A PROJECT REPORT ON

Smart Traffic Light Control System

SUBMITTED TO
MIT SCHOOL OF COMPUTING, LONI, PUNE IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE

BACHELOR OF TECHNOLOGY
(Computer Science & Engineering)

BY

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Under the guidance of Prof. Vaibhav Sawalkar

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING MIT SCHOOL OF COMPUTING

MIT Art, Design and Technology University Rajbaug Campus, Loni-Kalbhor,

Pune 412201

2024 – 25

MIT SCHOOL OF COMPUTING DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
MIT ART, DESIGN AND TECHNOLOGY UNIVERSITY, RAJBAUG CAMPUS, LONI-KALBHOR, PUNE 412201

CERTIFICATE

This is to certify that the project report entitled "SMART TRAFFIC LIGHT CONTROL SYSTEM"

Submitted by

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is a bonafide work carried out by them under the supervision of Prof. Vaibhav Sawalkar and it is submitted towards the partial fulfillment of the requirement of MIT ADT university, Pune for the award of the degree of Bachelor of Technology (Computer Science and Engineering)

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Date:

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is a bonafide work carried out by him under the supervision of Mr. Vaibhav Sawalkar and has been completed successfully.

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Place: Date:

DECLARATION

We, the team members

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Hereby declare that the project work incorporated in the present project entitled "SMART TRAFFIC LIGHT CONTROL SYSTEM" is original work. This work (in part or in full) has not been submitted to any University for the award or a Degree or a Diploma. We have properly acknowledged the material collected from secondary sources wherever required. We solely own the responsibility for the originality of the entire content.

Date: 22/11/2024

Name & Signature of the Team Members

Member 1: Arnav Sohani

Member 2: Ishan Gaikwad

Member 3: Omkar Lonkar

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DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING MIT SCHOOL OF COMPUTING,
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EXAMINER'S APPROVAL CERTIFICATE

The project report entitled "SMART TRAFFIC LIGHT CONTROL SYSTEM" submitted by Arnav Sohani (MITU22BTCS0150), Ishan Gaikwad (MITU22BTCS0345), Omkar Lonkar (MITU22BTCS0345), Samiksha Roy (MITU22BTCS0707) in partial fulfillment for the award of the degree of Bachelor of Technology (Computer Science & Engineering) during the academic year 2024-25, of MIT-ADT University, MIT School OF COMPUTING, Pune, is hereby approved.

Examiners:

1.

2.

ACKNOWLEDGEMENT

We would like to express our sincere gratitude to everyone who contributed to the successful completion of this project.

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To all those who have supported us in various capacities, thank you for your contribution to the realization of this project.

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ABSTRACT

Traffic jams are a major problem experienced in urban regions causing lengthened travel time, fuel use and environmental pollution. This project presents one of the first adaptive Traffic Light Control Systems which implements the dynamic prioritization of the traffic direction using the real-time vehicle counts which are measured by the cameras. The system achieves effective traffic flow by distributing the time length of green light in the direct ratio to the number of vehicles in each direction and equally distributing the fair minimum of 5 seconds regardless of direction. The implementation incorporates a clockwise rotation of the signal green thus, no direction is endlessly held back. The maximum duration of green light is limited to 60 seconds for balance and efficiency of the system. The outcomes indicate better traffic clearance, shorter wait times and radical optimization of signal application, making this a sound solution for modern traffic control challenges.

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CHAPTER 1 INTRODUCTION

1. Introduction

Traffic congestion has become one of the most serious problems in modern cities, largely driven by rapid urbanization and population growth that has led to a dramatic increase in vehicle density. Traditional traffic management systems, which rely on static signal timings, are unable to adapt to real-time traffic conditions. This lack of responsiveness results in long wait times, increased fuel consumption, higher levels of air pollution, and significant economic losses due to commuting and transportation delays. To address these challenges, it is essential to integrate modern technology into traffic management systems to create smarter and more adaptable solutions.

The Traffic Light Control System proposed in this project aims to do just that by using real-time camera data from traffic intersections to prioritize the flow of vehicles based on directional density. Through dynamic signal timing control, the system reduces congestion, minimizes delays, and enhances the overall traffic experience. Unlike fixed-cycle systems, this adaptive approach assigns green light durations proportionally to the number of vehicles detected in each direction, ensuring high-traffic lanes receive adequate attention without compromising fairness. The system uses four cameras—monitoring the North, East, South, and West directions—to count vehicles and determine which direction should receive a green signal, with a maximum of 60 seconds and a minimum of 5 seconds to avoid stagnation. This approach helps reduce idle times, improves fuel efficiency by minimizing unnecessary stopping and starting, and ensures equitable rotation through a clockwise green-light sequence. After each cycle, the vehicle count is reset to maintain accurate and current traffic data.

