Sensor Based Smart Traffic Controller with Real Time Monitoring

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A thesis submitted in partial fulfillment of the requirements for the degree of

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Thesis Supervisor:

Dr. Bakhtiar Khan Kasi

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Abstract

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A smart solution to traffic control and monitoring that goes beyond the traditional traffic management with fixed timer. Our solution will provide traffic solution with IP cameras that will use for vehicle monitoring and surveillance for assuring the constant flow of the traffic between different junctions. Synchronized traffic communicates with each other using the adopt optimal solution for less traffic congestion, prevention of the idling of cars and clearance of the emergency movements.

Keywords: Traffic congestion, signal lights, recommendation system, IP cameras, synchronized communication.

Undertaking

I certify that research work titled "Sensor Based Smart Traffic Controller with Real Time Monitoring" is my own work. The work has not been presented elsewhere for assessment. Where material has been used from other sources it has been properly acknowledged / referred.

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Acknowledgement

At first, we would like to thank our department who gave us opportunity to work on this project. A special gratitude we give to our supervisor Dr. Bakhtiar Khan Kasi for his support and guidance, which compile us to work in the project. We are highly indebted for his encouragement as well as for providing us all the necessary information regarding the project.

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CHAPTER 1

Introduction

Problem Statement:

The unusual delay in traffic signals, blockage in the junctions and over speeding are main problems in foremost cities; which cause hindrance in the passage of the traffic movement including emergency and VIP movements that results in idling of the people in the intersections. This is because of signal light allocation which is still based on fixed timers. The increase in traffic congestion results more fuel consumption and frustration i.e. either targeted vehicles are appearing or not but the timing of the signal will remain constant as before, whereas the traffic on any other roads that supposed to be more congested faces delay in red lighted signal at that spot of time which a lot of time and for that computers takes most of the time for that process and furthermore it also leads with the poor traffic management authority or system. Keeping the poor traffic management in view; our primary goal is to reduce traffic congestions, lesser the idling time and fuel consumption.

1.1 Objective:

Design a sensor based smart traffic controller system with real time monitoring to:

- Control and monitor the flow of traffic in the city.
- Change of fixed timers in traffic signals into dynamic timers.
- Make able to reduce road accidents and traffic congestion.
- Increase the limit of traffic productivity and efficient flow of traffic with minimum human interface.
- Reduce fuel consumption and human idling on the signals.

1.2 Product Scope:

This system targets to control and monitor the traffic flow within any city through recommendation system; it will replace fixed timers of traffic signals with dynamic timers. It will increase the limit of traffic productivity and the efficient flow of traffic with minimum human interface and reduce road accidents and traffic congestion.

1.3 Product Perspective:

This system used sensors to monitor real time traffic and sets a dynamic timer for the traffic controller to ensure a steady flow of traffic within different intersections. With the use of “Intelligent traffic management system” where Cameras will be set in all of the traffic signal junctions, they will be operating by software programs providing real time data on the location and movements of the vehicles. When vehicles left one signal then the number of vehicles passed will count and counted number of vehicles passed to the next signal. In case roads are not having traffic then no red light will show throughout the signal lights. Our solution is low cost and does not need expensive installations; it can easily be integrated with existing traffic signals with minimum overhead. Each and every set of traffic light will have the required communication equipment that would be used to transmit vehicle’s data from IP cameras or CCTV footage or feeds. There will be three main components of this project; traffic lights, queue detectors (IP Cameras), and central control system. The detectors will mention the traffic flow and all the mains road of city where detectors will set with traffic signals and in order to that system will control the lights to measure a free flow of traffic within the city.

Chapter 2

Literature Review

- Al-Sakran [1] proposes a system to reduce traffic congestion and road accidents that is based on IOT and uses RFID, GPS, cloud computing and wireless sensors.

- Bitam, et.al. [2] worked on a cloud computing model that can be used to improve traffic management by combining with intelligent transportation system.

- Mbodila, et.al. [3] discussed in their paper about the implementation of traffic monitoring model between signals that use wireless sensors as a tool to control traffic signals while RFID scanner is used to identify the vehicles in the congested roads so that the traffic officer determine appropriate road for motorists by using GPS.

- Cambridge city (UK), Amsterdam (the busiest regions of the Netherlands) and New York city are using some of the features of smart traffic control system.[4]

- Sharma, et Al. [5] suggested a solution for traffic jam by using as method of live video feed through attach the cameras as traffic signals by measuring the real time traffic density calculation.

- Marta Pla-Castells [6] studied to know about the potential of every smart city by that researcher means those cities that become a platform and facilitator for the applications and developers. Thus, the city makes able the resemblances of Internet as a catalyst and link to give required power to the people.

- Abida Sharif, et Al. [7] suggests instead of vehicle detection sensor in smart traffic system it suggest the update in the traffic details by fixing sensors in each 500 or 1000 meters for sensing and processing data.

- Megha H.N and R.H Goudar [8] suggested the surveillance system for those who are violating the traffic rules even in the absence of the traffic surgeon.

- Tejas Naik, et Al. [9] proposed solution using the RFID Sensor smart solution should be proposed for traffic congestions and for emergency movement during the peak hours.

- T. Rajesh kumar, et Al. [10] proposed IR sensors are fixed at the junctions at fixed distance which will detect and traffics information in the cloud for further instructions.

