# SMART TRAFFIC MANAGEMENT SYSTEM

**19EEE381 – Open Lab**

**Report**

*Submitted by*


| Roll Nos. | Student Names |
|---|---|
| CB.EN.U4ELC22017 | SUBA KEERTHANA |
| CB.EN.U4ELC22025 | LAKHSYA P |
| CB.EN.U4ELC22028 | MITHILESHWARAN |
| CB.EN.U4ELC22037 | NIVETHA GK |

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
AMRITA SCHOOL OF ENGINEERING,
AMRITA VISHWA VIDYAPEETHAM,
COIMBATORE - 641112


MARCH,2024

# Amrita School of Engineering

# Department of Electrical and Electronics Engineering

**Program Educational Objectives (PEOs)**

**PEO1:**Graduate can demonstrate electrical and electronics engineering problem solving skill along with proficiency in communication and professional excellence in project management and execution.

**PEO2:**Graduate can be employable in engineering services including ICT enabled sectors and also motivated for entrepreneurship.

**PEO3:**Graduate will be competent for higher studies in world class universities and research in industrial organizations.

**PEO4:**Graduate will manifest social commitment, environmental awareness and moral and ethical values in professional and other discourses.

**Program Specific Outcomes (PSOs)**

**PSO1:** Build and manage electro dynamic systems using Knowledge on electrical technology and semiconductor devices for allied services.

**PSO2:** Use computational tools and network dynamics for design, analysis and control of power systems integrated with renewable energy and Electric Vehicle.

**PSO3:** Leverage digital technologies employing state-of- the art control techniques and embedded controllers for industrial applications.

AMRITA VISHWA VIDYAPEETHAM
DEEMED TO BE UNIVERSITY

**BONAFIDE CERTIFICATE**

This is to certify that the open lab project report entitled **"Smart traffic Management System",** submitted by

| Roll Nos. | Student Names |
|---|---|
| CB.EN.U4ELC22017 | SUBA KEERTHANA |
| CB.EN.U4ELC22025 | LAKHSYA P |
| CB.EN.U4ELC22028 | MITHILESHWARAN |
| CB.EN.U4ELC22037 | NIVETHA GK |

is in partial fulfillment of the requirements for the award of the **Degree of Bachelor of Technology** in **"Electrical and Electronics Engineering"** is a bonafide record of the work carried out at Amrita School of Engineering, Coimbatore.

Internal Examiner External Examiner

# CONTENTS

# ABSTRACT

Traffic congestion and delay at urban intersections result in increased travel times, increased fuel usage, and safety issues. Conventional traffic light systems are based on fixed timings, which do not respond to real-time traffic conditions, resulting in inefficiencies. This project seeks to design a smart traffic management system with Raspberry Pi and YOLOv8-based image processing. The system has the capability of dynamically controlling signal timings with reference to traffic volumes, can recognize emergency vehicles in order to instantly clear the road, and let pedestrians add to red light phase for pedestrian clearance. Client-server architecture is implemented, and a Raspberry Pi plays the role of a server and a laptop takes the role of a client in real-time processing of images. This process optimizes free flowing traffic, lowers congestion, and enhances safety of roads. The project will also seek to minimize car idling time, hence reducing the amount of fuel consumed and less pollution within cities.

# INTRODUCTION

With urbanization at a fast pace, traffic congestion has become a particular problem. Conventional traffic lights have fixed timing and therefore suffer from inefficiency in managing dynamic traffic. Traffic congestion in intersections does not only result in delays but also higher fuel consumption and emissions, which further contribute to environmental issues. Emergency vehicles tend to get bogged down in heavy traffic, further increasing response time. Pedestrians too encounter difficulties in crossing roads safely, particularly in heavy-traffic areas.

The absence of real-time traffic monitoring and adaptive control systems in traditional systems results in unnecessary delays and inefficiencies. Most intersections have long waiting times even when the road is not congested, while others continue to be clogged due to inefficient distribution of signals. Moreover, traffic offenses such as jumping lights further disorganize traffic flow, resulting in dangerous road conditions. Utilizing contemporary technologies like AI-based image processing, real-time traffic detection, and adaptive control, this project seeks to enhance road safety and maximize traffic efficiency.

