ABSTRACT

The growing volume of vehicles in Semarang City presents significant challenges in traffic management, particularly the limitations of manual surveillance systems that are unable to provide quantitative data in real-time. This study implements a YOLOv8 object detection model trained via transfer learning on a custom dataset extracted directly from the Adaptive Traffic Control System (ATCS) closed-circuit television footage of Semarang City, subsequently integrated with the ByteTrack tracking algorithm and a virtual line crossing method to automatically count vehicle volume. The constructed dataset consists of 2,075 images containing a total of 30,879 bounding boxes across two vehicle classes: motorcycles and cars. Evaluation of the detection model demonstrates strong performance, achieving a Precision of 0.9507, a Recall of 0.9367, and a mAP@0.5 of 0.9764. End-to-end system testing was conducted across four CCTV video scenarios representing varying conditions of traffic density and illumination, yielding vehicle counting accuracies ranging from 86.86% to 100%. The best performance was achieved under low-density traffic with adequate lighting, while traffic density and intersection geometry complexity were identified as the dominant challenge factors. These results demonstrate that a locally-trained, open-source architecture is capable of delivering high accuracy, making it a viable transparent alternative to proprietary Edge AI analytics embedded in commercial camera systems.

Keywords : Vehicle Detection, YOLOv8, ByteTrack, Transfer Learning, Multi-Object Tracking, Virtual Line Crossing, Traffic Surveillance.