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Challenges and Opportunities in Vision-Based Vehicle Tracking Systems

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Abstract

This study compares different vehicle detection-tracking combinations and state-of-the-art (transformer-based detection) with state of practice in multi object detection for transportation purposes and proposes the best approach. We compare the performance of tracking using different detection-tracking combinations (YOLO5, FRCNN, DETR) - (SORT, ByteTrack) in different camera settings and three weather scenarios in terms of Recall, precision, IDF1, IDP, IDR, MOTA, MOTP, tracking consistency and processing time. The novel Transformer architecture is a deep learning network based on the attention mechanism developed in natural language processing. Due to its strong capabilities, recently it has attracted a huge amount of attention in computer vision. However, the performance of these recently developed networks in the transportation area needs to be examined. The result of this analysis showed that given our input cameras, DETR was outperforming other algorithms in terms of tracking consistency, and it was performing similar to FRCNN in terms of Recall with better performance in intersection conditions. YOLO5 is almost outperforming other algorithms in terms of Precision, MOTA, IDF1, and inference time. Except for one camera which DETR/FRCNN was performing better in terms of IDF1. This paper has practical significance in intelligent traffic management and control at intersections and highways.