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Multi-Vehicle Load Identification Using Existing Bridge Health Monitoring System

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1 Abstract

Collecting the information of traffic load, especially heavy trucks, is crucial for bridge statistical analysis, safety evaluation, as well as maintenance strategies. This paper presents a traffic sensing methodology that combines a deep learning based computer vision technique with the influence line theory. Theoretical background and derivations are introduced from both aspects of structural analysis and computer vision techniques. In addition, to evaluate the effectiveness and accuracy of the proposed traffic sensing method through field tests, a systematic analysis is performed on a continuous box-girder bridge. The obtained results show that the proposed method can automatically identify the vehicle load and speed with promising efficiency and accuracy, and most importantly cost-effectiveness. All these features make the proposed methodology a desirable bridge weigh-in-motion system, especially for bridges already equipped with structural health monitoring system.

Keywords: Bridge weigh-in-motion; traffic sensing; influence line; computer vision; deep learning; bridge structure

2 Introduction

Traditional vehicle dynamic loads measurement systems, such as bridge weigh-in-motion (BWIM), has disadvantages of multiple-vehicle problem and incomplete information acquisition [1][2]. Countering this, the paper presents a new highway vehicle load identification methodology based on advanced computer vision algorithm and bridge influence line principle. Applying the YOLO V3 algorithm, vehicle type, location and velocity are extracted from traffic video surveillance. Meanwhile, strain influence lines of traffic lanes are fitted based on the measured strain data of a four-span continuous girder box bridge. Furthermore, vehicle weight is calculated in combination of its location and the strain influence line. Vehicle load identification results validate the efficiency and accuracy of this proposed method.

3 Structural analysis

3.1 Bridge response analysis

Most BWIM systems are applied on girder bridges with small or medium span due to its structural simplicity. Compared with long-span bridges, middle-small span girder bridges perform linear

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