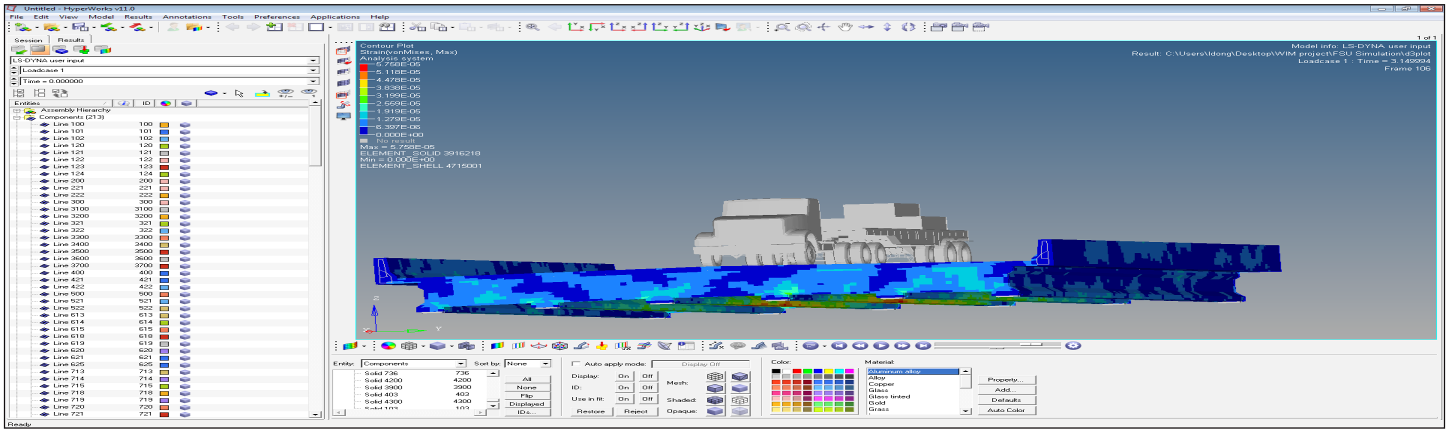
U.S. Department of Transportation
Office of Research and Technology

UTC Spotlight

University Transportation Centers Program

This month: Georgia Tech | May 2014

Next-Generation Wireless Sensing System for Transportation Infrastructure Safety



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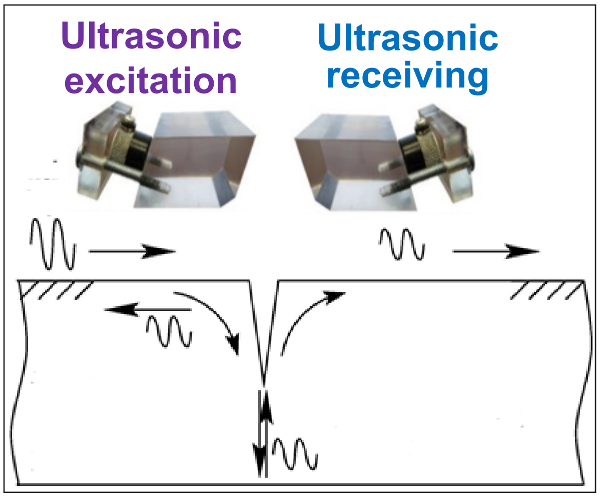
High-resolution computer model built by researchers showing dynamic response of a bridge structure to an 18-wheel truck.

Researchers at the National Center for Transportation Systems Productivity and Management (NCTSPM) are developing an advanced wireless monitoring system that not only weighs vehicles, it also captures data that can help measure the structural integrity of bridges and their response to traffic. The NCTSPM is a University Transportation Center housed at the Georgia Institute of Technology, which is jointly conducting this research with its consortium member, the University of Alabama at Birmingham, along with the Georgia and Alabama departments of transportation.

