Beneficial Effect of Combining Similar Low-Cost Accelerometer to improve the overall Accuracy and Noise Density

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Abstract

Structural Health Monitoring applications are receiving more and more attention nowadays. The epidemic problem with these evaluations is their high cost. For applying them to structures/ infrastructures with a low budget of SHM evaluations, low-cost sensors must be taken into account. However, low-cost accelerometers have higher noise density ratios which affect their accuracy and resolution. Using filters or post-processing methods alters the acquired information of the accelerometers. This article aims to enhance the accuracy and resolution of low-cost sensors by improving and controlling the spectral noise level through active noise improvement. This improvement is studied in this paper and supportive laboratory experiments have been illustrated.

Keywords: low-cost sensors; accelerometers; data acquisition; structural health monitoring; arduino.

1   Introduction

Structural Health Monitoring systems are composed of sensors that measure the structural response (such as accelerations, rotations, strains or deflections) over time. This information can be used to estimate changes in the structural performance of infrastructures [1][2]. The time variation of some environmental factors (such as temperature or humidity) that could produce crack opening, rotations, settlements, corrosion and other pathologies is so slow that they can be considered as quasi-static or static [3][4]. On the other hand, some events (such as the wave response due to earthquake ground motion, traffic-induced vibrations or ambient activities) surely need to be accounted for the dynamic nature of the structural response they induce. To observe and control them, dynamic SHM Systems are required [5][6]. The modal parameters needed for SHM application are mostly acquired by accelerometers [7].

MEMS sensors are silicon-based micromachined devices that traditionally incorporate an