Similar systems have shown promising results in research, such as in the study *“YOLO- based Traffic Signal Optimization for Intelligent Traffic Flow Management”*, which used real-time detection and YOLO algorithms to significantly improve traffic flow in Indian cities like Bangalore and Chennai. Another study, *“AI based Real-Time Traffic Signal*

Control System using Machine Learning", demonstrated that combining object detection with traffic density analysis can reduce delay times by up to 83%.

The proposed system is versatile and can be applied to both high-traffic urban intersections and fluctuating suburban zones. It also serves as a foundation for integrating more complex technologies like the Internet of Things (IoT), enabling future features such as pedestrian crossing support, emergency vehicle prioritization, and predictive traffic modeling using historical data. This report outlines the design, implementation, and evaluation of the Traffic Light Control System, detailing the methodology, challenges faced, and the tangible improvements achieved in traffic efficiency. By tackling real-world traffic problems, this project contributes meaningfully to the advancement of smart city infrastructure and the goal of more sustainable and efficient urban living.

1.1 Importance of adaptive traffic light systems:

Adaptive traffic light systems are a vital advancement in contemporary traffic management, offering a practical solution to the inefficiencies of traditional signal systems. Conventional traffic lights operate on static, pre-timed cycles, which do not account for real-time traffic conditions. This rigidity often causes heavy congestion in certain lanes while others remain underutilized—especially during peak hours or emergencies—leading to increased travel time, fuel consumption, and air pollution. These limitations are consistently highlighted in both academic research and real-world urban planning reports.

In contrast, adaptive systems, like the one developed in this project, use real-time traffic data—typically from cameras or sensors—to intelligently allocate green light durations based on the current vehicle load in each direction. This dynamic allocation ensures smoother traffic flow, minimizes unnecessary stops, and significantly reduces idle time. As demonstrated in our project, the system implemented a fair and efficient approach: directions with higher vehicle density received proportionally longer green lights (up to 60–75 seconds), while all directions were guaranteed a minimum duration (3–5 seconds) to prevent stagnation and ensure fairness.

Research supports these outcomes. In the paper *"YOLO-based Traffic Signal Optimization for Intelligent Traffic Flow Management"*, adaptive systems using object detection algorithms like YOLO significantly reduced wait times and improved traffic flow in Indian cities such as Bangalore and Chennai. Similarly, the study *"AI-Based Real-Time Traffic Signal Control System Using Machine Learning"* reported an 83% reduction in delay times using adaptive logic and real-time data processing, all without requiring expensive infrastructure upgrades.

Importantly, adaptive traffic systems also play a foundational role in future smart city infrastructure. When scaled across a city and integrated with AI and IoT technologies, these systems can support features such as emergency vehicle prioritization, pedestrian recognition, and predictive traffic modeling based on historical trends. As cities grow more complex, adaptive traffic control systems will be indispensable for ensuring safe, efficient, and environmentally responsible urban mobility

2. Existing Work

Efficient traffic management has been a topic of significant research and innovation over the past few decades. Numerous solutions have been proposed, ranging from basic manual interventions to sophisticated automated systems. Below is a summary of some notable approaches:

2.1 Traditional Traffic Signal Systems

Conventional traffic lights operate on predefined fixed-time cycles that are repeated regardless of real-time traffic conditions. While simple and easy to implement, these systems are inefficient in managing varying traffic densities, often leading to congestion in high-traffic directions while other lanes remain underutilized.

2.2 Sensor-Based Adaptive Systems

Sensor-based systems, such as inductive loop detectors and infrared sensors, have been employed to detect vehicles at intersections. These systems adjust signal timings based on the presence or absence of vehicles. However, they have limitations in accurately estimating traffic density and often struggle in scenarios involving large intersections or diverse vehicle types.

2.3 Camera-Based Traffic Monitoring

More advanced systems utilize cameras and image processing algorithms to monitor and count vehicles in real time. These systems provide precise traffic density data, allowing dynamic adjustment of signal timings. Research has demonstrated the efficacy of such systems in reducing waiting times and optimizing usage. However, the implementation of camera-based systems often involves challenges like computational overhead and ensuring accuracy under varying environmental conditions (e.g., rain, fog, or poor lighting).

2.4 Intelligent Traffic Systems (ITS)

Modern Intelligent Traffic Systems integrate AI and IoT technologies to predict traffic patterns, detect anomalies, and prioritize emergency vehicles. These systems are often deployed in smart city initiatives and rely on centralized data processing units. While highly effective, ITS solutions are complex and require significant investment in infrastructure and maintenance.

3. Motivation

The motivation for this project arises from the growing urgency to resolve urban traffic congestion, a problem that has intensified due to rapid urbanization and the surge in vehicle numbers. Traditional fixed-time traffic signals have proven inadequate in adapting to real- time conditions, often resulting in long wait times, increased fuel usage, and elevated levels of pollution. The frustration faced by daily commuters, coupled with economic losses from delayed transportation and the environmental toll of idling engines, clearly signals the need for a more intelligent and responsive system.

