Real-Time Shape Sensing to Monitor Flexible Structures

Fiber optic sensors detect changes without affecting performance and without the need for structural modifications

NASA Dryden Flight Research Center invites companies to license this shape-sensing technology that offers high resolution (0.5-inch) and a 100-Hz refresh rate. The technology is contained in a small, lightweight package that uses fiber Bragg grating (FBG) sensors and ultra-efficient, real-time algorithms. It is capable of interrogating and processing information for 1,000 sensors at rates up to 100 times per second. Developed for aircraft monitoring, the innovation also has applications in automotive, wind energy, and structural health monitoring as well as in medicine.

Benefits

- **Multiple engineering measurements**: Samples strain, temperature, and structural shape concurrently using a single system
- **High resolution**: Provides measurements along fibers up to 40 feet in length with sensors uniformly spaced 0.5 inch apart
- **High refresh rate**: Features a refresh rate of 100 samples per second each for up to eight fibers
- **Small and lightweight**: Needs hardware only the size of a shoebox and does not affect the performance of lightweight structures
- **Non-intrusive**: Uses monitoring fiber that does not affect structure performance
- **Easy manufacturing**: Assembles with off-the-shelf components and customizable software code from NASA
- **Robust**: Resists electromagnetic/radio frequency interference and radiation
Technological Details

This innovation initially was developed in response to a highly significant requirement for unmanned aerial vehicles (UAVs). Safe operation of UAVs requires accurate, real-time, in-flight determination of the shape of their highly flexible and highly deformable wings.

Dryden’s technology provides accurate and comprehensive measurements of structural shape changes for multiple locations on large structures that are undergoing displacement while in service. Although the wing shape algorithms can be applied to any structure, they are particularly applicable to lightweight, flexible structures that produce large structural deflections and where weight restrictions exist.

How It Works

The technology employs ultra-efficient, real-time, data-driven structural deformation algorithms, based on analytical methods in conjunction with highly multiplexed strain and temperature sensors. The sensors feed strain and temperature measurements into the system’s algorithms that then determine out-of-plane deflections in real time.

Why It Is Better

This Dryden innovation offers significant advantages over current sensing technologies. It can acquire a large number of accurate surface strain, temperature, and displacement measurements in real time for large structures that are undergoing a wide range of displacements during operation. Data acquisition is possible with a minimal weight penalty. Furthermore, this is the only technology available that can provide out-of-plane structural deflection, local strain, and temperature measurements in real time. Some sensors exist that provide multi-parameter sensing (pressure, strain, temperature), but none of them offers a validated, shape-sensing capability.

Patents

Dryden has two patents issued (U.S. Patent No: 7,520,176 and U.S. Patent No: 7,715,994) and two others are pending for this technology.

Commercial Opportunity

This technology is part of NASA’s Innovative Partnerships Program, which seeks to transfer technology into and out of NASA to benefit the space program and U.S. industry. NASA invites companies to consider licensing this Method for Real-Time Structure Shape Sensing (DRC-006-024, DRC-008-023, DRC-007-001, DRC-006-045) for commercial applications.

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