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# AI BASED SMART TRAFFIC MANAGEMENT SYSTEM

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**ABSTRACT-** ***Traffic congestion has become a major issue in urban areas due to the fixed-time traffic signal system that cannot adopt to real-time traffic conditions. The proposed project, AI Powered Adaptive Traffic Management System, aims to solve this problem by using Artificial Intelligence and Computer Vision to dynamically control traffic signals. The main problem with traditional systems is long waiting times, fuel consumption, air pollution, and delays for emergency services. The proposed project, AI Based Smart Traffic Management System, aims to address these problems by implementing an intelligent system that can monitor and control traffic signals dynamically based on live traffic conditions. The core problem statement of this project is the lack of adaptability in current traffic control system. This project rectifies the problem by using computer vision and machine learning traffic in real-time. The system uses YOLOv8 object detection algorithm with OpenCV to detect and count different types vehicles such as cars, buses , trucks, and motorcycles from live CCTV camera feeds. After counting, the traffic density is classified into Low, Medium, and High categories. Based on this classification, an algorithm calculates the optimal green signal time for each lane, instead of using a fixed timer. The further improve efficiency, a separate CNN model is integrated to detect emergency vehicles like ambulances and fire trucks. When an emergency vehicle is detected, the system automatically provides priority by giving a green signal to that lane immediately.***

**KEYWORDS:** ***AI Traffic Management, YOLOv8, Computer Vision, Real-time Traffic Analysis, Deep Learning, Vehicle Detection, Smart City.***

## INTRODUCTION

Traffic congestion is one of the most critical problems faced by urban cities today due to rapid pollution growth and increase in number of vehicles. Traditional traffic management systems used fixed-time

signal controls the operate on a predetermined time regardless of the actual traffic density on the road. This leads to unnecessary waiting time, increased fuel consumption, air pollution, and frustration amount commuters. Moreover, emergency vehicle like ambulances and fire trucks often gets stuck in traffic, which can result in loss of lives.

To overcome these challenges, there is a need for an intelligent system that can adapt to real -time traffic conditions. Artificial Intelligence and computer vision have emerged as powerful technologies to solve this problem. AI Based Adaptive Traffic Management System aims to monitor traffic flow using live CCTV cameras and automatically adjust the signal timings for each lane based on vehicle density.

The system uses YOLOv8 object detection algorithm to detect and count vehicles such as cars, buses, trucks, and motorcycles in real time. Based on the count, traffic density is classified and optimal green signal duration is calculated. A separate CNN model is also used to detect emergency vehicles and provide them immediate priority. This approach not only reduces congestion and waiting time but also makes cities smarter and more eco-friendly.

The implementation of such a system is essential for developing smart cities and improving the overall quality of urban transportation.

## RELATED WORK

Several researchers have worked on traffic management systems using different technologies.

Traditional traffic control systems rely on fixed-time signals and indictive loop sensors. However, the systems are not efficient during peak hours because they cannot adapt to changing traffic density.

In recent years, Computer Vision and Machine Learning have been widely used for intelligent traffic control. Zhang et AI. Proposed a system using background subtraction and blob detection for vehicle counting, but it had low accuracy during night and rainy conditions. With the development of deep learning, object detection algorithms like YOLO, SSD, and Faster R-CNN became popular. Redmon et AI. Introduced YOLO which provides real-time object detection with high accuracy. Many studies have used YOLOv3 and YOLOv4 for vehicle detection and traffic density estimation. However, most of these systems only focus on counting vehicles and do not adjust signal timings dynamically.

Some researchers also proposed systems for emergency vehicles detection using audio

sensors and RFID. But this methods require extra hardware installation in every vehicle which is not cost effective.

Future enhancements of this system include integration with IoT sensors for better data accuracy, cloud-based monitoring for traffic police, and prediction of traffic patterns using deep learning. This will help city planners to take proactive decisions and reduce congestion before it occurs. The system is cost-effective and can be deployed on existing CCTV infrastructure, making it suitable for implementation in developing smart cities across the country.

## LITERATURE SURVEY

Artificial Intelligence (AI) has become an important technology for improving traffic management in smart cities. Several research papers have proposed AI-based systems to reduce traffic congestion, improve road safety, and optimize traffic signal control. Traditional traffic management systems use fixed signal timings, which cannot efficiently handle changing traffic conditions. Researchers have introduced machine learning and computer vision techniques to overcome these limitations.