- Salama A.S., et. al. [11] designed a project of an intelligent system to manage the traffic lights with help of photoelectric sensors. for managing traffic lights with the help of photoelectric sensors. The process of sensor installation is very much important in the given system because it is needed to monitor vehicles moving at a particular road and then transfer that data to control room that can further controls the traffic lights to the sensor's readings accordingly to calculate the relative weight of each and every road by using an algorithm. The real time system monitoring will be able to program for emergency scenarios which guarantee the traffic fluency. This system can also be run automatically without any human intervention or can allow human intervention at certain circumstances.

- V. Kostakos, et. al. [12] state that, smart cities' markets estimates that hundred billion dollars can be used till 2025 and an annual spending report can be touch to 23 billion.

- Anandakumar, H. B, and Umamaheswari, K. B [13] created a strategy for traffic congestion on roads by utilizing picture preparation and a model to control traffic lights with the help of data received from camcorder.

- Malagund, et. al. [14] discussed that there are different strategies to deal with the traffic jam issues i.e. we can administer the traffic flow with the analysis of "video information", "inductive circle recognition", "infrared sensors", "remote sensor system" and etc.

- Younis and Moayeri [15] designed a system through that they tried to used dynamic traffic light control (DTLC) at road intersections that uses to gather all the data by measuring them with algorithm, and it was supposed that it will handle traffic flow but emergency vehicles were not their focus.

- Riyazhussain et. al [16] proposed to introduce a developed raspberry “Pi controlled traffic system” to compute the vehicles’ density.
- Shaghaghi et. al. [17] found a real time traffic control system which used Vehicular Ad-hoc Network (VANET). This system consisted of two phases: first phase was to estimate the vehicle’s density on road, while the second phase was to assist and analyze the obtained data for traffic control.
- Shrividhya, et Al. [18] studied the vision-based technique that use video processing to control traffic signals, and it was presupposed that it will minimize the traffic congestion by interconnecting with all other signals through a Wi-Fi router.
- Ashwani Sangwan and Kumar [19] proposed that overall traffic can be measured using loop detectors and pneumatic sensors in which we use IR senor that sense the amount of density of a road, it consists of IR transmitter and receiver that sense the density of the road and generate an output signal. The output IR signal then provided as an input to the microcontroller.
- Zeng, et. al. [20] in order to increase decision making, safety, utilization and comfort level, discussed the functionality and design of integrated traffic control system.

Chapter 3

Methodology

3.1 Product Functions:

The intended system will perform following functions:

1. Control and monitor the flow of traffic.
2. Change fixed timers on traffic signals into dynamic timers.

3.2 User's Classes and Characteristics:

Users for this system will be:

- Vulnerable road users (Emergency movement).
- Pedestrian (zebra crossing).
- Traffic constable.
- General public.
- Traffic control department.

3.3 Environment Operation:

This system is based on a desktop application with a recommendation system using Python/LUA, CSS, Jscript and bootstrap programming languages and machine learning techniques. We also have simulation demo for brief description of the working and functionality of the system. The simulation is performed using 'AnyLogic' software platform.

3.4 Constrains of Design and Implications:

Recommendation system will optimize the traffic signals during the peak hour according to the traffic flow.

- User familiarity with the system.
- GUI is only in English.

3.5 Assumptions and Dependencies:

As system is design to control and monitor the traffic flow of the entire city, therefore it will depend on some external links for example to place cameras on traffic intersections and to change fixed timers into dynamic ones, we will need to operate and update current traffic system for which we required permissions from government and other related authorities to deploy the system.

3.6 Requirements of External Interface:

3.6.1 User Interfaces:

- Front-end software: Tkinter, python.
- Back-end software: python, My SQL.
- Simulation software: AnyLogic.

3.6.2 Hardware Interfaces:

- IP cameras (visual sensor).
- Traffic signals.

3.6.3 Software Interfaces:

- Python programming.
- My SQL.

3.6.4 Communications Interfaces:

In order to make connection between traffic signals on different intersections, there will be synchronized communication between traffic signals in different intersections through wireless connections associated with cloud computing and Wi-Fi technologies.

3.7 System Features:

This part of project-based research will describe the functional requirements of the proposed system such as the functionality of the system which is supposed to be performed.

3.7.1 IP Camera:

IP camera is used to monitor and count the flow of traffic and detects vehicle's speed. It will be placed on each intersection. **Priority:** Essential.

3.7.2 Recommendation System:

Recommendation system is used to check the status of the signal lights with real time monitoring. **Priority:** High.

3.7.3 Traffic flow control:

The traffic flow control maintains a free traffic flow within any city. **Priority:** High.

3.7.4 Update traffic data:

When vehicles left one signal then the number of vehicles passed will count and counted number of vehicles passed to the next signal. In case roads are not having traffic then no red light will show throughout the signal lights. **Priority:** Essential.

3.8 Other Nonfunctional Requirements

3.8.1 Performance Requirements:

- System can work even in the peak hours of traffic.

3.8.2 Safety Requirements:

Reliable performance and integrity of data should be ensuring in the system. Since the system has 24/7 availability, so there should be backup for server. Data should be backed up every day and remain saved for six months at least to detect any record in case of inquiry.

3.8.3 Security Requirements:

By using appropriate technologies and strict user-access criteria, data must be keep protected from unwanted and unauthorized access. Operation rights for every user should remain define so that a user can only have access to specific terminals or functions.

3.8.4 Attributes of Software Quality:

- **Availability:** System will be available 24/7 hours.
- **Correctness:** System will correct the time assessment for signals.
- **Maintainability:** The system will maintain a free flow of traffic.

