SMART TRAFFIC MANAGEMENT SYSTEM

MINI PROJECT REPORT

CSD334

submitted by

Erin Rachel Thomas(MUT21CS051), Ferdin Shaji(MUT21CS054), John Martin(MUT21CS064), Sanjay Soney Varghese(MUT21CS115)

to

the APJ Abdul Kalam Technological University in partial fulfilment of the requirements for the award of the Degree

of

Bachelor of Technology

In

Computer Science and Engineering

Muthoot Institute of Technology & Science

Department of Computer Science and Engineering

Muthoot Institute of Technology and Science

Varikoli PO, Puthencruz - 682308

MAY 2024

DECLARATION

We at this moment declare that this submission is my work and that, to the best of my knowledge and belief, it contains no material previously written by another person nor material which has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgement has been made in the text.

Place: Kochi

Date: 07/05/2024

Erin Rachel Thomas

Ferdin Shaji

John Martin

Sanjay Soney Varghese

Muthoot
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CERTIFICATE

This is to certify that the report entitled **"Smart Traffic Management System"**, *submitted by* **Erin Rachel Thomas (MUT21CS051)** *to Muthoot Institute of Technology and Science, Varikoli for the award of the degree of Bachelor of Technology in Computer Science & Engineering is a bonafide record of the project work carried out by him, under our supervision and guidance. The content of the report, in full or parts has not been submitted to any other Institute or University for the award of any other degree or diploma.*

Ms. Sneha Sreedevi	Ms. Sneha Sreedevi / Ms. Jisha James	Ms. Rakhee M
Project Guide	Project Coordinators	Head of the Department

Place: Kochi

Date: May 11,2024

Muthoot Institute of Technology & Science

CERTIFICATE

This is to certify that the report entitled **"Smart Traffic Management System"**, *submitted by* **Ferdin Shaji (MUT21CS054)** *to Muthoot Institute of Technology and Science, Varikoli for the award of the degree of Bachelor of Technology in Computer Science & Engineering is a bonafide record of the project work carried out by him, under our supervision and guidance. The content of the report, in full or parts has not been submitted to any other Institute or University for the award of any other degree or diploma.*

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This is to certify that the report entitled **"Smart Traffic Management System"**, *submitted by* **John Martin (MUT21CS064)** *to Muthoot Institute of Technology and Science, Varikoli for the award of the degree of Bachelor of Technology in Computer Science & Engineering is a bonafide record of the project work carried out by him, under our supervision and guidance. The content of the report, in full or parts has not been submitted to any other Institute or University for the award of any other degree or diploma.*

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This is to certify that the report entitled **"Smart Traffic Management System"**, *submitted by* **Sanjay Soney Varghese (MUT21CS115)** *to Muthoot Institute of Technology and Science, Varikoli for the award of the degree of Bachelor of Technology in Computer Science & Engineering is a bonafide record of the project work carried out by him, under our supervision and guidance. The content of the report, in full or parts has not been submitted to any other Institute or University for the award of any other degree or diploma.*

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ABSTRACT

Traffic congestion is one of the most important problems to solve for any major urban area. As the number of vehicles plying on the roads continue to increase day by day, it is important to have schemes and methods to ease the flow of traffic.

One way of curbing this problem is to change the way we schedule traffic at junctions or intersections. The current implementation of these systems are by nature static, and do not take into account the load of vehicles on each route. They are timer based and set once, leading to inefficient usage of our roads. The proposed solution aims to take advantage of traffic cameras/surveillance cameras that have already been placed at these choke points.

The input from each camera is analysed and using object detection and image classification techniques, we identify the traffic density of each lane. Control signals from the controller will be then sent to the traffic lights, directing the flow of the traffic. The system ensures that all lanes have traffic movement by implementing a round robin system.

