

Innovation

SBIR Topic Number:
AF06-355

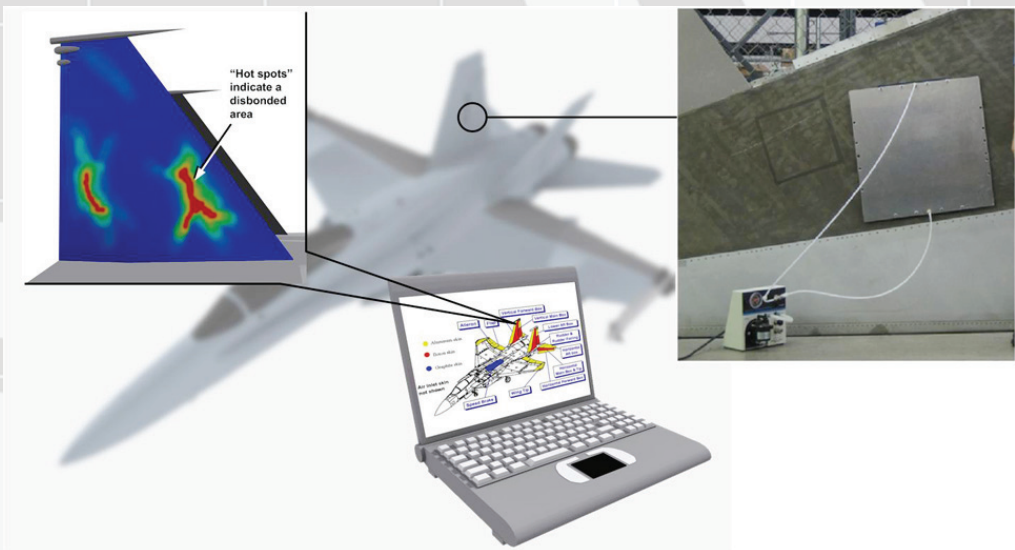
SBIR Title:
Damage Detection and Identification in Composites

Contract Number:
FA8501-07-C-0025

SBIR Company Name:
Intelligent Optical Systems, Inc.,
Torrance, CA

Technical Project Office:
Warner Robins Air Logistics Center, Robins AFB, GA

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.



Concept of IOS's Autonomous Damage Identification System: Data obtained with state-of-the-art fiber Bragg grating (FBG)-based hardware, integrated with validated University of California, Los Angeles (UCLA) algorithms, produce an autonomous structural nondestructive examination (NDE) system. Damaged areas appear red (left inset). Using vacuum suction, the large (2 sq. ft.) transducer panel can be directly applied in situ to the vertical stabilizer of an aircraft without needing to remove the stabilizer (right inset).

Accurate Damage Location and Identification in Composite Structures with Portable Unit

- Since both military and civilian aircraft have a significant and increasing composite content, an accurate and rapid on-site inspection method is needed for detection of composite internal damage/health at different levels of layers
- Intelligent Optical Systems (IOS) developed a novel diagnostic/prognostic ultrasound imaging technique for determining the location of structural damage in large composite aircraft components
- The size and weight of the system also promises to move the technique to field applications, enhancing safety by enabling rapid assessment of structural integrity
- The Air Force will benefit from replacing aircraft disassembly and individual water-jet coupled ultrasonic scans with an in situ technique, reducing depot maintenance time and cost

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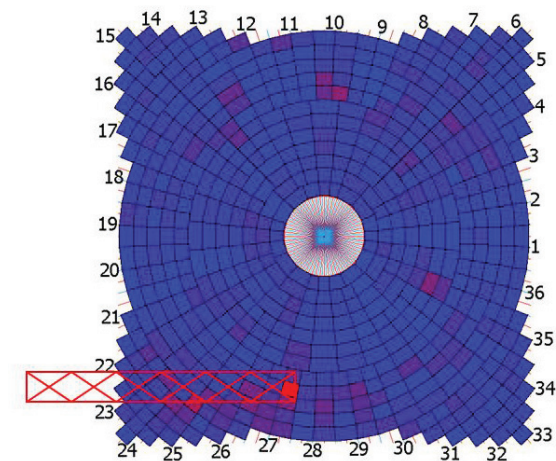
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Air Force Requirement

Composite materials based on boron, Kevlar, graphite, and carbon fibers are widely used in many advanced aerospace structural systems, which are subject to wear and tear and sometimes extreme operational conditions. Damage can occur in many different forms, such as delamination, disbonds, and fiber breakage in composites. Current detection methods are limited in locating and quantifying the damage; or require disassembly and transportation of the component, increasing the duration and cost of depot maintenance, and adding the risk of post-inspection damage. An accurate and rapid on-site inspection method is needed for detection of composite internal damage/health at different levels of the layers.

SBIR Technology

Under this SBIR contract, Intelligent Optical Systems (IOS) developed a novel diagnostic/prognostic ultrasound imaging technique for determining the location of structural damage in large composite aircraft components. A flexible panel with embedded ultrasonic source and a dense array of a large number of fiberoptic ultrasonic receivers is temporarily attached, without glue or epoxy, to an area of the composite structure. An instrument connected with a fiberoptic cable to the transducer panel automatically performs an ultrasonic scan over the entire area. Analysis of the ultrasound data in the system computer identifies and locates structural modifications/irregularities in the component.



Color-coded diagnostic image of calculated Damage Indices that compare pre- and post-damage ultrasound signal levels.

IOS has pioneered the use of optical fiber Bragg gratings (FBGs), microscopic structures within an optical fiber, to pick up minute ultrasonic vibrations. A single fiber can contain many of these Bragg grating ultrasound transducers (BrUTs), allowing the user to monitor ultrasound with hundreds of ultrasonic receivers without the unwieldy bulk of conventional piezoelectric transducers.

Potential Application

Both military and civilian aircraft have a significant and increasing composite content. As these structures age, there is a growing need for rapid, in situ in-service inspection for hidden damage. The technology demonstrated by IOS can fulfill this requirement by enabling automated inspection of large, curved surface areas. The two key innovations established in this project are: (1) the demonstration of repeatable, highly sensitive ultrasonic measurements performed with a flexible, temporarily attached sensor sheet that conforms to curved surfaces; and (2) the development of a fully automated, self-calibrating readout system.

The Air Force will benefit from replacing aircraft disassembly and individual water-jet coupled ultrasonic scans with an in situ technique, reducing depot maintenance time and cost. The size and weight of the system also promises to move the technique to field use, enhancing safety by enabling rapid assessment of structural integrity. Timely and more thorough nondestructive examination (NDE) of aging aircraft will increase safety while permitting them to remain in operation longer.

Company Impact

"IOS maintains a successful commercial product line in optical ultrasonic testing equipment," states Dr. Indu Saxena, Group Leader, Spectroscopy & Physical Sensors. "This SBIR contract has enabled IOS to expand into the testing of composite laminates, an important and growing application. The company has also benefited from further improving its high-frequency fiber readout technology, and from demonstrating reliable ultrasonic detection with a removable sheet of fiberoptic transducers, generating a patent application to protect this technology. We expect to further expand this technique into a wider array of nondestructive testing applications."



SBIR/STTR

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