Wireless sensors (nodes) provide real-time, dynamic measurements of a bridge's response to actual traffic stresses. Combined with a sophisticated computer model of the bridge being measured, structural response data supplied by the wireless nodes can be used to assess the gross weights and axle loadings of individual vehicles, essentially making the bridge a weighing scale. These bridge weigh-in-motion (BWIM) data can then be used in a number of ways, including identifying and controlling illegally overweight trucks.

Nondestructive evaluation (NDE) of bridge structures are achieved via wireless sensing nodes that support high-speed ultrasonic measurements for monitoring crack development on bridge members. Each wireless sensor node is capable of providing low amplitude, high-frequency (megahertz) excitations to the structural member that produce tiny-amplitude vibrations near cracks that, in turn, are detected by the sensor node after traveling around the crack. These captured vibration signals provide information on the size and location of cracks and assist in monitoring crack or damage growth in critical structural members. Thus this system can not only assist in monitoring and reducing illegally overweight trucks, it can also detect bridge damage.



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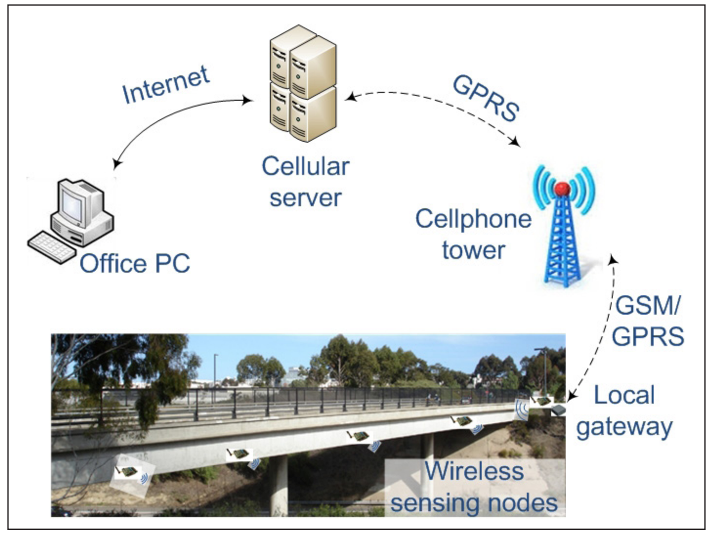
High-speed, tiny-amplitude ultrasonic vibration waves traveling around a structural crack.

Traditional sensing systems for both BWIM and NDE require bulky equipment that is impractical for deploying high densities of sensing nodes in the field. Recent developments in electronics have enabled researchers, through judicious selection and assembly of commercial-off-the-shelf components, to develop a new generation of compact, wireless sensing devices. Used in conjunction with solar panels, these devices should provide dense, low-cost sensor coverage that is independent of the electric power grid. Aggregated by on-site local gateways that communicate through cellphone networks, both BWIM and NDE data can be viewed in real time by DOT bridge engineers for close monitoring of bridge conditions.

By removing lengthy cables and bulky equipment, it is expected that a portable and self-powered wireless BWIM system incorporated with NDE will achieve adequate accuracy and reduce traditional cabled BWIM system cost (~$120k each) by at least 50 percent. The low cost and portability of the proposed system are among the most exciting aspects of this project. Such attributes can enable widespread adoption and make the technology a "game changer" in the health monitoring and asset management of transportation infrastructure. The research will assist in prolonging the service life of transportation infrastructure and should be particularly beneficial to State DOTs with limited bridge repair budgets. For more information on this project, please visit [http://nctspm.gatech.edu/node/69.](http://nctspm.gatech.edu/node/69)



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A comprehensive remote sensing system using short-distance low-power wireless technology to cover the bridge, and cellphone network for data distribution over Internet.

About This Project

This research project is led by principal investigator Yang Wang, Ph.D., of the School of Civil and Environmental Engineering at Georgia Tech in cooperation with Nasim Uddin Ph.D., at the University of Alabama at Birmingham and Laurence J. Jacobs Ph.D., and Jin-Yeon Kim Ph.D., of Georgia Tech. Ben Rabun, the State Bridge Engineer at GDOT, and George Connor, Maintenance Engineer at ALDOT, are key partners in this work.