Vibration Monitoring of Stay Cables Using Image Making and Pattern Recognition

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Summary

The statistically processed results are sometimes not intuitive for the structural health monitoring systems of cable-stayed bridges which process voluminous data from a lot of sensors. For this reason, the signals-image recognition algorithm using images more intuitive than numerical values is presented in this study. The signals-image here means not a photograph taken by any camera but the artificial image which consists of measured signals and their process results. It is applied to extract the features from signals and identify the cable vibrations. Consequently, identifying and classifying signals-images have been successfully performed.

Keywords: cable-stayed bridge; cable vibration; image recognition; structural health monitoring.

1. Introduction

In the last two decades, it has been shown that a great deal of research and development in the field of structural health monitoring (SHM), with integrated long-term monitoring systems implemented on cable-stayed bridges in Asia, Europe, and the United States. The stay cables are the main members of cable-stayed bridges. The stay cables can be easily excited by wind due to their flexibility and low damping. The severe vibrations of the stay cables have been observed from many cable-stayed bridges in service all over the world [1]. Hence, the response of the stay cables is considered to be important for bridge operators using the SHM systems.

The vibrations of the stay cables can be regarded as the short term response. Therefore, vibration signals are analyzed in time or frequency domain. However, the analysis results in these domains are sometimes not intuitive for the SHM systems of cable-stayed bridges which process voluminous data from a lot of sensors. For this reason, the image recognition algorithm using artificial images which are more intuitive than numerical values is proposed in this study. It is applied to extract the features from signals and identify the cable vibrations.

Wahbeh et al. [2] proposed the vision-based approach using the video camera for obtaining direct measurements of the absolute displacement time history at selectable locations of long-span bridges. They found that the proposed approach has the potential of leading to an economical and robust system for obtaining direct displacement of the system undergoing complex three dimensional deformations. Ji and Chang [3] proposed the image-based technique for measuring small cable vibration. The technique analyzes a digital image sequence of a vibrating cable segment captured by a CCD camera and calculates the displacement of cable segment and its natural frequency. They concluded that further development of the technique is still needed to apply to long-span cable-stayed bridges.

Basically, the techniques by Wahbeh and Ji used a commercial camera to make an image. Other researches not mentioned here are similarly using commercial cameras or electric devices for image processing. But, this study proposes the new method to make the artificial image not by a camera

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