Many studies use CCTV cameras and object detection algorithms such as YOLO to identify vehicles and estimate traffic density in real time. Deep learning models are also used to classify different types of vehicles and monitor traffic flow accurately. Some research combines AI with Internet of Things (IoT) sensors to collect live traffic data and automatically adjust signal timings based on vehicle density. Other studies focus on emergency vehicle prioritization, allowing ambulances and fire engines to pass through intersections quickly by changing traffic signals automatically.

The reviewed research shows that AI-based traffic management systems provide better accuracy, reduce travel time, decrease fuel consumption, and minimize traffic congestion compared to traditional methods.

## EXISTING METHOD

Traditional traffic management systems mainly use fixed-time traffic signals that operate according to predefined schedules without considering real-time traffic conditions. These systems cannot adapt to sudden increases in vehicle density, resulting in unnecessary delays and traffic congestion. Some existing methods use basic sensors such as inductive loop detectors or infrared sensors to detect vehicle presence. However, these sensors provide limited information and require frequent maintenance, making them costly to operate.

Many current traffic systems also depend on manual monitoring by traffic police or operators, which is time-consuming and prone to human error. They are unable to prioritize emergency vehicles such as ambulances or fire engines during heavy traffic. In addition, existing systems often lack the ability to live traffic data and make intelligent decisions automatically.

Due to these limitations, traffic congestion, fuel consumption, travel time, and air pollution continue to increase in urban areas. The lack of real-time decision-making and intelligent traffic control reduces the overall efficiency of transportation. These disadvantages highlight the need for an AI-based traffic management system that can monitor traffic continuously, vehicle density, and dynamically control traffic signals for better road management.

## PROPOSED METHOD

The proposed AI Traffic Management System is designed to overcome the limitations of designed to overcome the limitations of traditional traffic control systems by using Artificial Intelligence, Computer Vision, and real-time traffic analysis. The system utilizes CCTV cameras to continuously monitoring traffic at road intersections. The captured video is processed using AI based vehicle detection algorithms to identify and count the number of vehicles in each lane.

Based on the traffic density, the system automatically adjusts the traffic signal timing. Roads with higher vehicle density receive longer green signal durations, while roads with lower traffic receive shorter durations. The dynamic signal control helps reduce congestion, waiting time, and fuel consumption. The proposed system can also detect emergency vehicles such as ambulances and fire engines and provide them with priority by changing the traffic signals automatically. In addition, the system stores traffic data for the future analysis and traffic pattern prediction. This information can help traffic authorities make better decisions regarding road planning and traffic management. Comparing to existing methods, the proposed system is more efficient, accurate, and cost-effective. It minimizes human intervention, improves traffic flow, reduces travel time, and enhances road safety. Therefore, the AI Traffic Management System provides a smart solution for managing traffic in modern cities and supports the development of intelligent transportation system.

### SYSTEM ARCHITECTURE

The proposed AI Traffic Management System is designed to monitor and control

traffic efficiently using Artificial intelligence and Computer Vision. The system starts by capturing live traffic video through CCTV cameras installed at road intersections. The captured video is sent to the image preprocessing module, where the frames are enhanced and prepared for analysis.

Next, the AI-based vehicle detection module identifies and counts vehicles using a machine learning model such as YOLO. The traffic density analysis module calculates the number of vehicles in each lane and determine the congestion level. Based on this analysis the smart signal control module automatically adjust the traffic signal timings to reduce waiting time and improve traffic flow.

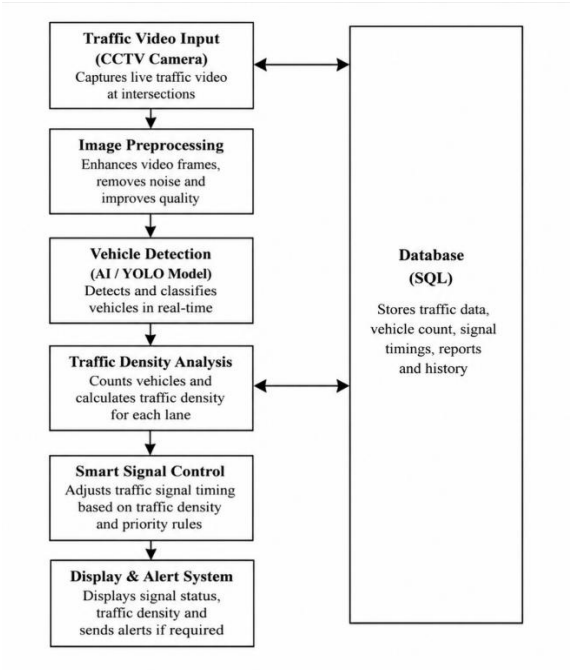


**Fig 1: System Architecture**

## METHODLOGY DESCRIPTION

1. **Traffic Video Input**

   The system begins by capturing live traffic video using CCTV cameras installed a road intersection. These cameras continuously monitor vehicles moment and send real time video frames to the system for further processing and analysis.