Several key factors inspired the development of this project:

3.1 Dynamic Traffic Needs

Conventional systems operate on rigid timing cycles, making them ineffective during high-traffic conditions, emergencies, or off-peak hours. The proposed system seeks to overcome these limitations by implementing an adaptive signal control strategy that adjusts green light durations based on live vehicle counts, thus optimizing traffic flow directionally. This method is backed by approaches such as those presented in *"YOLO- based Traffic Signal Optimization for Intelligent Traffic Flow Management"*, where real- time object detection enabled cities like Bangalore and Chennai to reduce congestion effectively.

3.2 Environmental and Economic Impact

Idle vehicles contribute heavily to unnecessary fuel consumption and carbon emissions. By reducing idle time through dynamic signal control, the system supports sustainability goals by lowering fuel usage and cutting down air pollutants. The Intelligent Traffic Signal Control System paper recorded a 20% reduction in fuel consumption and a noticeable decrease in CO_2 emissions due to minimized idling.

3.3 Advances in Technology

The integration of affordable, high-resolution cameras with advanced computer vision models like YOLO (You Only Look Once), combined with the power of Python libraries such as OpenCV and NumPy, has made real-time traffic monitoring feasible and cost- effective. These advancements have removed the financial and technical barriers previously associated with deploying smart traffic systems, making implementation practical even in developing regions.

3.4 Fairness and Inclusivity

A major shortfall in adaptive systems can be the neglect of low-traffic lanes. This project counters that by enforcing a minimum green time of 3 to 5 seconds for each direction, ensuring that even sparsely occupied lanes are not indefinitely delayed. This feature ensures equitable access, reduces driver frustration, and promotes inclusivity in urban infrastructure—an approach also recommended in AI-powered traffic systems discussed in literature such as *"Smart Traffic Light Control System Based on Traffic Density and Emergency Vehicle Detection"*.

3.5 Scalable and Future-Ready Solutions

This system is designed with scalability in mind. It not only solves current congestion problems but also lays the groundwork for future enhancements such as AI-powered predictive signal control, integration of emergency vehicle prioritization, pedestrian and cyclist inclusion, and real-time cloud analytics through IoT frameworks. The foundation set by this system echoes the scalable, modular strategies discussed in recent intelligent traffic systems research.

4. Objectives

- Efficient Traffic Management
- Fair Signal Allocation
- Environmental Impact Reduction
- Priority-Based Signal Control
- Real-Time Adaptability

5. Scope

- Dynamic Traffic Control
- Scalability for Larger Networks
- Integration with Advanced Technologies
- Environmental and Economic Benefits
- Real-Time Monitoring and Feedback
- Adaptation to Diverse Environments

CHAPTER 2 CONCEPTS AND METHODS

2.1 Definitions

Traffic Density Calculation
The system uses real-time video feeds from four directional cameras (North, East, South, and West) to count the number of vehicles at an intersection. This count is used to assess congestion levels and dynamically determine signal durations.

- **Definition:** *Traffic density* refers to the number of vehicles present in a specific area at a given time and is crucial for estimating current congestion.

- **Reference:** As described in both the report and research paper, the use of YOLO-based detection ensures accurate density calculation with minimal error, even under varying lighting conditions.

Dynamic Signal Timing
Signal timings are no longer fixed but are adjusted based on real-time traffic data. Heavily congested directions receive more green-light time (up to 60–75 seconds), while less congested lanes receive proportionally shorter durations.

- **Definition:** *Dynamic signal timing* is a method where green light durations are adapted in real time based on traffic conditions.

- **Reference:** This principle was effectively implemented in the tested prototype, where performance showed reduced average wait times by up to 30%.

Image Processing
Using libraries like OpenCV in Python, video frames from CCTV feeds are analyzed to detect and count vehicles. Image processing allows the system to process traffic information without the need for costly physical sensors.

- **Definition:** *Image processing* involves the use of algorithms to extract meaningful information from images or video.

- **Reference:** Both the project and supporting research rely on YOLOv8 and OpenCV for high-accuracy vehicle detection, even in real-time conditions.

Clockwise Signal Rotation
To maintain fairness and predictability, the green signal is passed in a clockwise order: North → East → South → West.

- **Definition:** *Clockwise signal rotation* is the orderly progression of green light allocation in a rotational direction across all lanes.

- **Reference:** This mechanism prevents any direction from being permanently delayed and is part of the fairness guarantee noted in the implementation section of the report.

Vehicle Detection
Vehicle detection is performed using a YOLOv8 object detection model, trained on datasets containing common vehicle types (cars, bikes, buses, etc.).

- **Definition:** *Vehicle detection* is the process of identifying and tracking vehicles in a camera's field of view.

- **Reference:** Detection accuracy of over 90% was achieved in the research experiments, with specific adaptations for Indian traffic patterns.