The proposed system will be able to take input from all relevant cameras placed at the location will be able to dynamically manage the load on our road networks.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

With rising urban populations and rapidly expanding cities, the demand for efficient traffic management solutions has become increasingly urgent. The proliferation of private vehicle ownership, exacerbated by the effects of the global pandemic, has imposed immense strain on existing transportation infrastructure. As cities continue to grow and evolve, traditional methods of traffic management are proving insufficient to cope with the escalating demands placed upon them. Consequently, there is an urgent need for innovative approaches that can effectively alleviate traffic congestion and enhance overall traffic management efficiency.

The current paradigm of traffic management often relies on static systems and outdated methodologies, leading to suboptimal utilization of existing infrastructure and inefficient traffic flow. Moreover, the conventional approach tends to overlook the dynamic nature of urban traffic patterns, failing to adapt to changing conditions in real-time. As a result, commuters experience prolonged travel times, increased fuel consumption, and heightened levels of frustration, while cities grapple with environmental degradation and economic losses.

In response to these challenges, there is a growing recognition of the need for agile, adaptable, and cost-effective solutions that can revolutionize the way traffic is managed in urban environments. Such solutions must leverage advancements in technology, data analytics, and machine learning to enable proactive decision-making and dynamic optimization of traffic flow. By harnessing the power of real-time data and intelligent algorithms, cities can enhance their ability to predict, analyze, and respond to traffic patterns, thereby minimizing congestion, improving road safety, and promoting sustainable urban mobility.

In this context, the development of a simple yet robust traffic management solution emerges as a pressing imperative. Such a solution should prioritize accessibility, scalability, and affordability, ensuring widespread adoption and seamless integration with existing infrastructure. By empowering transportation authorities with the tools and insights needed to effectively manage traffic, cities can lay the foundation for a more resilient, efficient, and livable urban environment.

1.2 SCOPE AND MOTIVATION

Our project seeks to develop a real-time responsive traffic management system capable of dynamically adapting to fluctuations in traffic density, ensuring a smoother flow of vehicles through urban intersections. This will involve integrating existing traffic surveillance cameras into the system to leverage already deployed infrastructure for comprehensive data collection and monitoring. Additionally, we aim to design a scalable framework that seamlessly integrates with existing infrastructure while allowing for future expansions, enabling deployment across different intersections and urban areas to adapt to varying traffic conditions and spatial requirements. The motivation behind our project lies in addressing the challenges posed by urbanization and the increasing strain on transportation infrastructure, exacerbated by factors such as rising private vehicle ownership and the impacts of the global pandemic. By developing a dynamic traffic management system utilizing advanced technologies like traffic cameras and real-time image processing, we aim to revolutionize traffic management practices, enhancing traffic flow efficiency and contributing to overall improvements in urban mobility, safety, and sustainability. Leveraging existing infrastructure will enable cost-effective implementation while ensuring scalability and adaptability for future urban developments.

CHAPTER 2

PROPOSED WORK

2.1 OBJECTIVES

The objective is to develop a real-time responsive traffic management system that can dynamically adapt to fluctuations in traffic density, ensuring a smoother flow of vehicles through urban intersections. This involves integrating existing traffic surveillance cameras into the system to utilize already deployed infrastructure for comprehensive data collection and monitoring. Additionally, we aim to design a scalable framework that seamlessly integrates with existing infrastructure while allowing for future expansions, ensuring adaptability across different intersections and urban areas to address varying traffic conditions and spatial requirements. This project is motivated by the urgent need to alleviate the challenges posed by urbanization and the increasing strain on transportation infrastructure, exacerbated by factors such as rising private vehicle ownership and the impacts of the global pandemic. By leveraging advanced technologies such as traffic cameras and real-time image processing, we aim to revolutionize traffic management practices, enhance traffic flow efficiency, and contribute to overall improvements in urban mobility, safety, and sustainability. Leveraging existing infrastructure will enable cost-effective implementation while ensuring scalability and adaptability for future urban developments.

2.2 PROBLEM STATEMENT

To solve the inefficiencies of existing traffic management systems, a dynamic approach utilizing technology such as traffic cameras and image processing for real-time adaptation is imperative in effectively managing increasing congestion.