- **Usability:** The system will have less idling time.

3.8.5 Business Rules:

- A two-way road can be change into one way in school timings.
- In emergency or VIP movements, signal can be specified for them.
- In case of strikes or violence, traffic signals can be block for particular road.
- Traffic constable can control the traffic manually, if an issue occurs in the system.

3.9 Analysis Models:

3.9.1 Use Case diagram:

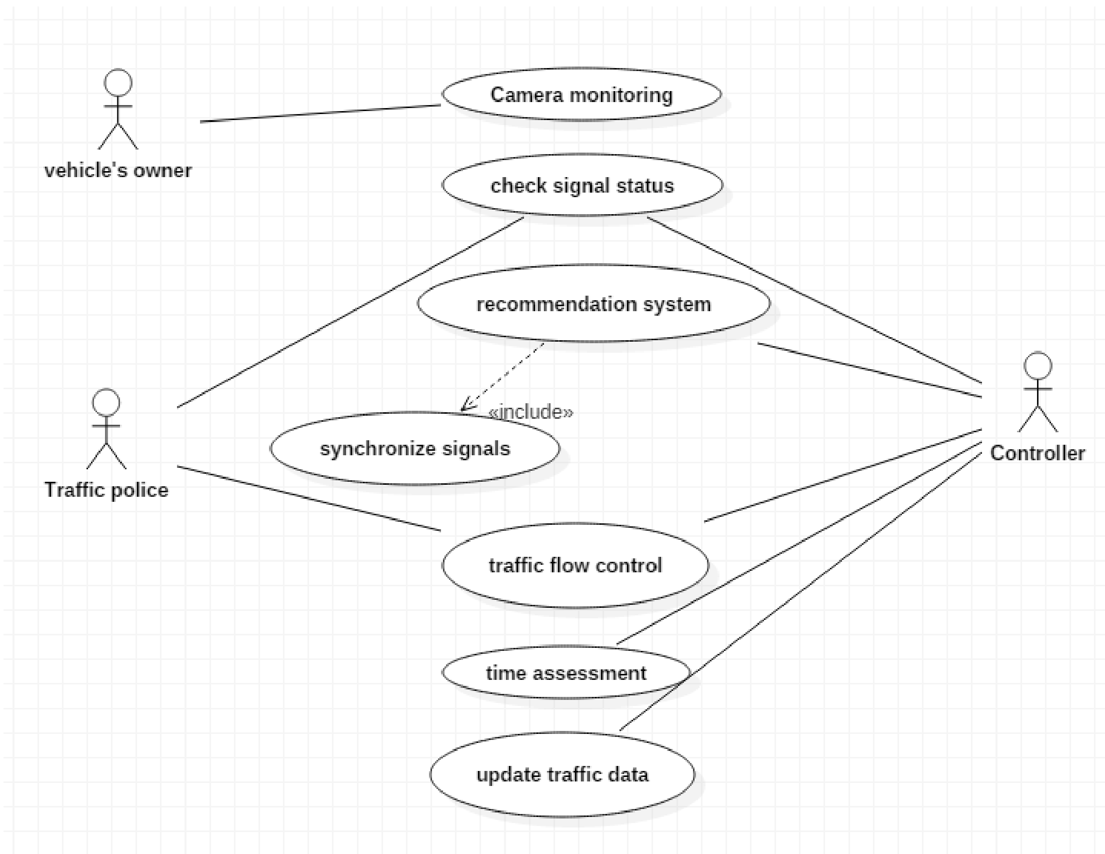

Fig 3.9.1 Use case model

3.9.2 Class Diagram:

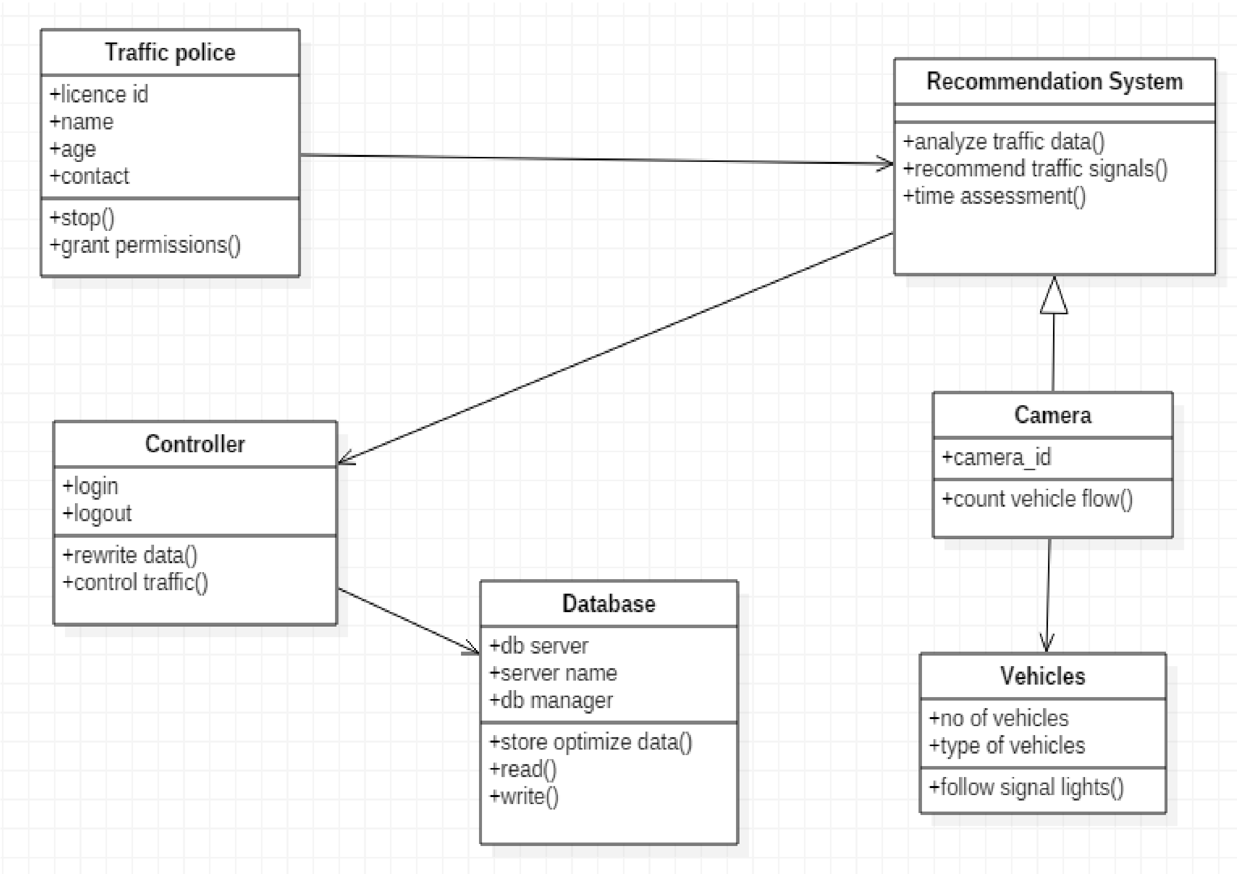

Fig 3.9.2 Class Diagram

3.9.3 Sequence Diagram:

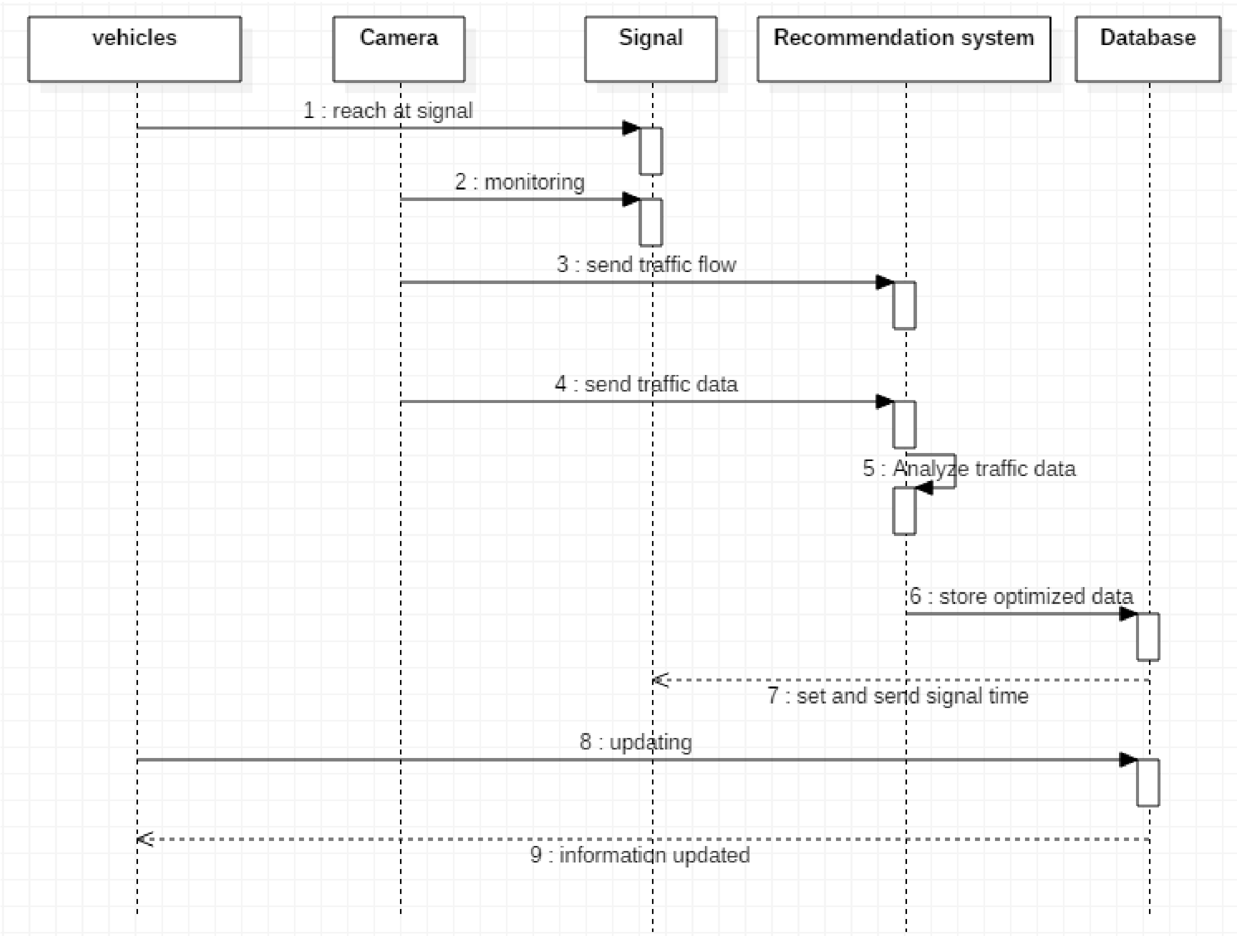

Fig 3.9.3 Sequence Diagram.

