Unit influence surface identification of long-span bridge based on spatial-temporal vehicle load monitoring

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Abstract

On-side bridge unit influence surface (UIS) calibration traditionally relied on the vehicle load test, which is expensive, time-consuming and traffic-interruptive, especially for long-span bridges. This paper proposes a novel method for bridge UIS identification based on the vehicle load monitoring. By employing a multi-vision system and computer vision algorithms, the distribution of the vehicles on the bridge deck is obtained. Then the data fusion between the vision system and weigh-in-motion (WIM) system is implemented to acquire the spatial-temporal vehicle loads on the deck. In the meanwhile, the deflection of the main-span is also obtained by the SHM system of the bridge. Thus, by means of the iterative computation and surface fitting, the UIS of the deflection is identified. The proposed method is arranged and applied to a practical long-span suspension bridge. Results have shown the feasibility of the method.

Keywords: long-span bridge; unit influence surface; vehicle load monitoring; computer vision; data fusion.

1 Introduction

The unit influence surface (UIS) is a mathematical model to to characterize input (loading) - output (response) interactions of a structure by analysing measurement data. Generally, the UIS of a practical bridge is identified via an experiment with testing vehicles, which requires various standard vehicles and long-term traffic closure. Specifically, for long-span bridges, the requirements are cumbersome and unaffordable for frequent structure experiments.

During the recent years, the computer vision aggregated with deep learning methods have been applied to civil engineering for complex modelling[1]. Typical cases such as damage recognition[2][3], vehicle monitoring[4], bridge reconstruction[5] and scene understanding[6]. These applications have verified the robustness and supplementary of the vision sensors.

In particular, the vision system is able to obtain the spatial-temporal distribution of the vehicles on the bridge deck. By means of the multiple cameras and weighing sensors, the complete vehicle load monitoring is which is one of the main dynamic loads of long-span bridges. On the other hand, the response of the bridge is obtained via the pre-embedded structural health monitoring (SHM)

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