Modal parameter identification of a curved cable-stayed model bridge based on EDA and DATA-SSI

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Abstract

For bridge health monitoring, the measured data may be unreliable due to various interferences. In order to get a reliable modal parameter identification result of a bridge, it is vital to have an inspection and a pre-processing on the bridge health monitoring data. Firstly, exploratory data analysis (EDA) was adopted to inspect the data quality, and the unreliable data measured from malfunctioning sensor was removed. Then, outlier analysis was performed to eliminate the abnormal data points from the data set. In the end, data driven stochastic subspace identification (DATA-SSI) combined with stabilization diagram was applied to identify the bridge modal parameters. A large scale curved cable-stayed model bridge was taken as an instance to verify the proposed method. The comparison of the modal parameter identification results of the original and the pre-processed data shows that the proposed method is effective, accurate and valuable.

Keywords: curved cable-stayed bridge; exploratory data analysis; outlier analysis; data driven stochastic subspace identification.

1 Introduction

Bridge structure is a key infrastructure of the entire transportation network, its failure or collapse will have a big impact on the local economy and extremely a negative impact on society[1]. So, it is of significant practical importance to analysis the data measured from real-time bridge health monitoring system and evaluate the operational state of a bridge. Real-time health monitoring data are acquired from the sensors installed on the bridge structure and transmitted to the remote database[2]. The quality of the measured data directly influences the accuracy of bridge modal parameter identification and bridge service state assessment. Hence the data should be of good quality. However, there are a lot of influencing factors that can cause the data abnormal during the acquisition and transmission processes, such as malfunctioning of sensors, defects of transmission system, failure of shielding measures, external interferences, etc. Most of the real-time bridge health monitoring system are installed on long span bridges, hence it is difficult for engineers to check each sensor along the large structure. At the same time, the collected data from real-time bridge health monitoring system is in huge amount because of the continuous collection, therefore it is not easy to examine the quality of the measured data via traditional data inspection techniques[3]. Due to the facts mentioned above, it is necessary to develop an efficient and reliable data inspection and pre-processing technique for bridge health monitoring.

Exploratory data analysis (EDA) was firstly introduced by John W. Tukey[4] in 1977, and EDA was used as a basic data visualization tool at that time due to its immature techniques[5,6]. With the development of EDA techniques, it has become an advanced tool for anomaly detection of large

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