NCITEC Project Information

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Title: Rapid Non-contact Measurement using Multiple Point Laser Doppler Vibrometry for Health Evaluation of Rail and Road Bridges

Abstract:

Measurement of dynamic responses to ambient stimuli can be used to evaluate as-built structural characteristics. These parameters can be used to determine the overall "health" of the structure; that is, the damage level and location can provide reliability information that aids infrastructure managers in maintenance decision-making. This type of inspection is most practical when it is non-destructive and swift.

In contrast to traditional vibration measurement systems, laser technology provides for rapid remote inspection. Laser Doppler vibrometers (LDV) have recently been used to capture non-contact vibration of bridges and are being used in an associated NCITEC project. Despite their abilities, commercial LDVs can only provide vibration information one point at a time. In order to increase inspection speed to a practical threshold, multiple simultaneous laser beams will be employed. The National Center of Physical Acoustics (NCPA) at the University of Mississippi has been a leader in developing an instrument for parallel vibration measurements at multiple points. Results have been positive for such applications as landmine and tunnel detection. Civil infrastructure has an entirely different frequency range; massive structures with such low frequencies present a unique challenge.

In this project, a new method for structural vibration measurements on bridges will be implemented. The overarching idea is that parallel vibration measurements at multiple points using a multi-beam laser Doppler vibrometer will enhance non-contact bridge inspection technology. As proof of concept, the proposed effort will employ the available MB-LDV for measurements on a scale model bridge. The multiple laser beams will fan out to make parallel vibration measurements in multiple points on the model. Velocities of all interrogated points are measured and recorded simultaneously and are expected to enhance the accuracy of bridge mode shape calculation. Precise mode shapes lead to improved damage detection and thus more effective inspection results. The structural health algorithm will be modified based upon parallel measurements, and noise levels will be examined for practical feasibility.

Civil Engineering and National Center for Physical Acoustics personnel will work together to create a larger field of multi-beam vision and build a vibration isolation support system. Experiments will be conducted on an available scale model reinforced concrete bridge. The UM structural health program will employ advanced signal processing to extract mode shape data for damage detection. Output plots will visibly identify damage level and location and will be evaluated for detection accuracy as well as inspection practicality for bridge maintenance.

This project is expected to contribute to at least 3 undergraduate/graduate courses (Structural Dynamics, Advanced Structural Dynamics, Acoustics) as well as fund 2 graduate student semesters, which will result in degrees. Technology transfer will include presented conference papers and submitted journal papers.

Start Date: January 1, 2014

End Date: December 31, 2014

Subject Categories:

(1) Bridges and other structures

(2) Maintenance and Preservation