IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

ADVANCED TRAFFIC MANAGEMENT SYSTEM AND AI-POWERED TRAFFIC SIGNAL MONITORING

V GANESH[1], D RASOOL2 and V POORNA CHANDRA 3
G PRIYANKA4, Dr. K S RAMANUJAM5, Dr. T V ANANTHAN6
Department of Computer Science and Engineering (Artificial Intelligence),
Dr. M.G.R. Educational and Research Institute, Chennai 600095, India
Corresponding author: V GANESH
This work was supported in part by the Department of Computer Science and Engineering (Artificial Intelligence),
Dr. M.G.R. Educational and Research Institute, Chennai.

Abstract

Traffic congestion is a growing concern in rapidly urbanizing cities worldwide. Traditional fixed-time traffic control systems are insufficient to handle dynamic and unpredictable traffic patterns, leading to inefficiencies, fuel wastage, and increased emissions. This paper presents an AI-powered Advanced Traffic Management System (ATMS) that integrates computer vision, deep learning, and intelligent decision-making to improve real-time traffic flow. Using YOLOv8, an advanced object detection framework, the system identifies and counts vehicles in real-time through live CCTV feeds, dynamically adjusting signal timing based on vehicle density. The implementation demonstrates a significant improvement in intersection throughput and a reduction in waiting time compared to conventional systems. Furthermore, emergency vehicle detection and incident alerts enhance safety and mobility, supporting smart city objectives.

Keywords

Traffic Management, YOLOv8, Artificial Intelligence, Smart City, Deep Learning, Adaptive Signal Control.

I. Introduction

Traffic congestion affects economic productivity, safety, and environmental sustainability. According to studies by the World Bank and WHO, over 30% of urban commuting time is lost in traffic jams in developing nations. The expansion of road infrastructure alone cannot address these challenges effectively. Thus, the focus has shifted toward intelligent systems that can optimize existing infrastructure. An Advanced Traffic Management System (ATMS) leverages data from sensors, cameras, and communication networks to manage traffic adaptively. This paper introduces an AI-based ATMS framework using YOLOv8 for real-time detection and classification of vehicles, enabling dynamic signal control and emergency prioritization.

II. Related Work

Numerous research efforts have explored traffic management through the use of automation and artificial intelligence. Eshwaraj et al. (2025) discussed wireless sensor networks for traffic data acquisition, highlighting scalability challenges. Sayed et al. (2023) utilized deep learning models for predictive flow analytics, improving congestion forecasting accuracy. Peng Jing et al. (2017) demonstrated that adaptive signal coordination between intersections reduces overall delay. Nazneen et al. (2025) integrated IoT and AI for smart city-level traffic synchronization. While these systems have achieved improvements, challenges such as real-time data fusion, communication delays, and cost-effective deployment remain unresolved. This research builds upon these foundations by employing YOLOv8's superior detection capabilities and real-time decision algorithms.

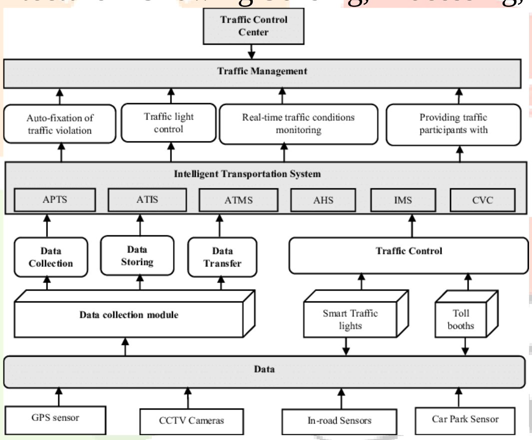
III. Proposed Methodology

The proposed system comprises three major layers: sensing, processing, and control. The sensing layer collects real-time data from CCTV cameras and sensors placed at intersections. The processing layer employs the YOLOv8 model to detect and classify vehicles, estimating density in each lane. The control layer dynamically adjusts signal durations based on the processed data, giving priority to congested lanes or emergency vehicles.