This project resolves these inefficiencies through the utilization of AI-based image processing and real-time detection approaches. The system optimizes traffic management by:

With growing population and transportation, traffic management at junctions has proven to be a significant challenge. Conventional traffic lights work on predetermined timing schedules, which do not take real-time traffic situations into consideration. This usually causes unnecessary delays and wasteful traffic movement. Fire trucks and ambulances also experience difficulty in crossing overcrowded intersections because the priority signals are unavailable. Pedestrians also experience short crossing times, resulting in unsafe conditions.

This project addresses these inefficiencies by leveraging AI-based image processing and real-time detection methods. The system enhances traffic management by:

- Adjusting signal duration based on vehicle density using YOLOv8.
- Detecting emergency vehicles and granting immediate green signal priority.
- Implementing pedestrian button control for safer crossings.
- Utilizing a client-server communication model for efficient processing and real-time decision-making.

# PROBLEM STATEMENT

Conventional traffic management systems do not account for dynamic traffic density and emergency scenarios, leading to:

1. **Inefficient Traffic Flow** – Fixed signal timings cause unnecessary delays, leading to increased congestion in high-traffic areas while other lanes with fewer vehicles remain underutilized.
2. **Delayed Emergency Response** – Emergency vehicles such as ambulances and fire trucks often get stuck in traffic, wasting critical time in life-threatening situations.
3. **Unsafe Pedestrian Crossings** – Pedestrians struggle to cross due to short signal durations, increasing the risk of accidents.
4. **Environmental Impact** – Excessive idling of vehicles due to poor traffic management results in unnecessary fuel consumption and increased CO2 emissions.

This project aims to develop a real-time adaptive traffic light system to optimize signal control and improve road safety using AI-driven image processing and intelligent decision-makin

# METHODOLOGY

The implementation follows a structured approach integrating hardware and software components to create an efficient and intelligent traffic management system.

## *1. Traffic Density-Based Signal Control*

- Capturing real-time footage using a webcam positioned at an intersection.
- Using YOLOv8 to detect and count vehicles in each lane.
- Categorizing traffic density into three levels: **Low (0-4 vehicles), Medium (5-14 vehicles), and High (15+ vehicles).**

- Adjusting green signal duration dynamically based on the detected density to optimize traffic flow.
- **Comparison with Traditional Systems:** Traditional systems use a static time allocation, leading to inefficiencies, whereas our AI-driven system ensures optimal signal timing based on real-time demand.

### *2. Emergency Vehicle Detection*

- Detecting flashing red and blue siren lights in live camera feeds using image processing techniques.
- Utilizing HSV color space filtering to identify emergency lights.
- Granting immediate green signal clearance when an emergency vehicle is detected to allow faster passage.
- **Benefits:** Faster emergency response times, reduced congestion, and improved road safety.

### *3. Pedestrian Button Control*

- A pedestrian push-button is installed at intersections.
- When pressed, it signals the system to extend the red light duration at the next cycle to provide sufficient crossing time.
- The signal timing is modified dynamically without interrupting the ongoing traffic cycle, ensuring smooth flow.
- **Real-World Implementation:** Similar systems are used in smart cities globally, reducing pedestrian accidents significantly.

### *4. Client-Server Communication*

- Raspberry Pi acts as a WebSocket server, processing real-time data and controlling traffic lights via GPIO.
- The laptop runs YOLOv8 and acts as a client, analyzing video feeds and sending control signals to the server.
- This architecture ensures efficient processing and a quick response time for real-time traffic management.

## RESULTS

The system was successfully tested in a simulated environment and demonstrated:

- **Dynamic Traffic Control:** Signal durations were adjusted efficiently based on real-time vehicle detection, optimizing traffic flow.
- **Emergency Vehicle Clearance:** The system promptly detected flashing sirens and granted priority access, reducing emergency response delays.
- **Pedestrian Safety:** The push-button control effectively extended crossing times without disrupting normal traffic patterns.
- **Efficient Communication:** The WebSocket-based client-server model enabled seamless real-time updates between the Raspberry Pi and the laptop.

- **Reduction in CO2 Emissions:** The optimized signal control led to reduced idling times, lowering vehicle emissions.