3.9.4 Activity Diagram:

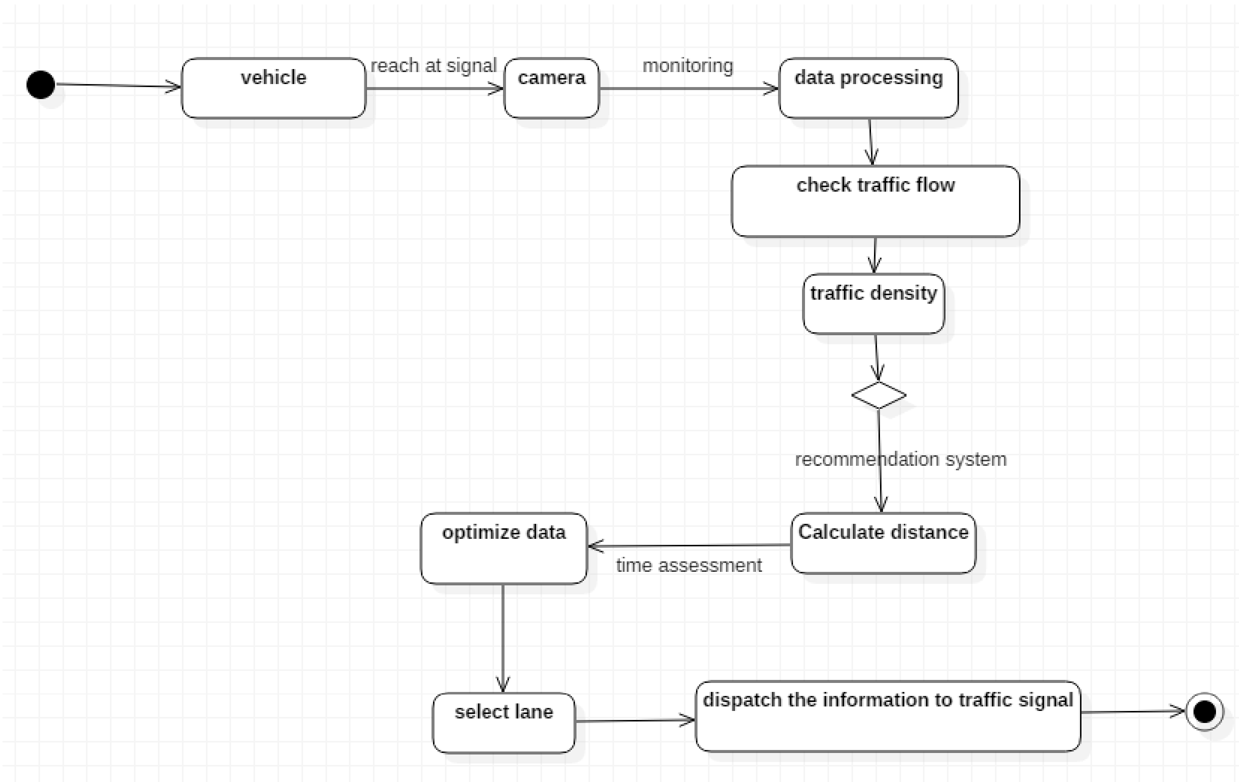

Fig 3.9.4 Activity Diagram.

Chapter 4

Result/Achievements

We have accomplished all major tasks of FYP which include:

- SRS document.
- UML Design Diagrams.
- Simulation.
- User interface.
- Hardware interface.
- Software interface.

4.1 Simulation:

4.1.1Main Module:

Figure 1 (main Module)

