Optical-Based Structural Health Monitoring of Truss Bridges

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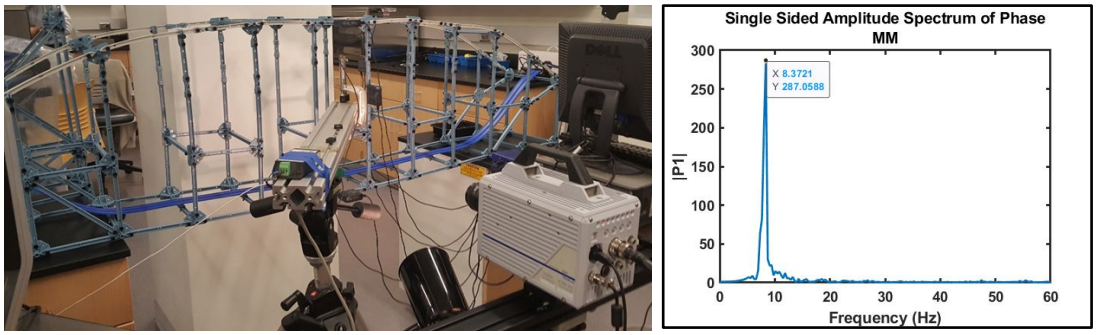
Abstract

Optical sensing techniques are an effective approach to extract system dynamics information for structural health monitoring (SHM). Traditional sensing hardware, such as accelerometers, require a large amount of time and monetary expense for the installation. Moreover, such permanently-installed data acquisition system demands a high cost of maintenance given its in-situ operational nature. Thus, noncontact sensing is a good alterative due to its better portability compared to traditional sensors. To process the camera data, phase-based motion estimation (PME) and magnification (PMM) have been investigated, which aim to extract and amplify subtle (invisible) motions that cannot be seen clearly without processing. This project aims to identify the shift of natural frequencies and change of the operational deflection shapes of truss bridges due to damage and load conditions using PMM. For this purpose, experiments on a laboratory-scale truss bridge was carried out, which is shown in Figure 1 with its frequency domain characteristic. With the intention of simulate diverse damaged scenarios, the damages were divided into severe damaged and light damages. It was feasible to identify the shifted natural frequencies from damaged cases which deviate from the healthy structure. Complementarily, a real truss bridge test was done and had a good dynamic response, allowing to identify the first few bending modes of the structure. Therefore, PME and PMM proved to be a powerful tool for dynamic information extraction, and frequency shift with the change of the operational deflection shapes shows great potential for damage detection.



(a) (b)

Figure 1: (a) Laboratory-scale truss bridge model, and (b) vibration power spectrum in frequency domain

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