2.3 EXISTING SYSTEM AND PROPOSED SOLUTION

2.3.1 EXISTING SYSTEMS

- The inductive loop detection system utilizes multiple turns of wire embedded in the roadway to detect changes in vehicle presence through induction frequency alterations. While effective in real-time traffic monitoring and occupancy detection, the system's reliability is compromised by poor construction methods. Moreover, infrastructure changes like road works or utility installations can disrupt its functionality.

- The Infrared Sensor System operates by capturing infrared signals emitted by vehicles, enabling vehicle detection based on signal interpretation. While advantageous for nighttime operation and pedestrian detection, the system's reliance on expensive equipment and susceptibility to weather conditions are notable limitations. Additionally, it lacks the capability to differentiate between vehicle types, and its installation and maintenance procedures are tedious

2.3.2 PROPOSED SYSTEM

The proposed solution integrates a network of strategically positioned traffic cameras at intersections, capturing real-time images of vehicle movement in each lane. These images undergo sophisticated processing using advanced algorithms to detect vehicle presence and assess lane occupancy. Leveraging machine learning techniques, our system accurately counts vehicles and evaluates traffic density. A dynamic signal control algorithm, centrally operated, analyzes this processed data, generating adaptive signal timings for each lane based on factors such as traffic density and vehicle priority, including emergency vehicles. These adaptive signal timings are swiftly transmitted to the traffic lights, enabling real-time adjustments of signal phases and durations. By dynamically optimizing traffic flow in response to changing conditions, our proposed solution aims to mitigate congestion and enhance intersection efficiency, ultimately improving urban mobility and reducing travel times.

