

SAVITRIBAI PHULE PUNE UNIVERSITY

A
Seminar Report
On

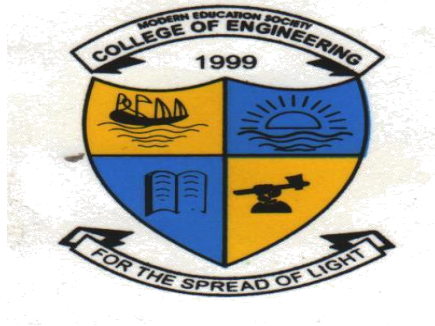
DYNAMIC TRAFFIC LIGHT CONTROL

Submitted by

ROHIT TONDARE	71710586F
RAHULNARAYAN IYER	71710500J
ADITYA UNDRE	71710590D
AKANKSHA PATIL	71710452E

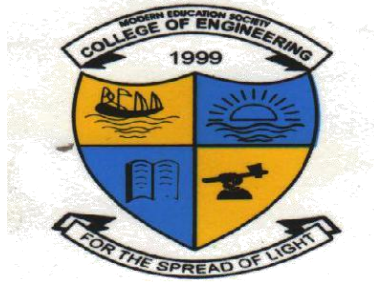
Guided By

Prof. P. M. Bagul



Modern Education Society's College of Engineering, Pune-01
Department of Electronics & Telecommunication
YEAR 2019-2020

**Modern Education Society's College of Engineering Pune 19,
Bund Garden, V.K. Joag Path, Pune 411001.**



Department of Electronics & Telecommunication

CERTIFICATE

This is to certify that

ROHIT TONDARE	71710586F
RAHULNARAYAN IYER	71710500J
ADITYA UNDRE	71710590D
AKANKSHA PATIL	71710452E

have successfully completed Seminar work entitled “DYNAMIC TRAFFIC LIGHT CONTROL” is a Bonafide Work carried out in the 7th Semester as a partial fulfillment for the award of degree BE E&TC Engineering of SavitribaiPhule Pune University during academic year 2019-20.

Project Guide
Prof. P. M. Bagul

Head of Department
Dr. P. B. CHOPADE

Project Coordinator
Dr. P. N. Kota
Dr. R. S. KADAM

External Guide

ACKNOWLEDGEMENT

It gives us immense pleasure to express our gratitude and thanks to all those who helped in the timely completion of the project work. We have a great pleasure in expressing our deep sense of gratitude and indebtedness to Dr. P. B. Chopade, HOD, Department of E&TC Engineering, Modern Education Society's College of Engineering, Pune for his constant support and encouragement.

We would like to express our thanks to Prof. P. M. Bagul, Project Guide, for her invaluable guidance, constant supervision and sustained encouragement throughout the tenure in this project work.

We are thankful to our parent & friends for their kind help and support throughout the course.

MR. ROHIT TONDARE

MR. RAHULNARAYAN IYER

MR. ADITYA UNDRE

MS. AKANKSHA PATIL

INDEX

(CONTENTS)

Sr No.	Title	Page No.
1	Abstract	7
2	Introduction	8
3	Literature Survey	10
4	Proposed Work	12
5	Theory and Concepts	14
6	Flow Chart	20
7	Results	21
8	References	24

INDEX

(FIGURES)

Sr No.	Title	Page No.
1	Block diagram	12
2	Node MCU	14
3	Raspberry pi	15
4	SSD Model	17
5	Communication	18
6	Output of SSD model	21
7	Output of SSD model	21
8	Output of SSD model	22
9	Output of SSD model with Region of Interest	22
10	Output of TomTom Maps API	23

INDEX

(FIGURES)

Sr No.	Title	Page No.
1	Comparison of different Models based on FPS	16
2	Comparison of different Models based on Accuracy	16
3	Accuracy v/s FPS	17

ABSTRACT

In recent era, due to the increase in population and the number of vehicles bought, there is a problem of congestion of traffic in the major cities around the globe. This not only increases the time delay but also increases the fuel consumption and air and noise pollution. It is observed that conventional traffic flow is intricate and non predictable. There is also a lack of synchronization between signals due to which additional traffic jams are created. Furthermore emergency vehicles like ambulances, fire trucks etc. are delayed. This project aims to solve the aforementioned problems by implementing real time control of the traffic signals using Image Processing, IoT and Object detection. Embedded Systems are small and can be integrated with the existing infrastructure in order to reduce the cost and complexity. We have proposed the use of Image Processing and Object Detection to calculate the density of traffic and also to identify Emergency vehicles, and IoT in order to attain synchronization between signals.

