Project Brief – 080019 / 9H9010

Civil Infrastructure
Fiber Sensing System for Civil Infrastructure Health Monitoring

Develop an economical, fiber-optics-based system for monitoring the structural health of large infrastructure elements such as bridges or pipelines utilizing light pulses traveling down-cable to provide high-resolution, localized identification of both static and dynamic conditions without the need for installing large networks of discrete sensors.

Sponsor: Distributed Sensor Technologies, Inc.
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- Project Performance Period: 2/1/2009 - 6/25/2012
- Total project (est.): $8,548 K
- Requested TIP funds: $4,030 K

Distributed Sensor Technologies, Inc. (Santa Clara, Calif.) and joint venture partners Optiphase, Inc., (Van Nuys, Calif.); Redfern Integrated Optics, Inc., (Santa Clara, Calif.) and the University of Illinois at Chicago plan an innovative monitoring system for large structures such as bridges or pipelines that substitutes a single optical fiber sensing cable for potentially hundreds of discrete, local strain or fracture sensors. Sophisticated analysis of backscattered light from short pulses of laser light sent down the fiber turns the entire length of the fiber into a sensor, registering both static conditions—strains and their variations over time in the structure, for example—and dynamic conditions—structural breaks, cracks or vibrations, for example. If successful, the project would enable an economical method to instrument large structures for continuous, high-resolution monitoring and detection of crack initiation, deformation and other critical structural conditions. The system will be continuously evaluated and tested in laboratory size structures as in bridges in order to develop efficient solutions for monitoring and inspection. By replacing local discrete sensors with lengths of optical fiber, the system would mitigate initial deployment cost of the discrete sensors and a variety of bandwidth and transmission problems associated with collecting data from a large number of discrete sensors, while potentially offering more precise location of faults and problems. To achieve this, the research team must overcome several challenging technical obstacles. At the heart of the proposal is the ability to simultaneously apply two different optical sensing and analysis techniques—coherent Rayleigh and Brillouin scattering—using common opto-electronics and a single sensor cable. Both techniques will require interrogation and processing enhancements over the current state of the art to achieve the resolution and fidelity needed for the monitoring system. This also includes the development of improved laser sources, a precision laser control module, and a novel fiber-optic sensor cable which optimizes fiber mechanics for the two measurement techniques, can be economically manufactured in long lengths and is sufficiently rugged for deployment and bonding to large, exposed structures. TIP support is required to pursue this project because the several technology development targets require a mix of both basic and applied research that is not addressed by other federal funding programs and that involves too much risk for private funding.

For project information:
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Active Project Members

- Distributed Sensor Technologies, Inc. (Santa Clara, CA)
  [Original, Active JV Member]
- Optiphase, Inc. (Van Nuys, CA)
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- Redfern Integrated Optics, Inc. (Santa Clara, CA)
  [Original, Active JV Member]
- University of Illinois, Chicago (Chicago, IL)
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