CHAPTER 3

PROJECT DESIGN

3.1 SYSTEM ARCHITECTURE

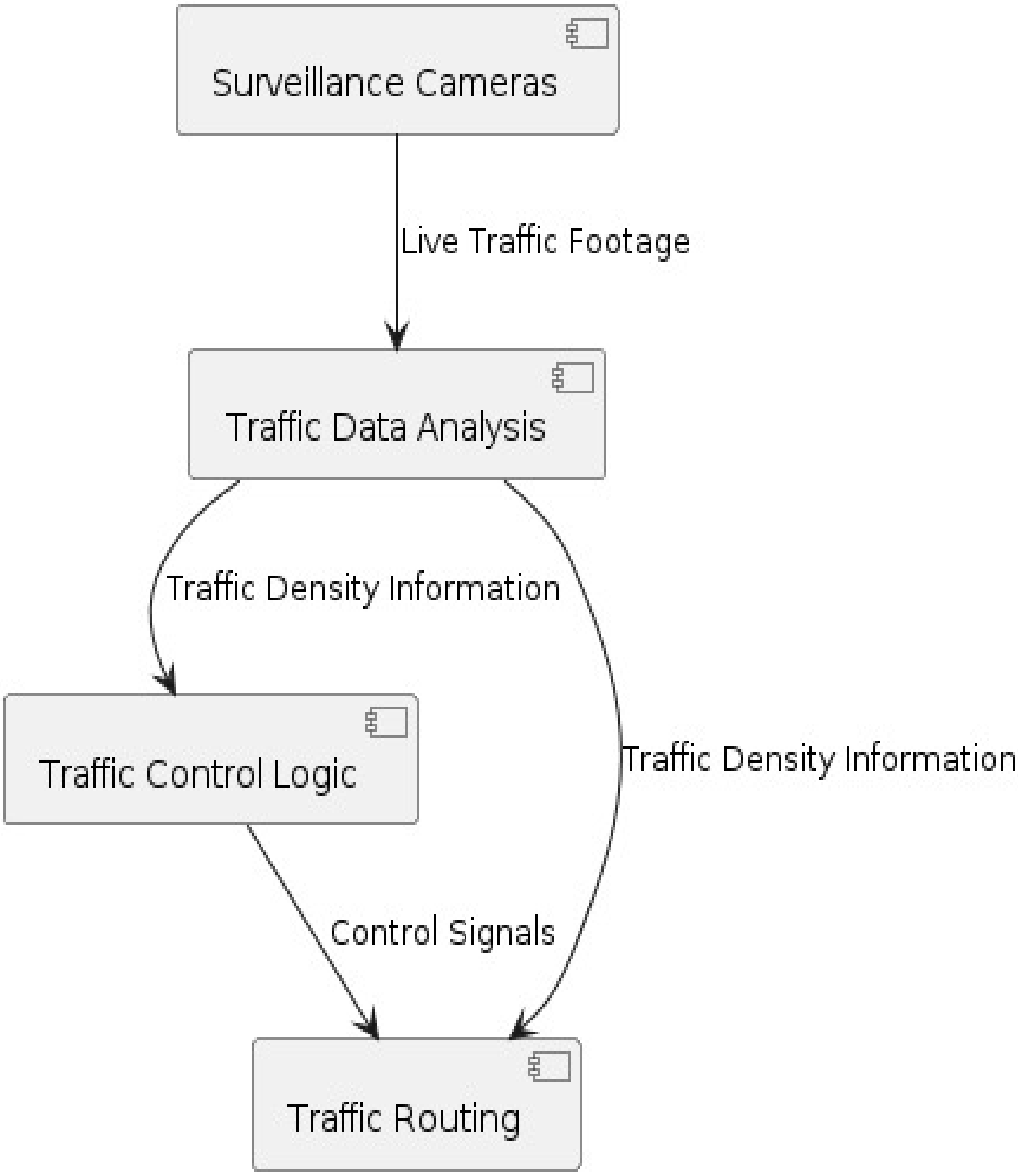


Figure 3.1: Architecture diagram

3.2 MODULES

3.2.1 Vehicle Count Module

This module gets the video feed from all the cameras configured in the system, performs vehicle detection algorithm on the input and outputs the number of each vehicle to the signal generator module which returns the signal timing for each lane. The traffic signals are generated accordingly to each lane. It also creates a window for the monitoring of the different lanes, displaying the vehicle detection operation and the number of vehicles in each lane.

3.2.2 Signal Generator Module

This module gets the number of vehicles form the Vehicle Count model and then uses a linear regression model to predict the required duration of the traffic signal for the lane and returns it to the Vehicle Count module.

