Structural Health Monitoring of Existing Bridges by Vibration Measurement

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Summary

This paper describes some studies relating to structural health monitoring techniques based on vibration measurement using laser Doppler vibrometer (LDV) and MEMS based sensor. 1) Compact and portable LDV measurement system was developed and applied to tensile force measurement of cables in a cable-stayed bridge. 2) The system combining LDV with Total Station was developed for the purpose of automated remote measurement for whole large bridge. 3) A new wireless LAN accelerometer based on MEMS technology was evaluated and applied to field measurement of bridges.

Keywords: Structural Health Monitoring; Bridges; Vibration; Measurement; Laser Doppler Vibrometer; MEMS.

1. Introduction

Through the high level of research interests and activities in structural health monitoring (SHM) in the world, the concept of SHM is applied and incorporated into bridges by installing a lot of sensors [1]. However, up until now, integrity diagnosis techniques for existing bridges have mainly been conducted by subjective visual inspections. Therefore, there is a strong need to establish objective and effective SHM techniques for monitoring of existing bridges.

Deterioration or damage of a structure leads to the change of stiffness or mass. The change appears in dynamic characteristics such as natural frequency of the structure. Therefore vibration based SHM is quite effective [2]. Also recent development of measurement technologies is promising for vibration based SHM.

This paper describes some studies relating to the development of vibration based SHM techniques for bridges. In the first half of the paper, for the purpose of realizing non-contact and remote measurement of large bridge, SHM techniques using laser Doppler vibrometer (LDV) are reported; at first, compact and portable LDV measurement system was developed and applied to tensile force measurement of cables in a cable-stayed bridge. Next the system combining LDV with Total Station was developed for automated remote measurement of whole large bridge. In the latter half of the paper, SHM techniques using MEMS (Micro Electro Mechanical System) based sensor, which is expected to realize huge and dense sensor network for infrastructures, are reported; A new wireless LAN accelerometer based on MEMS technology was evaluated and applied to field measurement of bridges.

2. Structural Health Monitoring using laser Doppler vibrometer

2.1 Laser Doppler vibrometer

LDV is an optical instrument employing laser technology to measure velocity based on the Doppler principle. The characteristics of LDV are the followings: first, in comparison with conventional transducers such as an accelerometer, non-contact and long distance measurement is possible without adding mass or stiffness to an object. Secondly, velocity is measured very high accurately, and frequency bandwidth is very wide. Thirdly, by attaching a scanning unit of mirror in front of the

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