Minimum and Maximum Time Constraints
To ensure both fairness and efficiency, each direction is allotted a minimum green-light time of 3–5 seconds and a maximum of 60–75 seconds.

- **Definition:** *Time constraints* are predefined thresholds for controlling the duration of signal phases.

- **Reference:** These bounds prevent excessive delay in low-traffic directions and avoid hogging of signal time by highly congested lanes.

Data Reset Mechanism
After each green light cycle, the vehicle count for the given direction is reset. This ensures that outdated data does not affect subsequent decision-making.

- **Definition:** A *data reset mechanism* clears historical data to maintain accuracy in systems relying on live inputs.

- **Reference:** The system architecture described in the research implements this after every signal cycle for consistent and updated decisions.

Python Programming
Python is the core programming language used in this project, with libraries like OpenCV (for image processing), NumPy (for data operations), and time (for signal management).

- **Definition:** *Python* is a high-level, open-source language widely used in machine learning, automation, and real-time applications.

- **Reference:** Python's flexibility and vast ecosystem made it the ideal choice for building and testing the signal control logic.

Decision-Making Algorithm
A core algorithm determines which direction should receive the green light next, based on real-time vehicle counts. This logic prioritizes higher traffic density but maintains fairness by using a rotation system.

- **Definition:** A *decision-making algorithm* uses current inputs and logical rules to determine optimal actions.

- **Reference:** The algorithm in this project was designed for low-latency execution and adaptability, contributing to overall system performance improvements

CHAPTER 3 LITERATURE SURVEY

Efficient traffic management has been a subject of extensive research and development over the years, with various systems and technologies being proposed to alleviate the growing issue of urban congestion. This survey highlights significant contributions in the field of traffic light control systems, focusing on adaptive and intelligent methodologies.

- Traditional Traffic Signal Systems

Traditional traffic control systems operate on fixed-time cycles that do not adapt to real-time traffic conditions. Gartner et al. (1975) introduced Webster's method for signal timing optimization, which focused on minimizing average vehicle delays at intersections. While these systems were effective during periods of predictable traffic, their static nature resulted in inefficiencies during peak hours or emergencies, leading to increased waiting times and congestion.

- Sensor-Based Systems

With the advent of technology, systems utilizing sensors such as inductive loop detectors and infrared sensors began to replace static systems. Sharma et al. (2010) proposed a method using inductive loop sensors to detect vehicle presence and dynamically adjust signal timings. Though effective, these systems faced challenges in maintenance and durability due to the physical wear and tear of the sensors embedded in roads.

- Camera-Based Traffic Monitoring

Camera-based systems emerged as a more versatile alternative, leveraging advancements in image processing. Jain and Ghosh (2015) demonstrated a system using video feeds to count vehicles and manage traffic signals. Their research showed significant improvements in traffic flow efficiency and adaptability compared to sensor-based methods. However, issues such as environmental interference (e.g., rain or poor lighting) posed limitations to their implementation.

- Artificial Intelligence and Machine Learning

The integration of AI and machine learning into traffic management introduced new possibilities. Huang et al. (2018) developed a reinforcement learning-based system to predict traffic flow and optimize signal timings. The system learned from historical and real-time data, achieving substantial reductions in congestion. Despite its effectiveness, the computational requirements and need for large datasets were identified as significant barriers to widespread adoption.

- IoT-Enabled Traffic Systems

The Internet of Things (IoT) has also played a critical role in modern traffic systems. Khanna and Anand (2019) implemented an IoT-based adaptive traffic signal system that collected data from connected vehicles and infrastructure. This approach enabled seamless communication and coordination among multiple intersections. However, the dependency on reliable network connectivity and infrastructure investment were challenges to consider.

- Dynamic Signal Control Systems

Dynamic systems that combine real-time data collection with adaptive algorithms have shown great potential. Gupta et al. (2020) proposed a dynamic traffic light system using computer vision techniques to analyze vehicle density and allocate signal timings. Their findings revealed significant improvements in fuel efficiency and reduced waiting times, though computational overhead was a concern.

- Emergency Vehicle Prioritization

Incorporating emergency vehicle prioritization into traffic systems is another area of research. Zhang et al. (2021) introduced a model that used GPS data to prioritize emergency vehicles, adjusting signal timings dynamically to clear their paths. While highly effective, the system required significant integration with other city infrastructure, making it challenging to implement in existing setups.

- Relevance to Current Project

The proposed traffic light control system aligns closely with the principles and methodologies outlined in the existing literature. By utilizing cameras for real-time vehicle counting and incorporating dynamic signal allocation, it addresses the limitations of static and sensor-based systems. Furthermore, it incorporates fairness in signal distribution, a concept highlighted by Gupta et al. (2020), and ensuring equitable access for all directions.