3.3 DATA FLOW DIAGRAM

3.3.1 DFD LEVEL 0

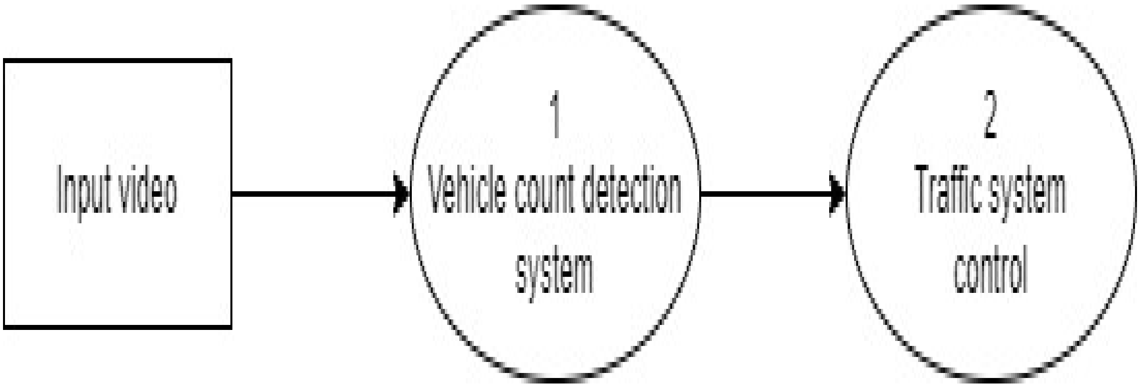


Figure 3.2: Dataflow diagram level 0

3.3.2 DFD LEVEL 1

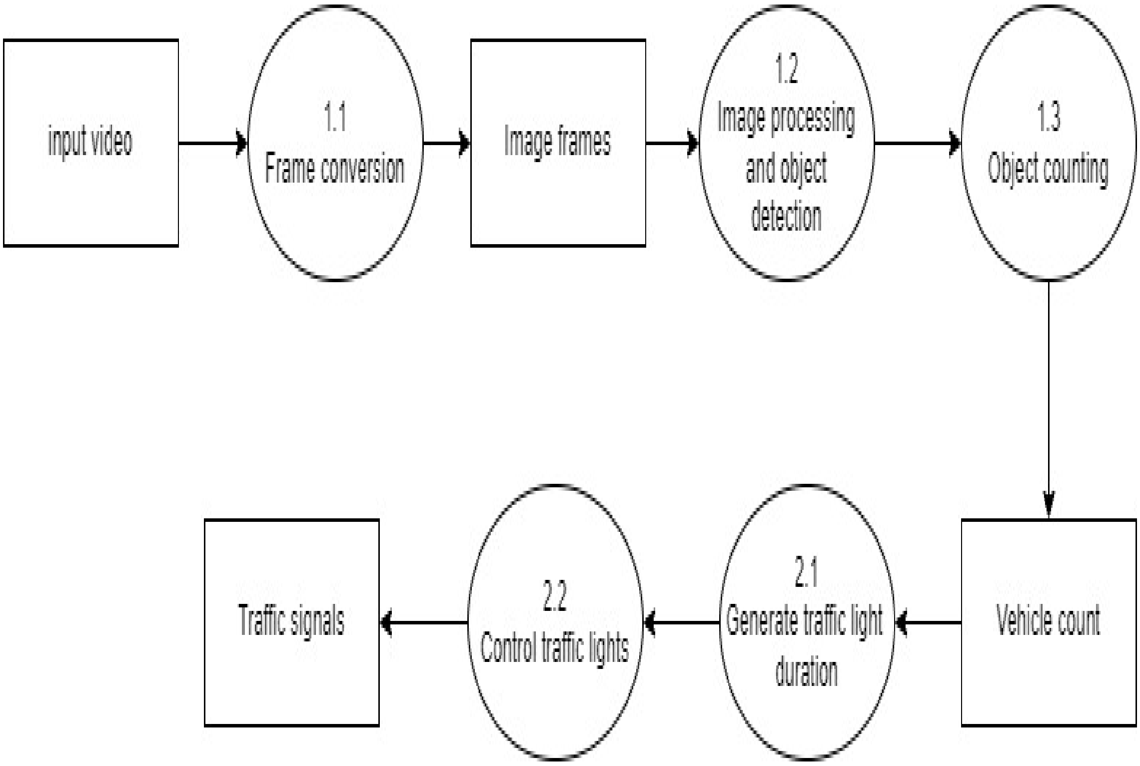


Figure 3.3: Dataflow diagram level 1

3.3.3 DFD LEVEL 2

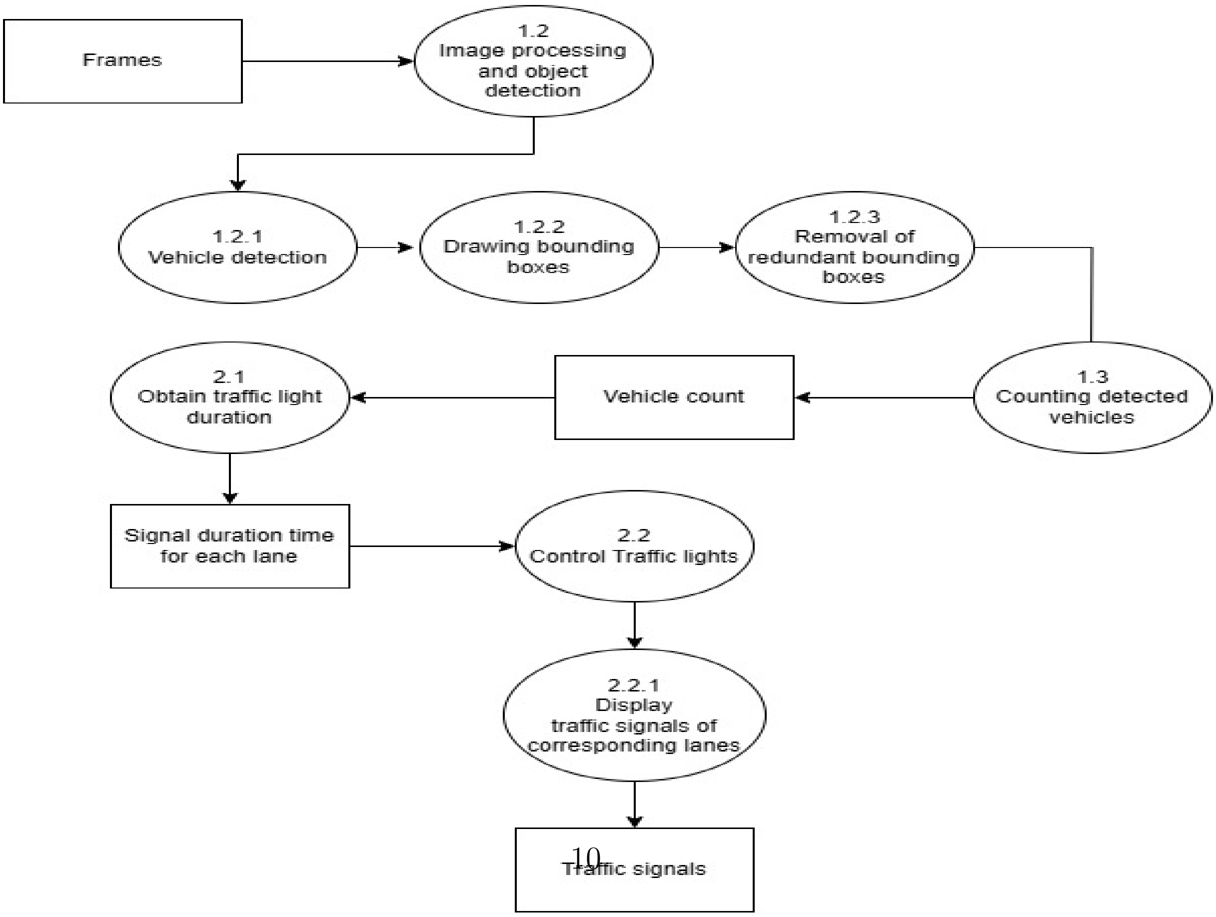


Figure 3.4: Dataflow diagram level 2

3.4 TECHNOLOGY STACK

- **Python:** Python serves as the primary programming language for the project, providing the necessary flexibility and simplicity to integrate various modules seamlessly. With its extensive libraries and strong community support, Python is well-suited for developing traffic management systems. In this project, Python is used for handling data processing, facilitating communication between modules, and implementing system logic.

- **TKinter:** TKinter is employed to create a user-friendly interface tailored for visualizing traffic data and offering control options to users. By utilizing TKinter, the project designs windows and other GUI elements to present real-time traffic information, such as vehicle density, traffic flow, and control settings. This interface allows users, such as traffic controllers or administrators, to monitor the system.

- **OpenCV:** TKinter is employed to create a user-friendly interface tailored for visualizing traffic data and offering control options to users. By utilizing TKinter, the project designs windows, buttons, and other GUI elements to present real-time traffic information, such as vehicle density, traffic flow, and control settings. This interface allows users, such as traffic controllers or administrators, to monitor the system and make necessary adjustments.