2. **Image preprocessing**

   The captured video frames are pre processed to improve image quality by removing noise, adjusting brightness and enhance clarity. This step helps the AI model detect vehicles more accurately and different lighting and weather conditions.

3. **Vehicle Detection**

   The pre processed images are used an AI-based object detection model such as YOLO.

   The model detects different types of vehicles, including cars, buses, trucks, and motorcycles, and counts them in real time.

4. **Traffic Density Analysis**

   The detected vehicle data is used to calculate traffic density in each lane. The system identifies traffic congestion levels and determines which road requires a longer green signal to improve traffic flow.

5. **smart signal control**

Based on the traffic density analysis, the system automatically adjust the traffic signal timings. Roads with higher traffic receive longer green signals, while roads with lower traffic receive shorter green signals, reducing waiting time congestion.

## RESULTS AND DECISION

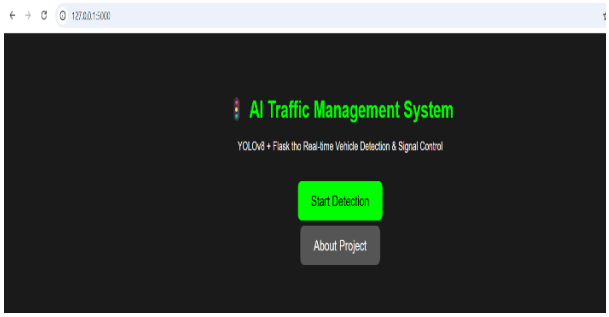


**Fig 2: Home page of AI Based Traffic Management System**

The home page the AI Traffic Management System developed using Flask and YOLOv8. The interface provides two options : Start Detection and About Project

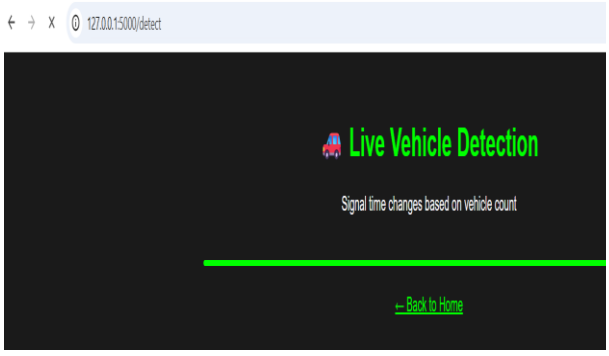


**Fig 3: Live Vehicle Detection**

The Live Vehicle Detection page of the AI Traffic Management System. After clicking Start Detection, the system uses the YOLOv8 model to detect and count vehicles in real time.

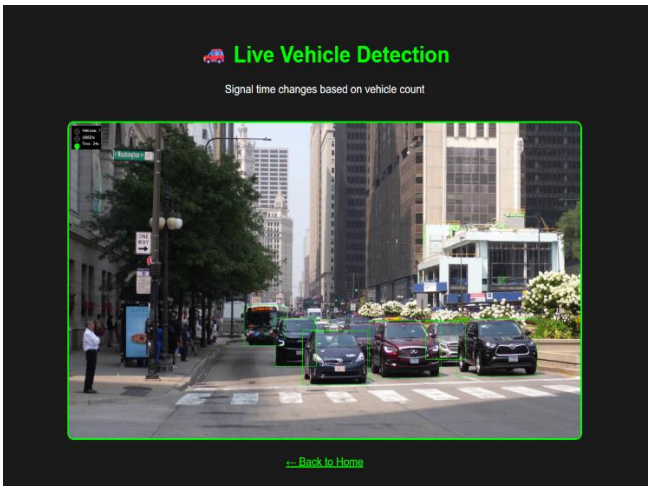


**Fig 4: Green Signal for High Traffic Density**

The system counts the number of vehicles on the road and analyses the traffic density. Since the traffic density is high the traffic signal is turned green to allow vehicles to pass smoothly.