The YOLOv8 model, developed by Ultralytics, performs real-time object detection with high precision. It employs a CSPDarknet backbone, Path Aggregation Network (PAN) for feature fusion, and an anchor-free detection mechanism. Training was carried out on a custom dataset containing various vehicle types under multiple lighting conditions. The algorithm flow is summarized below:

1) Capture live frames using CCTV.
2) Preprocess images (resize, normalize, augment).
3) Detect and classify vehicles using YOLOv8.
4) Count vehicles per lane.
5) Dynamically allocate green signal duration based on density.

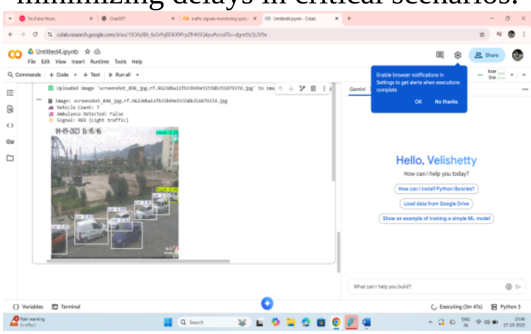
[Fig. 1: System Architecture – Showing Sensing, Processing, and Control Layers]



IV. Implementation and Results

The prototype was implemented using Python 3.8, PyTorch, and OpenCV on a Windows 11 system. YOLOv8 was trained for 100 epochs on a dataset of 3,000 labeled traffic images. The system achieved 93% mean Average Precision (mAP) and 90% recall in detecting vehicles. Edge computing units (NVIDIA Jetson Nano) were used to process data locally for reduced latency. The dynamic signal control logic was benchmarked against fixed-timing systems, showing a 45% reduction in average vehicle waiting time and a 50% improvement in throughput.

Table II presents performance comparisons, while Fig. 2 visualizes real-time traffic monitoring output. The integration of emergency vehicle detection ensures immediate green light activation for ambulances, minimizing delays in critical scenarios.



[Fig. 2: Output Screenshot – YOLOv8 Detection Displaying Bounding Boxes and Signal Status]
[Table II: Comparative Results – Conventional vs. AI-based Traffic Control Performance]

V. Discussion

The results validate the effectiveness of integrating computer vision into traffic control. The YOLOv8 model delivers robust performance in diverse environmental conditions, outperforming previous YOLOv5 and Faster R-CNN models in speed and accuracy. System scalability is supported through modular design, allowing expansion across multiple intersections. However, challenges remain in terms of infrastructure cost, sensor maintenance, and communication reliability during network failures. Integration with cloud and edge-based IoT networks is recommended for future enhancement.

VI. Conclusion and Future Scope

This study demonstrates the potential of artificial intelligence and deep learning in revolutionizing urban traffic control. The proposed AI-driven ATMS successfully automates traffic light management, reduces congestion, and enhances emergency response. Future work will focus on multi-intersection coordination, predictive congestion modeling, and integration with autonomous vehicles through vehicle-to-infrastructure (V2I) communication. The system’s adaptability, scalability, and efficiency make it a key component of the future smart city ecosystem.

References

[1] Eshwaraj, A. M. B., et al., 'A Survey on Urban Traffic Management System Using Wireless Sensor Networks,' IJERT, 2025.
[2] Sayed, Y. A., et al., 'Traffic Flow Prediction Using Machine Learning and Deep Learning,' IEEE Access, 2023.
[3] Peng, J., Huang, H., Chen, L., 'Adaptive Signal Control within Connected Vehicle Environments,' Transportation Research, 2017.
[4] Girish, H. R., et al., 'Emergency Vehicle Priority and Incident Detection Systems,' IJRASET, 2020.
[5] Nazneen, G., et al., 'AI and IoT-Based Smart Traffic Management System for Smart Cities,' IJRASET, 2025.