CHAPTER I

INTRODUCTION

1.1 Introduction to Dynamic Traffic Light Control.

Automobile is a great invention for people to travel and extend their reach. Unfortunately, in recent times the increasing number of vehicles can cause a series of economical and social problems. However due to limited availability of land, the roads cannot be widened to suit the traffic needs. Conventional traffic light systems use a fixed cycle of predefined pattern to control the dynamically changing traffic flow. There are numerous conventional methods for traffic signal control but most of them sometimes fail to deal efficiently with the complex, time-varying traffic conditions and controller can't satisfy real-time character for traffic signal. The existing methods for traffic signal control can be classified into two categories: Fixed-Time strategies and Traffic-Responsive strategies. Fixed-Time strategies use historical traffic information to decide traffic signal settings, while Traffic-Responsive strategies make use of real-time measurements to calculate in real time the suitable signal settings. Dynamic Traffic Light Control refers to the control of flow of traffic via the signals in real time i.e. Traffic Responsive strategy.

1.2 Need of Dynamic Traffic Light Control.

It commonly occurs that, at a particular intersection there is high density of traffic in one lane and there is very low density of traffic in the others. Despite that, the green time for all the lanes is the same. Another major problem is the excess waiting time for emergency vehicles. Due to the static nature of current system, there is no easy way to detect emergency vehicles. As there is no synchronization between signals, there is no free flow of traffic which increases the overall waiting time. Due to this Emergency vehicles are stuck in traffic and can be fatal for patients.

1.3 Advantages of Dynamic Traffic Light Control.

Dynamic Traffic Light Control will provide synchronization between signals, ensure priority to Emergency vehicles and drastically reduce the waiting time while taking full

advantage of the existing infrastructure. Giving priority to Emergency vehicles will help save lives. Synchronization between signals will ensure that the Emergency vehicle is getting a free lane as well as ensure free flow of traffic. Calculation the density of traffic will help reduce the overall waiting time at a signal.

CHAPTER II

LITERATURE SURVEY

2.1 Survey

In our personal interview with the DCP of Traffic, Pune, he mentioned that currently there is a huge lack in infrastructure in our city. The road and signal infrastructure is not able to cope up with the rapid growth in the number of cars. The number of vehicles is increasing but the width of the roads is stagnant. As there are a lot of malls and buildings, increasing the width of the roads is not possible. Therefore a system is needed that will allow the movement of these vehicles in an organized manner. A similar technology is being used at 50 intersections in Pittsburgh and since launching, it has reduced wait times at intersections by up to 40%, according to the company. It also claims that journey times in the city have fallen by 25% while vehicle emissions have dropped by up to 20%. In Hagen, Germany, they are using artificial intelligence to optimize traffic light control and reduce the waiting time at an intersection. Simulations suggest it can decrease waiting times at lights by up to 47% compared to a traditional pre-timed signal plan. The system is already predicting traffic conditions 15 minutes in advance with 89% accuracy compared to what happens in reality.

- CHEN Wenjie et.al [1] proposed a system which implements a realtime dynamic traffic control system.
- Yi Tian et.al [2] proposed, “A Fuzzy Logic Controller with Adaptive Dynamic Programming Optimization for Traffic Signals”, in which the traffic control is done with different types of programming optimization for the control of traffic flow.
- Wei Wu and Wang Mingjun [3] proposed, “Research on Traffic Signal Control Based on Intelligence Techniques”, in which different techniques for traffic signal control were discussed.
- LilinZanget.al [4] proposed, "An Intelligent Control Method for Urban Traffic Signal Based on Fuzzy Neural Network", in which the traffic control was done based on a neural network which implemented Fuzzy Logic.