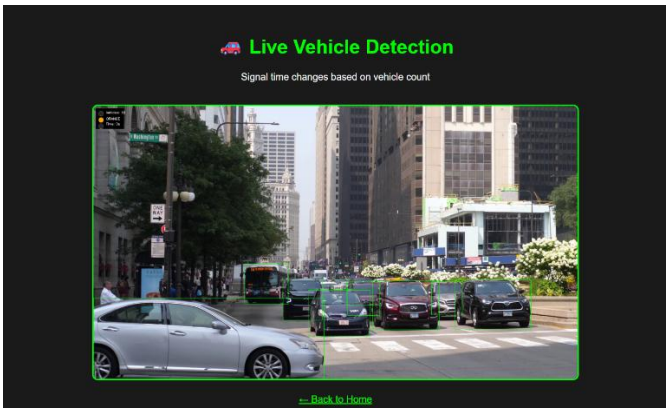


**Fig 5: Orange Signal for Moderate Traffic Density**

The AI Traffic Management System displaying an orange traffic signal. The system uses the YOLOv8 model to detect and count vehicles in real time.

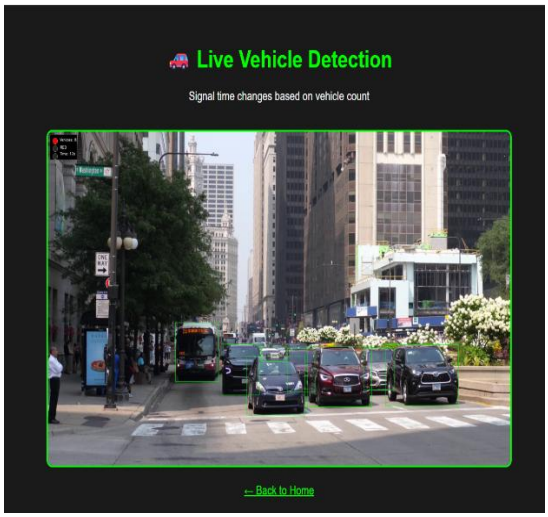


**Fig 6: Red Signal For Low Traffic priority**

Based on the traffic density analysis, the signal changes to red, indicating the vehicles on the current road must stop while traffic from the another direction is allowed to move.

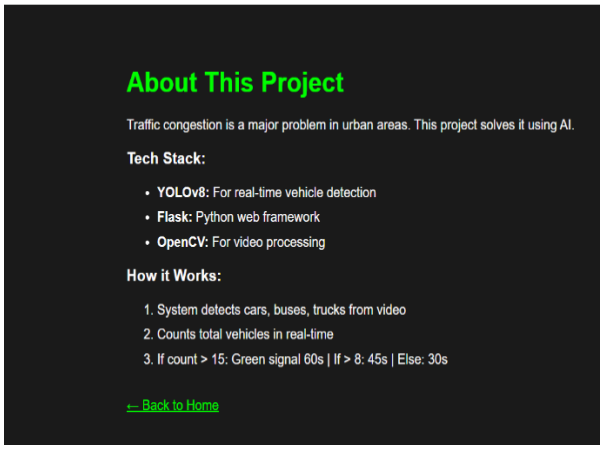


**Fig 7: About Project Page**

The About Project page of the AI Traffic Management System. It provides a brief overview of the project, explaining that the system uses Artificial Intelligence to reduce traffic congestion in urban areas.

## CONCLUSION

The AI Traffic Management System is an efficient and intelligent solution for reducing traffic congestion using Artificial Intelligence. The system uses YOLOv8, OpenCV, and Flask to detect and count vehicles in real time through CCTV video. Based on the traffic density, it automatically adjusts traffic signal timings, reducing waiting time and improving traffic flow. The system also minimizes the fuel consumption, travel time, and air pollution while enhancing road safety. Compared to traditional fixed-time traffic signals, this AI-based approach provides better accuracy, faster decision-making, and improved traffic management. Overall, the project demonstrate a smart, reliable, and cost-effective solution for modern urban transportation systems.

## FUTURE SCOPE

The AI Traffic Management System can be enhanced by integrating internet of things sensors and 5G communication for faster real-time traffic monitoring. Future version can prioritize emergency vehicles such as ambulances and fire engines automatically. The system can also be expanded to detect traffic rule violations, accidents, and parking availability using advanced AI models

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