



technology opportunity

Fiber Optic Shape Sensors

Sense changes in shape in real time without affecting performance and without the need for structural modifications



Method for Real-Time Structure Shape Sensing

NASA Dryden Flight Research Center invites companies to license this shape-sensing technology that offers high resolution (0.5-inch) and a 60-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 a rate of 60 times per second. The innovation has applications in many areas including automotive, aeronautics, wind energy, medicine, and structural health monitoring.

Benefits

- **Multiple engineering measurements:** Samples strain, temperature, and structural shape concurrently using a single system
- **High resolution:** Provides measurements along 40-foot fibers with sensors uniformly spaced 0.5 inch apart
- **High refresh rate:** Features a refresh rate of 60 samples per second for eight fiber optic channels
- **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 a structure's performance
- **Easy manufacturing:** Assembles with off-the-shelf components and customizable software code from NASA
- **Robust:** Resists any (or all) electromagnetic/radio frequency interference and radiation

Applications

The invention is applicable to lightweight, flexible structures of any nature. The sensor arrays are virtually weightless and can provide enormous numbers of engineering measurements at 0.5-inch spacing. Because the spatial resolution provided by the fiber-optic sensors mimics biological systems, the applications are far-reaching and include:

- **Aerospace:** Tracking structural shapes and aircraft frames; hydraulic hoses, flexible booms
- **Automotive:** Studying truck or automobile frames to improve safety or actively control handling
- **Structures:** Monitoring the overall health of structures such as bridges and dams that undergo constant stress
- **Wind Turbines:** Monitoring blade shapes and force to improve efficiency and longevity
- **Medical:** Determining shape and pressure in non-invasive surgery and probes

Technology 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.

The 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 provides the capability to 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 offer a validated, shape-sensing capability.

Patents

Dryden has one patent issued (U.S. Patent No. 7,520,176) and two others are pending for this technology.

Licensing and Partnering Opportunities

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

For more information about this technology licensing opportunity, please call or e-mail:

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For information about other technology opportunities, contact:

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