- **yolov3:** Yolov3 is specifically utilized for vehicle detection within the project. By incorporating Yolov3, the system accurately identifies vehicles in the video streams captured by traffic cameras. This capability allows the system to track vehicle movements, estimate traffic density, and detect congestion in real-time. Yolov3's speed and accuracy make it suitable for handling large volumes of video data efficiently, ensuring timely responses to changing traffic conditions

3.5 SYSTEM REQUIREMENTS

- **RAM (Memory):** Recommended: 8GB DDR4 RAM
- **Storage:** Disk Space: 50GB SSD
- **Operating System (OS):** Windows 11
- **CPU (Processor):** Dual-core Intel Core i3-9100 (4 threads, 3.6GHz)
- **Video Camera:** 1280x720p, 30 fps

CHAPTER 4

IMPLEMENTATION

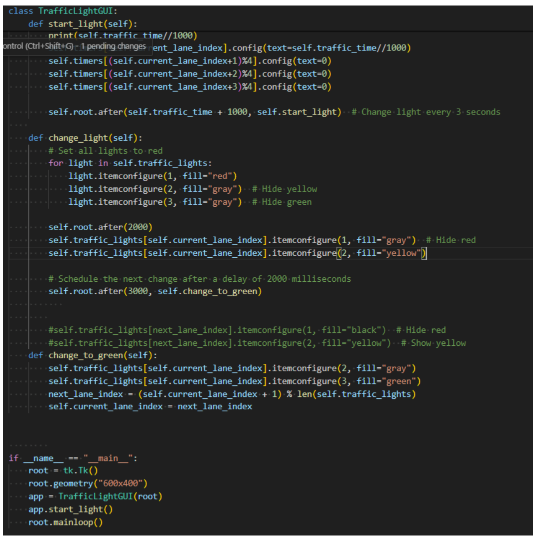
4.1 CODE SNIPPETS

Vehicle Detection:

```python
# Resize frame to fit grid
frame = cv2.resize(frame, (grid_width // cols, grid_height // rows))

height, width, _ = frame.shape
blob = cv2.dnn.blobFromImage(frame, 0.00392, (416, 416), (0, 0, 0), True, crop=False)
net.setInput(blob)
outs = net.forward(output_layers)

# Initialize lists to store bounding boxes, confidences, and class IDs
boxes = []
confidences = []
class_ids = []

# Process detections
for out in outs:
    for detection in out:
        scores = detection[5:]
        class_id = np.argmax(scores)
        confidence = scores[class_id]
        if confidence > 0.5 and class_id in vehicle_class_ids:
            # Object detected as a vehicle
            center_x = int(detection[0] * width)
            center_y = int(detection[1] * height)
            w = int(detection[2] * width)
            h = int(detection[3] * height)

            # Rectangle coordinates
            x = int(center_x - w / 2)
            y = int(center_y - h / 2)

            # Add bounding box, confidence, and class ID to lists
            boxes.append([x, y, w, h])
            confidences.append(float(confidence))
            class_ids.append(class_id)

# Apply non-maximum suppression to remove redundant bounding boxes
indices = cv2.dnn.NMSBoxes(boxes, confidences, score_threshold=0.5, nms_threshold=0.4)

bounding boxes and count vehicles
for i in indices.flatten():
    x, y, w, h = boxes[i]
    cv2.rectangle(frame, (x, y), (x + w, y + h), (0, 255, 0), 2)
cv2.putText(frame, f'Vehicle: {len(indices)}', (20, 40), cv2.FONT_HERSHEY_SIMPLEX, 0.5, (0, 255, 0), 2)
for i, cap in enumerate(caps):
```