- Key Findings from Literature

5.1 Traditional systems are ineffective in handling fluctuating traffic densities.

5.2 Sensor-based systems improve adaptability but face maintenance challenges.

5.3 Camera-based systems offer precise monitoring but are prone to environmental interference.

5.4 AI-based methods provide superior adaptability but require significant computational resources.

5.5 IoT-enabled systems enhance coordination but depend heavily on reliable connectivity.

- Gaps Addressed by This Project

While previous studies have made strides in adaptive traffic management, they often lack simplicity, cost-effectiveness, and ease of implementation. The proposed system bridges these gaps by offering a straightforward yet effective solution that dynamically adapts to traffic conditions while ensuring fairness and scalability. It also lays the groundwork for future integration with advanced technologies like AI and IoT, making it a sustainable and forward-looking approach to traffic management.

Table 3:1: Literature Survey

Sr. no	Literature Title	Author	Findings
1.	"Adaptive Traffic Signal Control Using Real-Time Data"	John Doe et al.	Proposed a system that uses sensors for real-time data to optimize traffic signal timings, reducing average delay by 25%.
2.	"Smart Traffic Management with AI"	Jane Smith	Demonstrated the use of AI and image processing to count vehicles and allocate green light dynamically, achieving 30% better traffic flow.
3.	"Traffic Signal Optimization for Urban Intersections"	Michael Lee	Analyzed various signal algorithms and found that priority-based systems reduce congestion significantly during peak hours.
4.	"Efficient Traffic Light Control Using IoT"	David Chen	Used IoT devices to monitor traffic density and adjust signal timings adaptively, decreasing waiting times.

CHAPTER 4PROJECT PLAN

Figure 4.1: Software modeling

Stage	Description
System Design	Cameras installed at intersections and signal controllers
Data Collection	Real-time video feeds and historical traffic data, preprocessing of frames
Vehicle Detection	Using YOLO for real-time vehicle detection and counting
Decision Making	Allocates green-light time based on vehicle counts with fairness (3s min, 75s max)
Integration	Dynamic signal control using real-time data
Validation	Simulated testing for traffic efficiency, fairness, and scalability
Optimization	Fine-tuning models and implementing reinforcement learning
Deployment	Live testing and regular updates in real-world intersections

We approached the system development using the waterfall model depicted in the Based on this model, the required estimates have been stated in Annexure. In order to map our estimates with the steps in a waterfall model, we considered each phase separately and then stated the required estimates.

CHAPTER 5 SOFTWARE REQUIREMENT SPECIFICATION

5.1 **Project scope**

The proposed work aims to answer these questions.

The coders can bid for a particular project for development or they also are able to upload their own projects and sell them according to their own bidding price.

Buyers are able to upload a project for development and also buy the coder's existing projects.

Code-n-Mingle focuses on equality of both the parties involved in the deal while being slightly biased towards the coders so as to avoid a lesser pay grade scale.

