TIP Project Brief – 080012/9H9008

Civil Infrastructure
Cyber-Enabled Wireless Monitoring Systems for the Protection of Deteriorating National Infrastructure Systems

Develop a comprehensive system for monitoring and assessing the structural health and integrity of major infrastructure elements such as bridges on a regional basis, with innovations ranging in scale from "smart material"-based sensors at the level of individual structural components up through structure-level data integration and interpretation to a Web-based system for information aggregation and decision support at the regional level.

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- Project Performance Period: 2/1/2009 - 1/31/2014
- Total project (est.): $19,162 K
- Requested TIP funds: $8,998 K

A joint venture led by the University of Michigan (Ann Arbor, Mich.) plans to develop a comprehensive system for monitoring the structural integrity of major elements of the nation's infrastructure—systems of bridges in particular—by combining innovations at length scales ranging from individual structural components of a single bridge up to the regional management of a collection of bridges. Together with research partners Weidlinger Associates (New York, N.Y.), SC Solutions (Santa Clara, Calif.) LFL Associates (Ann Arbor, Mich.), Monarch Antenna (Ann Arbor, Mich.) and Prospect Solutions (Albany, N.Y.), the team will develop a suite of technologies to identify fatigue and corrosion in bridges, two closely related degradation mechanisms that if left unchecked lead to brittle structural failures. At the most basic level, these focus on self-sensing “smart materials” that can be incorporated into the structure of the bridge and that are better suited than discrete sensors for detecting purely localized failures, like cracks. An example would be cement composites where the electrical or magnetic properties of the cement change in response to strain or cracking. Power “harvesting” technologies based on electromagnetic and micro-electromechanical (MEMS) devices that derive power from vibrations in the bridge structure—including a unique technique that employs normally useless low-frequency vibrations—will power the system. Data will be transmitted to base stations using a new ultra-low-power wireless telemetry system. Other innovative elements of the plan include a low-level data management that handles initial data processing in the sensor nodes to reduce the load on the transmission network and the higher level monitors, an additional sensor system that correlates structural changes with vehicular traffic loads, an internet-based system that links data streams from the sensor network with net-based structural models and analysis tools and decision-making tools that allow managers to make informed and optimal decisions on maintenance and upkeep without sacrificing safety and performance. Michigan and California have agreed to provide the research team with access to operational bridges and bridge models that will serve as testbeds for the proposed technologies. The technology could easily be adapted to other large infrastructure systems such as roads, pipelines and tunnels. TIP support is needed because of the high aggregate risk of developing and intergrating a complex set of new, multidisciplinary technologies.

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Active Project Members

- Li, Fischer, Lepech & Associates LLC (Ann Arbor, MI)
  [Original, Active JV Member]
- Monarch Antenna, Inc. (Ann Arbor, MI)
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- Prospect Solutions, LLC (Loudonville, NY)
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- University of Michigan (Ann Arbor, MI)
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- Weidlinger Associates, Inc (New York City, NY)
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