Figure 4.1: Vehicle detection

Visualisation:



```python
class TrafficLightGUI:
    def start_light(self):
        print(self.traffic_time//1000)
ontrol (Ctrl+Shift+G) - 1 pending changes ent_lane_index].config(text=self.traffic_time//1000)
        self.timers[(self.current_lane_index+1)%4].config(text=0)
        self.timers[(self.current_lane_index+2)%4].config(text=0)
        self.timers[(self.current_lane_index+3)%4].config(text=0)

        self.root.after(self.traffic_time + 1000, self.start_light)  # Change light every 3 seconds

    def change_light(self):
        # Set all lights to red
        for light in self.traffic_lights:
            light.itemconfigure(1, fill="red")
            light.itemconfigure(2, fill="gray")  # Hide yellow
            light.itemconfigure(3, fill="gray")  # Hide green

        self.root.after(2000)
        self.traffic_lights[self.current_lane_index].itemconfigure(1, fill="gray")  # Hide red
        self.traffic_lights[self.current_lane_index].itemconfigure(2, fill="yellow")

        # Schedule the next change after a delay of 2000 milliseconds
        self.root.after(3000, self.change_to_green)


        #self.traffic_lights[next_lane_index].itemconfigure(1, fill="black")  # Hide red
        #self.traffic_lights[next_lane_index].itemconfigure(2, fill="yellow")  # Show yellow
    def change_to_green(self):
        self.traffic_lights[self.current_lane_index].itemconfigure(2, fill="gray")
        self.traffic_lights[self.current_lane_index].itemconfigure(3, fill="green")
        next_lane_index = (self.current_lane_index + 1) % len(self.traffic_lights)
        self.current_lane_index = next_lane_index



if __name__ == "__main__":
    root = tk.Tk()
    root.geometry("600x400")
    app = TrafficLightGUI(root)
    app.start_light()
    root.mainloop()
```

Figure 4.2: Visualizaton

```python
import numpy as np
import tensorflow as tf
from tensorflow.keras import layers, models

# Define your custom training data
def vehicle_count(num):

    X_train_custom = np.array([[1], [2], [3], [4], [5], [10], [15], [20], [25], [30]])  # Input integers
    y_train_custom = np.array([[5], [6], [6], [7], [15], [22], [25], [35], [45], [60]])  # Output integers

    # Define the model architecture
    model = models.Sequential([
        layers.Dense(64, activation='relu', input_shape=(1,)),
        layers.Dense(64, activation='relu'),
        layers.Dense(1)
    ])

    # Compile the model
    model.compile(optimizer='adam', loss='mean_squared_error')

    # Train the model with your custom data
    model.fit(X_train_custom, y_train_custom, epochs=10, batch_size=1)

    # Now you can use this model to predict output integers for new input integers
    # For example:
    input_integer = np.array(num)  # Example input integers
    predicted_output = model.predict(input_integer)
    #print(predicted_output[0][0])
    return predicted_output[0][0]
```

Figure 4.3: Signal Prediction Model

CHAPTER 5

CONCLUSION

The development of the Smart Traffic Management System tackles the intricate issues associated with urban traffic congestion. By integrating cutting-edge technologies like real-time image processing, machine learning, and adaptive signal control, our system offers a dynamic and proactive approach to traffic management, capable of swiftly responding to evolving traffic scenarios.

The successful realization of the project's objectives underscores the potential of technology-driven solutions to enhance urban mobility, safety, and sustainability. Through the utilization of existing infrastructure and the utilization of data analytics, we've demonstrated the feasibility of optimizing traffic flow, mitigating congestion, and enhancing overall transportation efficiency.

Furthermore, the adaptability inherent in our system ensure its applicability across diverse urban landscapes. Whether implemented in bustling city centers or suburban regions, the Smart Traffic Management System seamlessly integrates with existing traffic infrastructure, providing a cost-effective and solution for traffic management authorities.

Looking ahead, the insights gained from this project lay the foundation for further advancements in traffic management systems. As technology continues to evolve, there are ample opportunities for refining and expanding our system, enabling even greater enhancements in urban mobility and quality of life.

In conclusion, the Smart Traffic Management System signifies a pivotal milestone in the ongoing quest to create smarter, more efficient, and sustainable cities. Through a commitment to innovation and collaboration, we can continue driving positive transformation and usher in a brighter future for urban transportation.

5.1 REFERENCES

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