ABSTRACT

The rapid growth of traffic volume on toll roads highlights the need for an automated traffic monitoring system capable of accurately detecting and counting vehicles in real time. Conventional manual counting methods are inefficient and prone to inconsistency, making computer vision-based approaches increasingly relevant for intelligent transportation systems. This research proposes the implementation of the YOLO12 model for vehicle detection and countng of four wheeled or larger vehicles from toll road surveillance video. Five YOLO12 variants (n, s, m, l, and x) were evaluated under two training scenarios, with and without data augmentation. Vehicle counting was performed by integrating the BoT-SORT tracking algorithm, where each vehicle was counted once upon crossing a predefined virtual line. Detection performance was assessed using precision, recall, mAP@0.5, and mAP@0.5:0.95, while counting accuracy was evaluated using Mean Absolute Error (MAE) againts manually obtained ground truth data. Experimental results show that all YOLO12 variants achieved strong detection performance, with mAP@0.5 values exceeding 0.98 and mAP@0.5:0.95 values above 0.94. In the counting experiment involving 136 vehicles, the system obtained an MAE ranging from 6 to 7 vehicles, indicating a relatively low counting error. Increasing model complexity did not significantly improve counting accuracy, whereas the YOLO12n variant demonstrated the best balance between accuracy and computational efficiency, achieving an MAE of 6 and the highest processing speed of 11.48 FPS on a mid-range GPU.

Keywords : YOLO12, vehicle detection, vehicle counting, BoT-SORT