4.1.2 Main Logic Design:

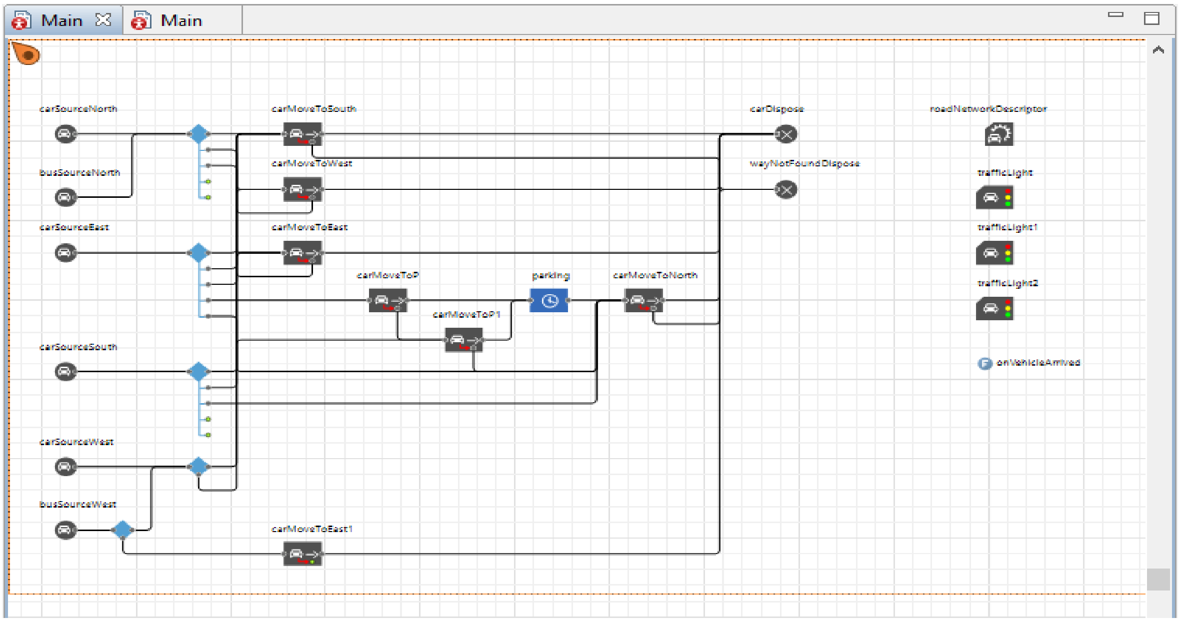

Figure 2 (main logic design)

4.1.3 Sub Module:

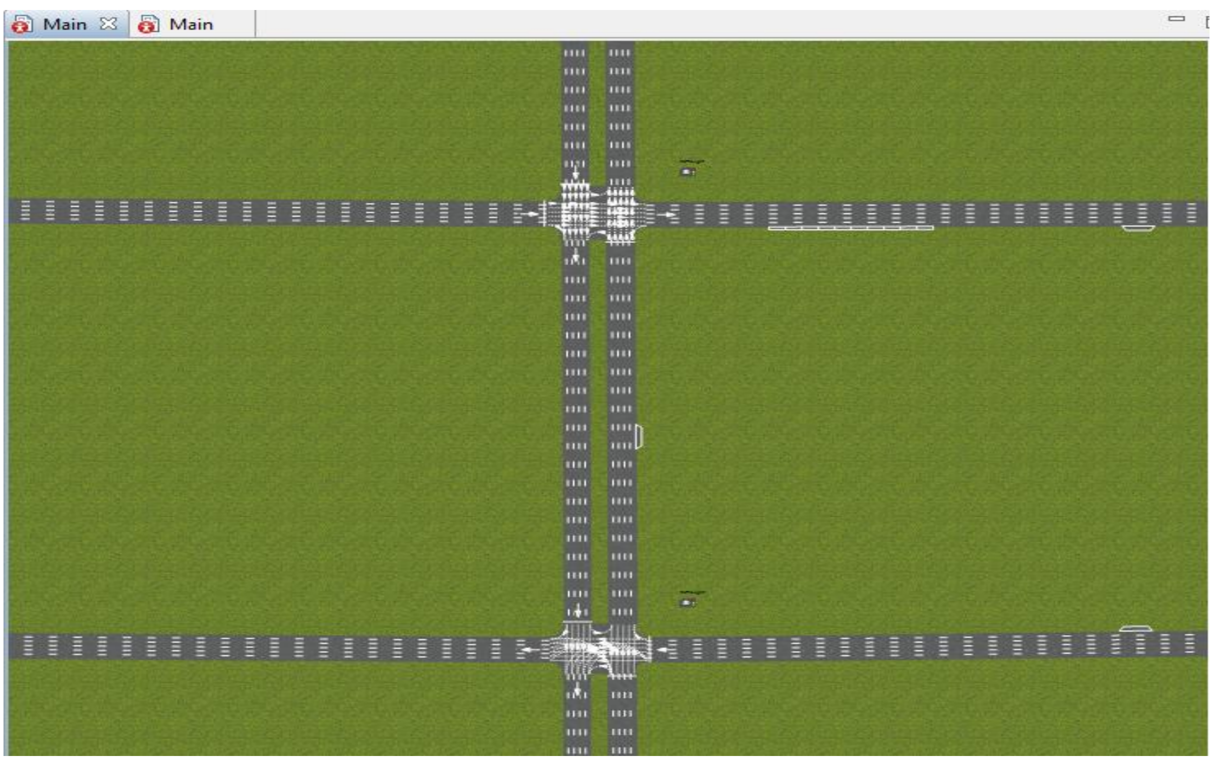

Figure 3 (Sub Module)