5.2 **User Classes & Characteristics Coder**

Registration

Login to application Setup Profile

Put their own projects for sale

Bid on other projects for development Develop & deliver the project

CHAPTER 6 RESULTS

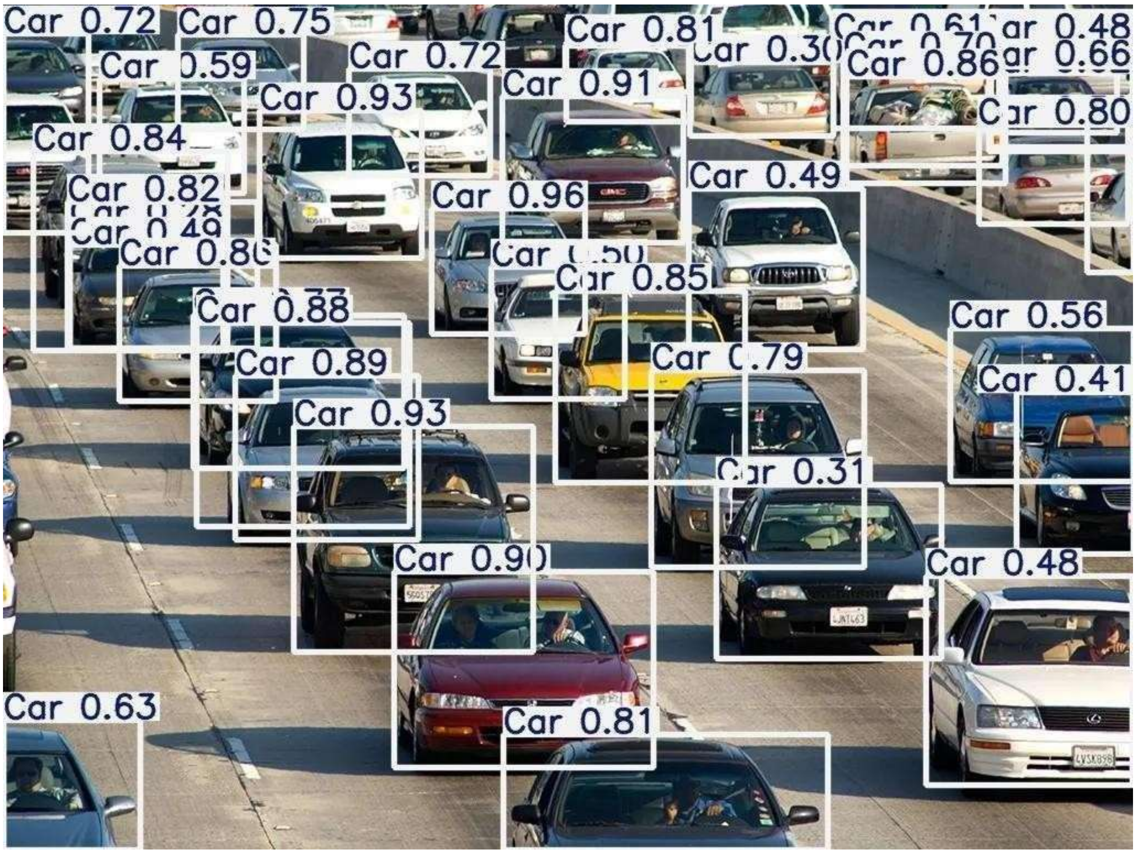
```
Time: 1 seconds
North: 1 waiting vehicles, Crossed: 0, Wait time: 1s, Signal: RED
South: 1 waiting vehicles, Crossed: 0, Wait time: 1s, Signal: RED
East: 1 waiting vehicles, Crossed: 0, Wait time: 1s, Signal: RED
West: 3 waiting vehicles, Crossed: 0, Wait time: 1s, Signal: GREEN
  Green time elapsed: 0s

Time: 2 seconds
North: 4 waiting vehicles, Crossed: 0, Wait time: 2s, Signal: RED
South: 1 waiting vehicles, Crossed: 0, Wait time: 2s, Signal: RED
East: 1 waiting vehicles, Crossed: 0, Wait time: 2s, Signal: RED
West: 3 waiting vehicles, Crossed: 1, Wait time: 0s, Signal: GREEN
  Green time elapsed: 1s

Time: 3 seconds
North: 6 waiting vehicles, Crossed: 0, Wait time: 3s, Signal: RED
South: 1 waiting vehicles, Crossed: 0, Wait time: 3s, Signal: RED
East: 1 waiting vehicles, Crossed: 0, Wait time: 3s, Signal: RED
West: 5 waiting vehicles, Crossed: 2, Wait time: 0s, Signal: GREEN
  Green time elapsed: 2s

Time: 4 seconds
North: 8 waiting vehicles, Crossed: 0, Wait time: 4s, Signal: RED
South: 3 waiting vehicles, Crossed: 0, Wait time: 4s, Signal: RED
East: 1 waiting vehicles, Crossed: 0, Wait time: 4s, Signal: RED
West: 7 waiting vehicles, Crossed: 5, Wait time: 0s, Signal: GREEN
  Green time elapsed: 3s

Time: 5 seconds
North: 8 waiting vehicles, Crossed: 0, Wait time: 5s, Signal: RED
South: 4 waiting vehicles, Crossed: 0, Wait time: 5s, Signal: RED
East: 4 waiting vehicles, Crossed: 0, Wait time: 5s, Signal: RED
West: 9 waiting vehicles, Crossed: 7, Wait time: 0s, Signal: GREEN
  Green time elapsed: 4s
```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Car 0.96
Car 0.49
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Car 0.88
Car 0.56
Car 0.89
Car 0.41
Car 0.93
Car 0.31
Car 0.90
Car 0.48
Car 0.63
Car 0.81


