Edge-Based Traffic Congestion Management Using YOLOv8 and Adaptive Signal Control

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Abstract:

Traffic congestion in contemporary urban space is a serious problem as it contributes to delay in traveling, fuel consumption, and poor quality of life. The traditional fixed time based traffic lights do not have the flexibility to adjust to unforeseen changes in the traffic movement therefore leading to poor use of roads and long traffic jams. The present paper presents a proposal of Intelligent Traffic Congestion Management System to be used as real time monitoring and adaptive control of traffic in terms of traffic signal. High-definition roadside cameras and IoT sensors are used in the system, and the traffic data is processed on edge computing devices with a YOLOv8-based deep learning model to determine the vehicle density and queue length accurately. These indicators of congestion are fed to a signal controller based on reinforcement learning that adjusts traffic signal timings dynamically in an effort to reduce congestion. The resultant data is geo-tagged and stored in PostgreSQL-PostGIS spatial database, and a Reactbased dashboard allows visualizing traffic data in real time, heatmaps, and analytics to traffic authorities. The experimental analysis demonstrates that the average waiting time is reduced, the intersection throughput improves, and the cost-effective solution that is appropriate in the intelligent management of urban traffic has been obtained.

Keywords:

Traffic Congestion, Intelligent Transportation System, YOLOv8, Edge Computing, IoT Sensors, Adaptive Signal Control, Reinforcement Learning, PostGIS, Urban Mobility. management of intelligent traffic in the cities.