Air Force Requirement

The Air Force has a requirement to advance the current state-of-the-art of turbine engine vibration monitoring in order to provide a more accurate health assessment of their turbine engines. Innovative ideas and solutions are required to provide a comprehensive vibration monitoring system that shows significant improvement compared to systems currently in use. These advanced vibration monitoring diagnostic and prognostic capabilities must be targeted for on-board, real-time, and in-flight applications, and would become part of a comprehensive Engine Health Management (EHM) or Prognostic Health Management (PHM) system capable of predicting the remaining useful life of the engine. This technology advances the Air Force's desire to move from time-based maintenance to condition-based maintenance on their turbine engines. Condition-based maintenance reduces operational and ownership costs of military aircraft engines, thus fulfilling an objective of the Air Force Versatile Affordable Advanced Turbine Engines (VAATE) program.

SBIR Technology

Impact Technologies' high frequency vibration monitoring system, shown schematically on the previous page, collects and analyzes engine vibration data to predict the current health of a very critical set of aircraft engine and accessory components, namely bearings, gears and shafts. The concept at the core of this system is the rich information content in the high frequency regions of the signal spectrum related to bearing and gear failures during the fault inception stage. It uses non-contact sensors and accelerometers mounted on externally accessible locations to collect data. It currently functions with high-performance commercial off-the-shelf (COTS) data acquisition and processing systems, or it can be adapted to on-board aircraft hardware. This ultra-high frequency (UHF) system sequentially acquires sensor data, performs sensor validity checks, extracts multiple features from the high bandwidth data, fuses these multiple features, and evaluates the fused outcome to provide the current health status of the monitored components

Potential Air Force Application

This SBIR program was originally sponsored by the Joint Strike Fighter (F-35) System Program Office (SPO), and is being targeted for implementation on this program. More generically, Impact Technologies targeted the following three major areas for implementation of this system by the Air Force--maintenance test cells, at-wing, and on-board. Implementation in these environments will enable incipient fault detection and an early warning on the order of 5-10 missions as demonstrated in repeated, controlled laboratory testing. This window of 5-10 missions will provide a higher level of mission readiness, reduce unplanned maintenance and increase availability, in addition to improving overall aircraft safety.

Company Impact

Impact Technologies has commercialized their high frequency vibration monitoring software as FirstCheck™, ImpactEnergy™ and GearMod™ software modules, and has licensed these to Pratt & Whitney for implementation on the Joint Strike Fighter (F-35) and to Northrop Grumman for engine and drive train diagnostics / prognostics of the Army's Fire Scout Vertical Takeoff and Landing Tactical Unmanned Aerial Vehicle (VTUAV). Impact is also pursuing other significant potential transition opportunities, including adaptation of the UHF system algorithms for the F-136 engine with General Electric, the F-135 LiftFan™ with Rolls-Royce, and drive train component prognostics on the UH-60 and Vigilante platforms with the Army. In addition, Impact offers their high frequency vibration monitoring system as an end-to-end, hardware and algorithm solution to meet bearing health monitoring needs of a variety of DoD and commercial turbine engines.

This SBIR program has been integral to Impact Technologies' development of vibration diagnostics in this and many other areas. Mark Redding, Impact's President, commented, "This funding has been critical to our business and is the principal reason for our success and growth." The company's Director of Engineering, Dr. Michael Roemer, further amplified this point saying, "We have seen these investments in equipment diagnostics, prognostics, and health management provide us the technology base to offer solutions directly to the military services and their contractors." Carl Byington, Impact's Director of Systems Engineering, addressed it in terms of risk reduction, "Many of the engine and component manufacturers don't want to invest in a new technology that they perceive as risky or might require innovating into a new business model. The SBIR program allowed us to reduce this risk, through a series of technology-maturing demonstrations, and successfully transition from a 'good idea' to a Phase III implementation. It's a win-win-win."

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