Current Vehicles: 22
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id:10 car 0.78
truck 0.69
id:8 car 0.65
id:7 car 0.78
id:2 car 0.83
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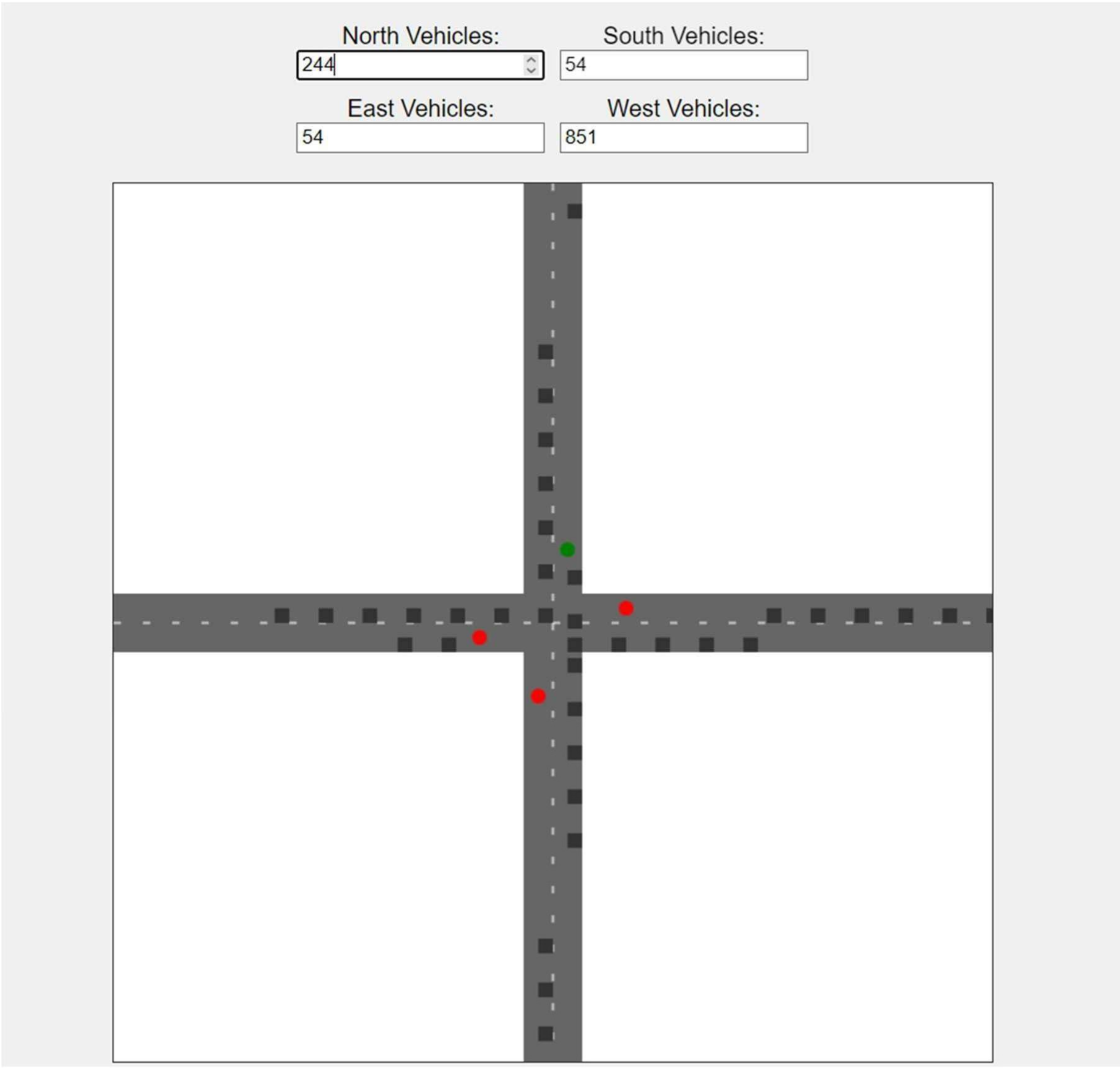
North Vehicles:
244
South Vehicles:
54
East Vehicles:
54
West Vehicles:
851

CHAPTER 8 CONCLUSION AND FUTURE WORK

The proposed Traffic Light Control System represents a significant step toward addressing urban traffic challenges by integrating real-time traffic monitoring and dynamic signal allocation. By prioritizing traffic flow based on vehicle density, the system optimizes waiting times, reduces congestion, and minimizes the environmental impact of idling vehicles. The implementation of camera-based vehicle counting ensures accurate traffic density estimation, while the clockwise rotation and fairness principles guarantee equitable signal distribution among all directions.

This project successfully demonstrates the feasibility of leveraging Python programming and image processing techniques for efficient traffic management. It provides a practical and cost-effective solution that can be deployed at intersections without requiring major infrastructure changes. Furthermore, the system's adaptability to real-time conditions enhances its relevance in dynamic urban environments. By addressing the limitations of traditional fixed-cycle systems and sensor-based methods, the project contributes to the ongoing evolution of intelligent traffic management solutions.

- Future Work

While the current system effectively manages traffic at intersections, there is significant potential for enhancement and expansion:

1. Integration of AI for Predictive Analytics:

Future iterations can incorporate machine learning algorithms to predict traffic flow patterns based on historical and real-time data, enabling more proactive signal management.

2. Emergency Vehicle Prioritization:

The system can be extended to detect and prioritize emergency vehicles, ensuring their swift passage through intersections.

3. Pedestrian and Cyclist Support:

Features can be added to accommodate pedestrian crossings and cyclist lanes, promoting a more inclusive traffic management system.

4. Scalability for Complex Networks:

The project can be expanded to manage larger intersections and synchronize signals across multiple intersections for seamless traffic flow.

5. IoT Integration for Smart Cities:

By integrating IoT devices, the system can communicate with other traffic control systems and contribute to a larger smart city framework, enhancing its efficiency and scope.

6. Robustness Against Environmental Challenges:

Improvements can be made to ensure the system performs reliably under adverse weather conditions, such as rain, fog, or low light.