### Implementation Challenges and Solutions

1. **Hardware Limitations:** Raspberry Pi has limited processing power. **Solution:** Offloading AI processing to a laptop.
2. **Low-Light Detection Issues:** Nighttime detection accuracy was lower. **Solution:** Using infrared-enhanced cameras and improving image preprocessing.
3. **Traffic Flow Variability:** Variability in traffic patterns could cause fluctuations in detection accuracy. **Solution:** Implementing real-time learning models to adapt to traffic flow changes.

## CONCLUSIONS & FUTURE WORK

This project successfully demonstrates an AI-driven smart traffic management system, significantly improving traffic efficiency and road safety. The combination of YOLOv8 object detection, Raspberry Pi-based control, and real-time decision-making creates an effective solution for modern traffic management.

Future enhancements may include:

- **IoT Integration:** Adding cloud-based monitoring and remote traffic management through IoT connectivity.
- **Enhanced AI Models:** Implementing advanced deep learning models for higher detection accuracy, including distinguishing between different types of vehicles.
- **Multi-Intersection Coordination:** Expanding the system to synchronize traffic signals across multiple intersections for city-wide optimization.
- **Vehicle-to-Infrastructure (V2I) Communication:** Enabling direct communication between vehicles and traffic lights for intelligent traffic flow adjustments.
- **Machine Learning Optimization:** Using real-time feedback loops to improve signal timing dynamically based on traffic trends.

By integrating these advancements, the system can further enhance urban mobility, reduce congestion, and improve overall transportation efficiency.

## REFERENCES


[1] Zulkifli, A.R., Ali, K., Abd Rahman, Z. (2022). Raspberry Pi Based Intelligent Traffic Signal Control at Intersections. In: Wahab, N.A., Mohamed, Z. (eds) Control, Instrumentation and Mechatronics: Theory and Practice. Lecture Notes in Electrical Engineering, vol 921. Springer, Singapore

[2] V. Venkatesh, P. Raj, et al., "An intelligent traffic management system based on the Internet of Things for detecting rule violations," 2023 Int. Conf. ACCAI, DOI: 10.1109/ACCAI58221.2023.10199293.

[3] A. Pavani, P. Krishna Priya, et al., "The use of image analysis for IoT-based smart traffic density management," 2023 Int. Conf. ICACITE, DOI: 10.1109/ICACITE57410.2023.10182734.

[4] C. Dema, Y. Wangchuk, et al., "Traffic control system using AI camera and time-of-flight sensor," 2024 Int. Conf. INCOS, DOI: 10.1109/INCOS59338.2024.10527746.

[5] E. Basil and S. D. Sawant, "IoT based traffic light control system using Raspberry Pi," *2017 International Conference on Energy, Communication, Data Analytics and Soft Computing (ICECDS)*, Chennai, India, 2017, pp. 1078-1081

[6] S. Riyazhussain, Riyazhussain, C. R. S. Lokesh, P. Vamsikrishna and G. Rohan, "Raspberry Pi controlled Traffic Density monitoring system," *2016 International Conference on Wireless Communications, Signal Processing and Networking (WiSPNET)*, Chennai, India, 2016, pp. 1178-1181

[7] Omar, M., Yakub, F., Niranjana, G., Azizan, A., Liana, F., Suseela, G. (2025). A Novel Intelligent Traffic Control System for Identifying Traffic Congestion and Emergency Vehicle Detection in Malaysia. In: Venkataraman, R., Marudappan, P., Rajasekharan Indra, M. (eds) Internet of Things. ICIoT 2023. Communications in Computer and Information Science, vol 1971. Springer, Cham.

[8] Wágner, T., Tettamanti, T., Varga, B., Varga, I. (2024). PLC-Based Traffic Light Control for Flexible Testing of Automated Mobility. In: Yang, XS., Sherratt, S., Dey, N., Joshi, A. (eds) Proceedings of Ninth International Congress on Information and Communication Technology. ICICT 2024 2024. Lecture Notes in Networks and Systems, vol 1011. Springer, Singapore.

[9] M. L. Suarez *et al*., "Dynamic allocation of traffic light plans as a traffic reduction strategy," *MOVICI-MOYCOT 2018: Joint Conference for Urban Mobility in the Smart City*, Medellin, 2018

[10] D. Dzhibarov and I. Grigorov, "Road traffic modelling and development of a specific traffic light control system," *2021 International Conference Automatics and Informatics (ICAI)*, Varna, Bulgaria, 2021, pp. 382-384,