A Fully Automated and Noncontact Method for Force Identification of Cables Based on Microwave Radar

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Abstract

This study proposes a full-automated and non-contact cable force identification method based on microwave radar. Several algorithms have been presented for data processing. The time domain data records by microwave radar is firstly transformed into frequency domain by Fast Fourier Transform. Then, the eigen-frequencies are simultaneously identified with the proposed fast sieve method. Subsequently, a novel algorithm using hash map and weighted voting is applied to estimate orders of eigen-frequencies. Finally, the average ratio between eigen-frequencies and their orders is estimated by weighted least square method, and then the cable force is calculated by using cable frequency formulas. The method has been validated by field tests.

Keywords: cable force, frequency spectrum, microwave radar, sieve method, weighted hash voting, least square method, tension string theory.

1 Introduction

Cable is one of the most significant load-bearing components of cable-stayed bridges. Therefore, cable force estimation is of vital importance in bridge inspection and health monitoring for structural assessment.

Vibration method is widely used in cable force identification, where cable force is calculated by identified cable eigen-frequencies. The most commonly used sonsors for this purpose are accelerometers and displacement meters, etc. Nevertheless, the installation of these sensors is time-consuming and labour-intensive, particularly considering hundreds of cables of one bridge.

In recent years, lots of optical detection technologies have been developed and applied in cable vibration measurement. Chu et al. [1] introduced optical method into cable vibration identification by utilizing a novel processing method of image threshold matching. Du et al. [2] proposed that single point and multi-point images can be taken by camera, and compared their theoretical results with the results of

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