- OmkarRamdasGaikwad et.al [5] proposed, “Image Processing Based Traffic Light Control”, in which image processing was used to determine the number of vehicles in a particular lane.
- Md. Munir Hasan, et. al [6] proposed, “Smart Traffic Control System with Application of Image Processing Techniques”, in which a smart traffic control system is used and the traffic density is determined with the help of image processing.
- Md. Fahim Chowdhury et. al [7] proposed, "Real Time Traffic Density Measurement using Computer Vision and Dynamic Traffic Control", in which the traffic density is determined with the help of computer vision and dynamic programming.
- Paul Jasmine Rani. L et. Al [8] proposed, "DYNAMIC TRAFFIC MANAGEMENT SYSTEM USING INFRARED (IR) AND INTERNET OF THINGS (IoT)", in which the traffic density is determined with the help of IR sensors and they communicate with the main controller through IoT.

CHAPTER III

PROPOSED WORK

3.1 Problem Statement

The purpose of this project is to develop a system that will solve the issue of excess traffic on a particular signal as well as have total synchronization between all the signals in a particular area. Additionally there is a problem for the emergency vehicles of not being able to pass through the signal without the presence of a traffic cop.

3.2 Motivation.

It commonly occurs that, at a particular intersection there is high density of traffic in one lane and there is very low density of traffic in the others. Despite that, the green time for all the lanes is the same. Another major problem is the excess waiting time for emergency vehicles. Due to the static nature of current system, there is no easy way to detect emergency vehicles. Therefore we are inclined to design a system that will detect the lane with highest traffic and make its signal green. In case an emergency vehicle is detected that particular lane will be given highest priority until the emergency vehicle has passed.

3.3 Block Diagram

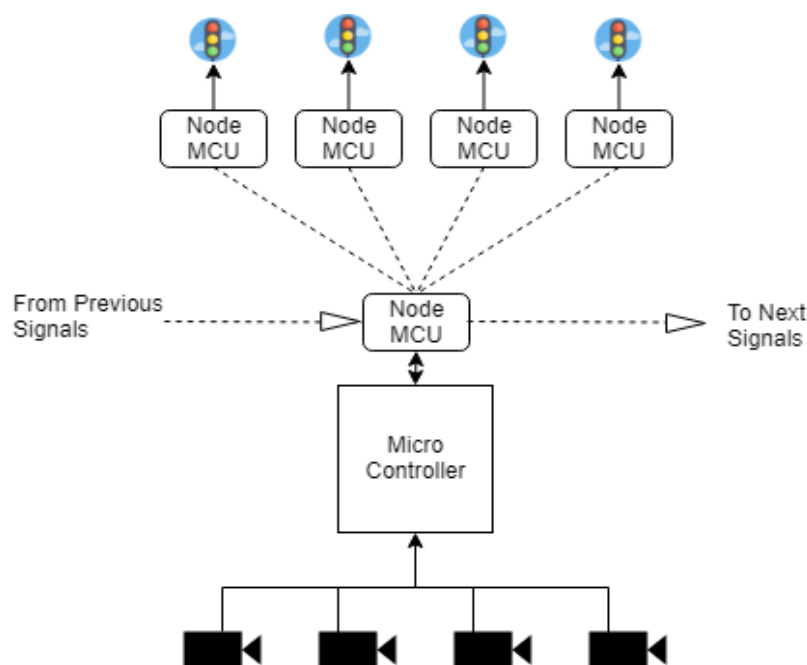


Figure 1 Block Diagram

3.4 Methodology.

In order to reduce the waiting time at a signal, we are proposing the use of Dynamic Traffic Light control with the help of Image Recognition, IoT and Object detection. The major data will be collected from the existing CCTV cameras. With the help of the data from the CCTV cameras, Emergency vehicles also will be detected. With the help of this system, there will be no waiting time for Emergency vehicles. There will be intercommunication between signals at adjacent intersections as well as between the signals at an intersection in order to have a full interconnection and synchronization in the system. This data will be backed up by data from maps provided by TomTom Maps API. TomTom maps has an API called Traffic API which will provide the data required for the backing the data from the CCTV cameras.