4.1.4 Sub Module logic Design:

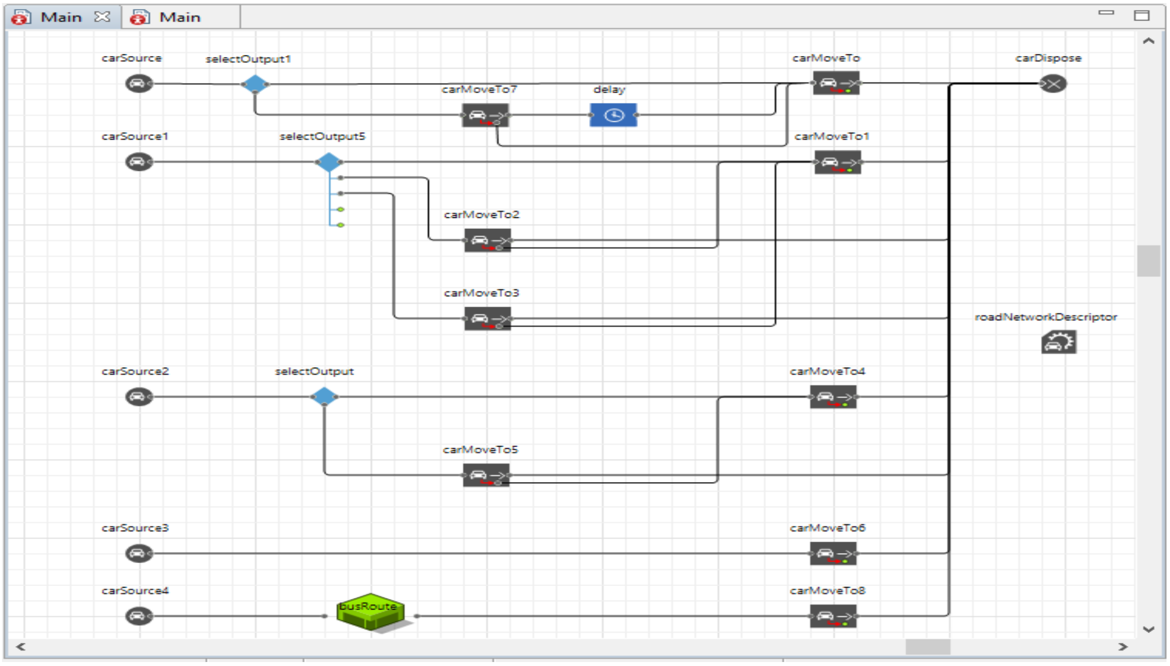

Figure 4 (Sub Module Logic Design)

4.1.5 Traffic Optimization Graph:

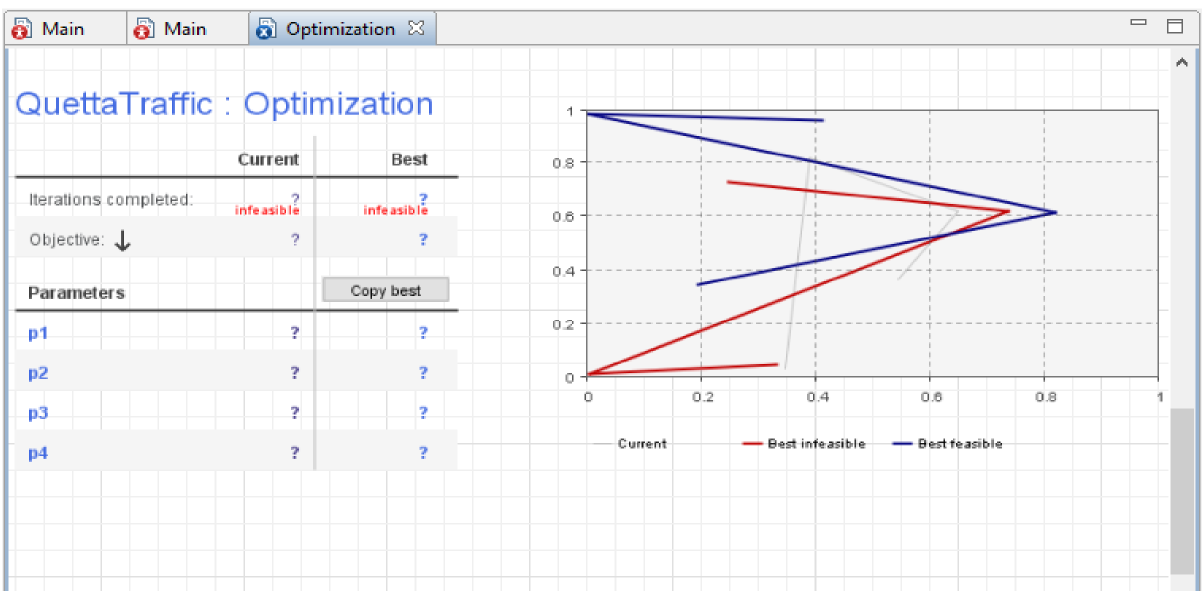

Figure 5 (Traffic Optimization Graph)

4.2 User Interface:

Figure 6 (User Interface)

