A camera calibration method for bridge live load identification using plane marks on the pavement

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Abstract

Computer vision has become an effective way to collect the information of traffic load, which is crucial for bridge statistical analysis, safety evaluation, and maintenance strategies. To obtain the information of vehicles such as position and wheelbase, the location and orientation of the camera should be calibrated in advance, but the calibration needs measurement and sometimes is difficult to implement because of heavy traffic flow. Therefore, this paper proposes a camera calibration method using plane marks on the pavement without measurement. The plane marks are designed to be convenient and economical for construction so any bridge or road with a potential demand of vehicle monitoring can consider to prepare such marks on the pavement. The feasibility of the proposed method is verified through computer simulation and a model test.

Keywords: camera calibration; plane marks; computer vision; vehicle positioning; traffic load.

1 Introduction

As effects in the service stage include the effects of live loads and dead loads[1], monitoring of traffic load, which is one of live loads, is important for safety evaluation[2]. In addition, in the last decades, the use of concrete and steel composite beam structural systems has received significant attention due to their construction speed together with structural and cost advantages[3]. The fatigue life prediction for composite beam is vital, which also requires live load monitoring data.

Information of the vehicles on a bridge contains the positions, speeds, types, size, and numbers of axles of the vehicles[4]. In the above information, types and density can be obtained from the 2-D image analysis. However, to obtain the spatiotemporal information of vehicles, 2-D image coordinates must be transformed to spatial coordinates.

Before the coordinate transformation, camera calibration is a necessary work. Calibration is a process that solutes the camera parameters using the known spatial coordinates of feature points of targets. The existing camera calibration method include 1-D target calibration[5][1], 2-D target calibration[6][11], 3-D target calibration[12] and self-calibration. Nowadays, in some fields requiring high precision in camera calibration such as industrial measuring, calibration methodologies based on 2-D plane target are widely used.

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