CHAPTER IV

THEORY AND CONCEPTS

1.1 Introduction to IoT.

The term “Internet of Things” was coined by Kevin Ashton in 1999. The ‘Thing’ in IoT can be any device with any kind of built-in-sensors with the ability to collect and transfer data over a network without manual intervention. The embedded technology in the object helps them to interact with internal states and the external environment, which in turn helps in decisions making process. In a nutshell, IoT is a concept that connects all the devices to the internet and let them communicate with each other over the internet. IoT is a giant network of connected devices – all of which gather and share data about how they are used and the environments in which they are operated.

1.2 Hardware used in IoT

In order to connect the devices to the internet, a Wi-Fi module is used. In our project we are using an ESP8266 derived module called NodeMCU. ESP8266 is a Wi-Fi microchip which was developed by Espressif Systems that comes with both TCP/IP and a microcontroller. NodeMCU supports the MQTT protocol using Lua access the MQTT broker and can also drive various LCD's, Relays, etc.

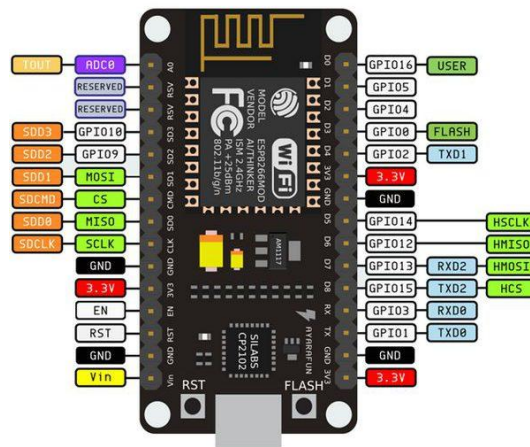


Figure 2NodeMCU

1.3 Introduction to Image Recognition and Object Detection

Image Recognition or Object Detection refers to the process of identifying all the objects present in a particular image. An image recognition algorithm takes an image as input and

outputs what the image contains. In other words, the output is a class label (e.g. “cat”, “dog”, “table” etc.). In order to recognize the objects in the image, the algorithm has to be trained to learn the differences between different classes. In order to make the job easier of the Image Recognition algorithm a few pre-processing steps are performed. Basically the pre-processing is used to normalize the brightness and contrast of the images. Sometimes even Gamma correction also produces slightly better results.

1.3.1 Hardware used for Image Recognition and Object Detection

The Raspberry Pi is a small credit-card sized computer developed in the United Kingdom by the Raspberry Pi Foundation. CPU speed ranges from 700 MHz to 1.2 GHz for the Pi 3 & has 1 GB of RAM. SD cards are used to store the operating system and program memory. It has four USB slots, HDMI and composite video output, and a 3.5 mm phone jack for audio. For lower level output it has a number of GPIO pins which support common protocols like I²C. Pi 3 is also equipped with Wi-Fi 802.11n and Bluetooth. There is a list of operating systems supported by Raspberry Pi like RISC OS Pi, FreeBSD, NetBSD, Plan 9 from Bell Labs, Windows 10 IoT Core, xv6, Haiku, HelenOS, Genode OS Framework and many more. The Raspberry Pi Foundation recommends the use of Raspbian, a Debian-based Linux operating system.