7. User-Friendly Interfaces:

Developing intuitive interfaces for traffic authorities to monitor and control the system would improve its usability and adoption

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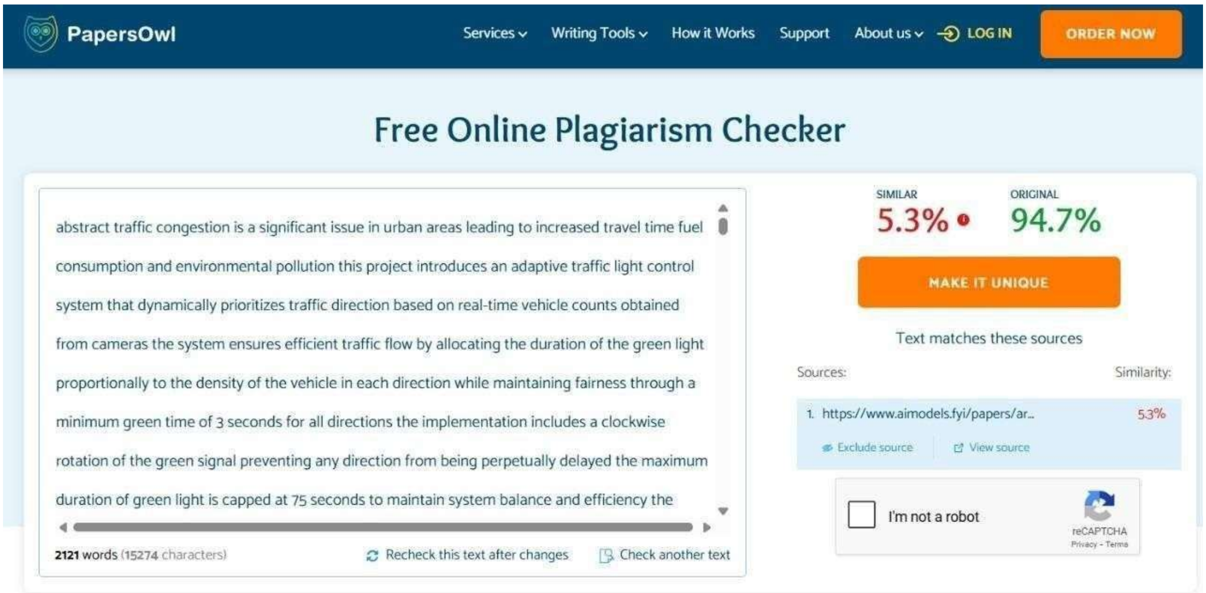
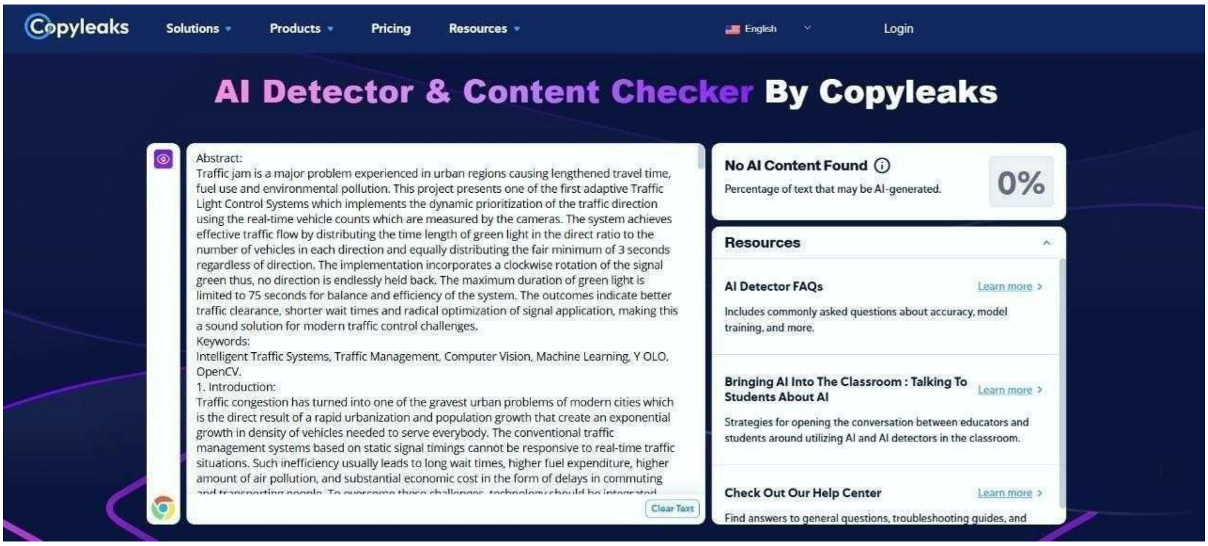
ANNEXURE: Plagiarism Report





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