TIP Project Brief – 080011 / 9H9007

Civil Infrastructure

Self Powered Wireless Sensor Network For Structural Bridge Health Prognosis

Develop a novel system for continuously monitoring the structural health of bridges using wireless sensors that "harvest" power from structural vibration/wind energy and assembles data from a variety of sensors for interpretation through damage assessment/reliability algorithms.

Sponsor: Mistras Group, Inc.,DBA Physical Acoustics Corporation
195 Clarksville Road
Princeton Junction, NJ 08550

- Project Performance Period: 2/1/2009 - 1/31/2014
- Total project (est.): $13,899 K
- Requested TIP funds: $6,930 K

A joint venture led by Physical Acoustics Corporation (PAC, Princeton Junction, N.J.) plans to develop a suite of new technologies that will enable an easily deployed, self-powered network of wireless sensors, together with analysis tools, to provide continuous monitoring of the structural integrity of bridges. The Federal Highway Administration estimates that more than 70,000 bridges in the United States are structurally deficient. While about 10,000 bridges are built, replaced or rehabilitated annually, there is a significant need for a system to provide continuously updated information on the structural health of bridges to better prioritize repair operations and to notify bridge owners of extreme events such as collisions. The system proposed by PAC and research partners Virginia Tech (Blacksburg, Va.), the University of South Carolina (Columbia, S.C.) and the University of Miami (Coral Gables, Fla.) will include an innovative system for "harvesting" its own power from ambient motions and vibrations in the bridge using piezoelectric materials. The instrument package itself will utilize acoustic emission (AE) sensing; a passive, non-destructive monitoring technique that detects acoustic waves emitted by active flaws such as cracks. The AE sensors will be complemented with active piezoelectric sensors that "ping" the structure to detect echoes from cracks and other flaws, and sensors for strain, acidity, temperature, humidity and similar factors. The exact sensor combination will depend on the nature of the bridge construction. The research targets both steel and concrete bridges. The sensor data, transmitted through a wireless system, will feed computer models of the structure and a data interpretation system that will make assessments and predictions of the bridge's structural integrity on the basis of continuously updated information. Built-in self-check capabilities will eliminate the need for routine sensor maintenance. The power harvesting feature will eliminate the need for either a hard-wired power source for the hundreds of sensor nodes required or a reliance on batteries that would have to be regularly replaced. This aspect greatly reduces both installation and maintenance costs for the monitoring system. TIP support is needed to offset the several high-risk elements of the proposal. These elements include development of the energy harvesting system, the sensors themselves, and the data interpretation, damage assessment and health prognosis software.

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Active Project Members

- Mistras Group, Inc., DBA Physical Acoustics Corporation (Princeton Junction, NJ)
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- University of Miami (Coral Gables, FL)
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- University of South Carolina Research Foundation (Columbia, SC)
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- Virginia Polytechnic Institute and State University (Blacksburg, VA)
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