4.3 Camera Detection and Counting:

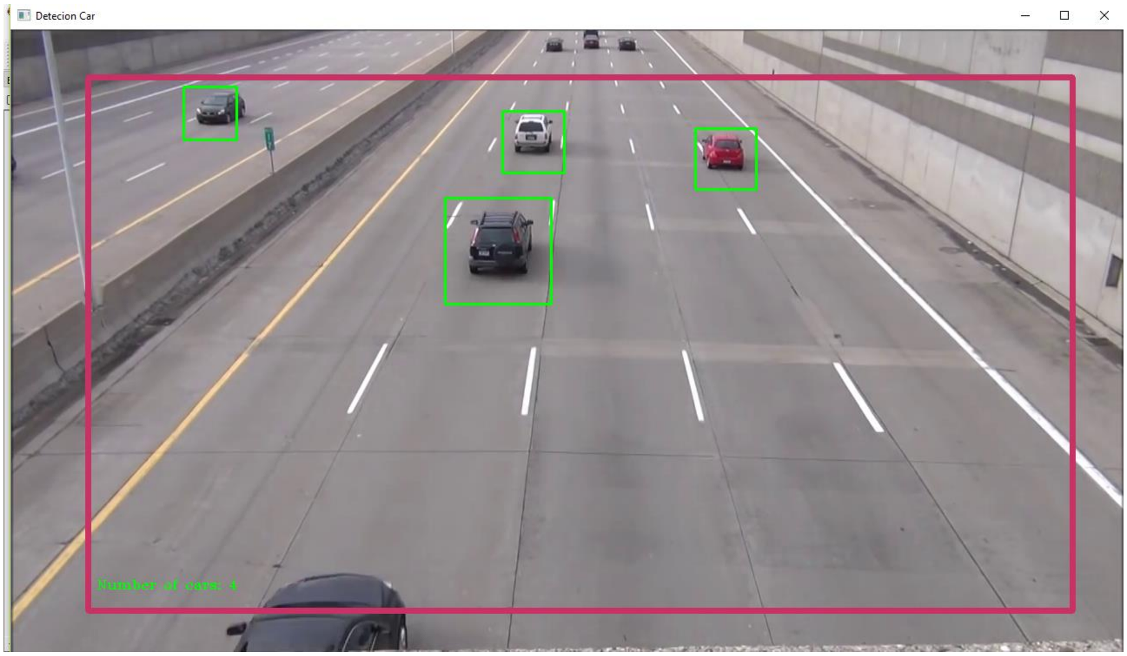

Figure 7 (Cameras Detection and Counting)

4.4 Buttons:

```
def vp_start_gui():
  '''Starting point when module is the main routine.'''
  global val, w, root
  root = tk.Tk()
  top = Toplevel1 (root)
  root.mainloop()

w = None
def create_Toplevel1(root, *args, **kwargs):
  '''Starting point when module is imported by another
program.'''
  global w, w_win, rt
  rt = root
  w = tk.Toplevel (root)
  top = Toplevel1 (w)
  return (w, top)

def destroy_Toplevel1():
  global w
  w.destroy()
  w = None

class Toplevel1:
  def __init__(self, top=None):
     '''This class configures and populates the toplevel
window.
```

4.5 Video Load:

```
def LoadVideo():
    path= fd.askopenfilename()
    cap=cv2.VideoCapture(path)
    while True:
        ret,frame=cap.read()
        if ret==False:
            break
        gray =
cv2.cvtColor(frame,cv2.COLOR_BGR2GRAY)
        cars = car_cascade.detectMultiScale(gray, 1.06,5)
        count=len(cars)
        for (x,y,w,h) in cars:
            cv2.rectangle(frame,(x,y),(x+w,y+h),(255,0,0),2)
            #roi_color = frame[y:y+h, x:x+w]
        cv2.putText(frame, str(count),(10,400),
cv2.FONT_ITALIC, 2,(255,255,255),2,cv2.LINE_AA)
        self.carsRight.configure(text=count)
        self.timeRight.configure(text=count*2)
        self.cdRight.config(text=count*2)

        cv2.imshow('frame',frame)

        if  cv2.waitKey(1) & 0xFF==ord('q'):
            break
    cv2.destroyAllWindows()
```

4.6 Load Camera:

```
def RunCamera():
   # path= fd.askopenfilename()
  #  cap=cv2.VideoCapture(path)
    cap = cv2.VideoCapture(0)

    while True:
        ret,frame=cap.read()
        if ret==False:
            break
        gray =
cv2.cvtColor(frame,cv2.COLOR_BGR2GRAY)
        cars = car_cascade.detectMultiScale(gray, 1.06,5)
        count=len(cars)
        for (x,y,w,h) in cars:
            cv2.rectangle(frame,(x,y),(x+w,y+h),(255,0,0),2)
            #roi_color = frame[y:y+h, x:x+w]
        cv2.putText(frame, str(count),(10,400),
cv2.FONT_ITALIC, 2,(255,255,255),2,cv2.LINE_AA)
        self.carsDown.configure(text=count)
        self.timeDown.configure(text=count*2)
        self.cdDown.configure(text=count*2)

        cv2.imshow('frame',frame)

        if  cv2.waitKey(1) & 0xFF==ord('q'):
            break
    cv2.destroyAllWindows()
```

4.7 Counting Function:

```
 totcars=int(self.carsDown.cget("text"))+int(self.carsRight.cge
t("text"))
        self.TotalCars.configure(text=totcars)
        self.totalTime.configure(text=totcars*2)
```

4.8 Comparison:

```
car_cascade = cv2.CascadeClassifier('cars.xml')
```

4.9 Priority Algorithm/ Run Traffic:

```
def RunTraffic():
    right=int(self.carsRight.cget("text"))
    down=int(self.carsDown.cget("text"))
    time.sleep(1)
    if(right>down):
        countdown()
        CDR()
        root.mainloop()

    else:
        time.sleep(1)
        countd()
        CDD()
        root.mainloop()


def countd():
    down=int(self.carsDown.cget("text"))
    down-=1
    self.carsDown.config(text=down)
    self.timeDown.config(text=down*2)
    self.cdDown.config(text=down*2)
    tot=int(self.TotalCars.cget("text"))
    tot-=1
    self.TotalCars.config(text=tot)
    self.totalTime.config(text=tot*2)
```

CHAPTER 5

Conclusion

The project gives a real time traffic monitoring and steady flow of traffic. The proposed system uses IP Cameras that monitors the real time traffic with combination of recommendation system to collect and analyze real time traffic data using technologies like IOT. The system will help to achieve traffic fluency and to reduce traffic jams and idling time.

According to Romanian and US researchers (Carnegie Mellon University) the time spent by motorists waiting for slights to change could be reduced by over 28%, and CO2 emission could be cut by as much as 6.5%. The initial results are promising and encouraging that the idle time for all traffic was reduced by 40 % and the overall travel times within the city were reduced by 25% [21][22].

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