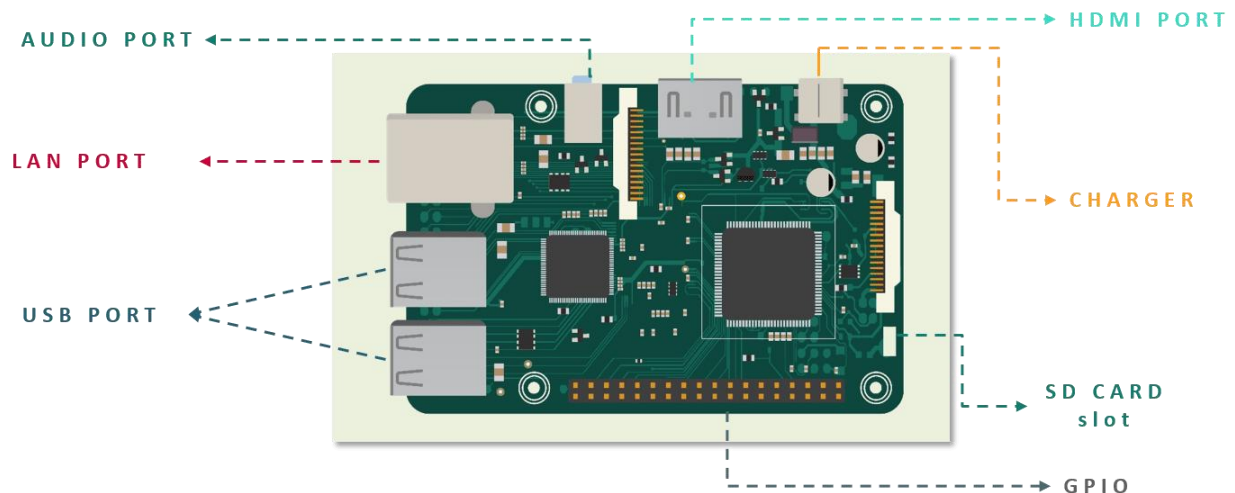


Figure 3 Raspberry Pi

4.4 Object Detection.

The major data to the system is provided by the CCTV cameras. Object Detection is used in order to determine the density of traffic. A number of different AI object detection models are available viz. SSD, YOLO, Mobile-Net, etc. After comparing the different models, the SSD model was selected as it has good performance to accuracy ratio and can be computed on embedded devices like the Raspberry Pi.

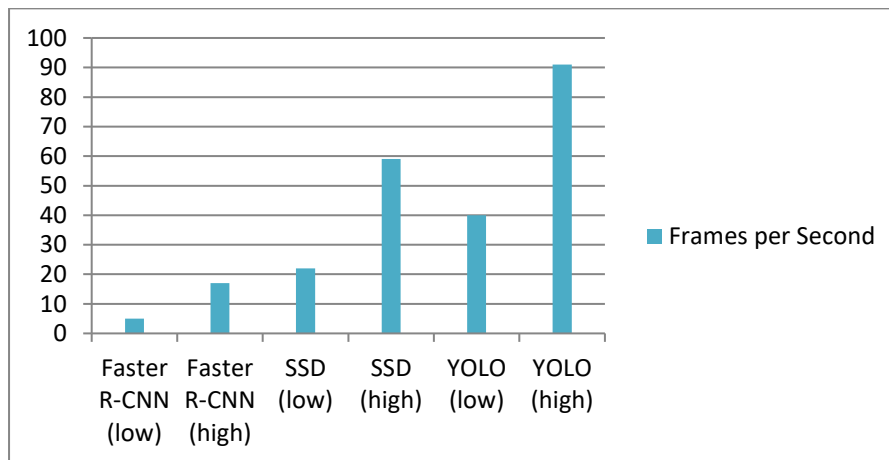


Chart 1

Frames Per Second (FPS) is the number of frames a particular model can compute with per second. Chart 1 shows the comparison between different Object detection models based on the FPS. It can be concluded that YOLO has the highest FPS and SSD high model has the second best FPS.

