Abstract

Instrumentation and vibration monitoring of civil structures has gained importance during the last decades due to potential applications in modal identification and structural health monitoring. The identification of dynamic properties of structures allows numerical models to be updated whereas structural health monitoring allows damage in structures to be both identified and characterized with the goal of anticipated lower-cost interventions. Accelerometers are the most common instruments used in civil structures due to the fact they can be attached directly to the structure without the need of an independent fixed frame of reference. In cases where values of displacements are desired, they are often estimated indirectly through double numerical integration of the measured accelerations. However, these numerical methods commonly introduce considerable errors in the results. This paper presents the development, validation and real-scale implementation of a novel system for direct displacement measurements of civil structures. The system consists of low-cost laser pointers that are attached to the structure, a screen and video camera and image processing algorithms that run on a laptop PC. The validation of the system was carried out with a series of laboratory tests and the comparative analysis of results using reference instruments. The system was implemented on a pedestrian bridge in Cali, Colombia, and the displacements obtained with the laser system are compared with those estimated from accelerations measurements. The results show that the proposed system is a precise low-cost alternative for instrumentation applications in civil engineering.

Keywords

Modal identification, structural health monitoring, laser sensors.