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Visual Weigh in Motion: A Vision-based Vehicle Tracking and Load Estimation

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ABSTRACT

Measuring vehicle load is essential for ensuring the safety and longevity of transportation infrastructure. It enables engineers and authorities to perform load capacity assessment, which determines whether a bridge or roadway can safely support the weight of passing vehicles under various conditions. Traditionally, vehicle load identification relies on weigh-in-motion (WIM) systems, which capture weight data as vehicles travel over embedded sensors. However, the widespread adoption of WIM systems is hindered by their complex installation, high implementation costs, and ongoing maintenance demands. To address these limitations, this study proposes the visual weigh-in-motion (V-WIM) framework for tracking and identifying vehicle loads using computer vision techniques. The V-WIM consists of two main components: the vehicle weight estimation and the vehicle tracking and location estimation. Vehicle load is estimated using tire deformation parameters extracted from tire images through object detection and optical character recognition (OCR) techniques. A deep learning-based YOLOv8 algorithm is employed as the vehicle detector, combined with the Bytetrack algorithm for tracking vehicle location. The vehicle load and its corresponding location are then integrated to simultaneously identify the vehicle load and its location. The performance of the proposed method was evaluated through two component validation tests and one system validation test, demonstrating its effectiveness in addressing the limitations of existing methods.

REFERENCES

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