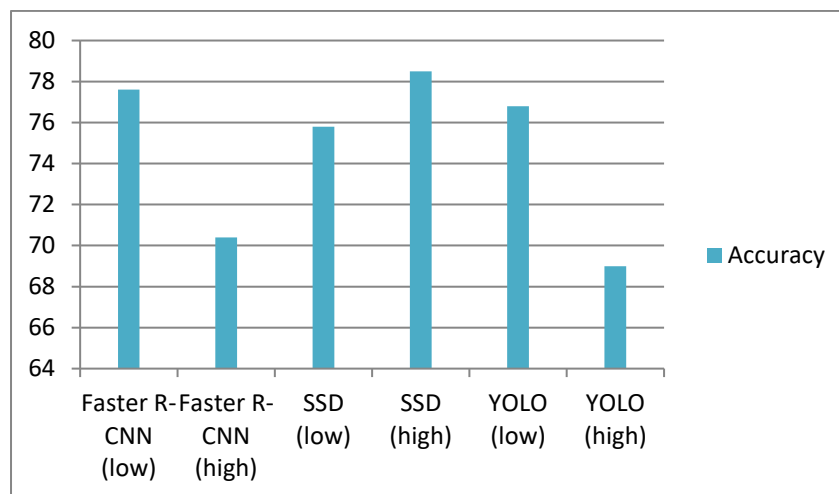


Chart 2

The accuracy of a AI object detection and recognition model is defined as the number of objects detected and recognized accurately. Chart 2 shows the comparison between different AI models based on their accuracy. It can be concluded that SSD (high) has the highest accuracy while YOLO has low accuracy.

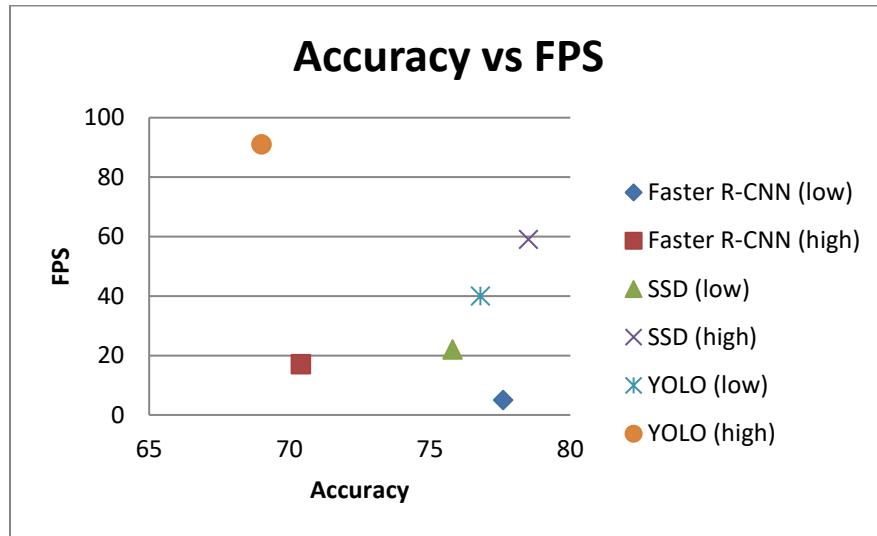


Chart 3

Chart 3 shows the comparison between different AI models based on FPS v/s Accuracy. SSD (high) has the best ratio while YOLO has lowest ratio of FPS v/s Accuracy. In accordance with the observations based on Chart 3, SSD (high) AI model has been selected for object detection and recognition.

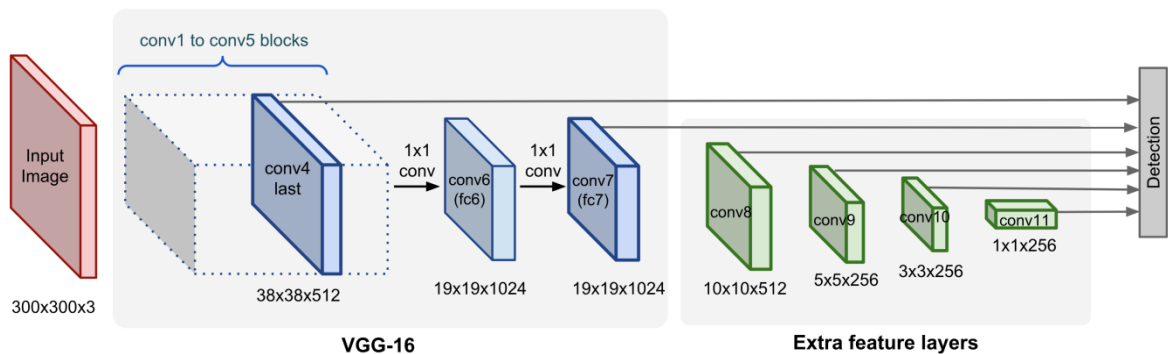


Figure 4 SSD model

4.5 Inter-Communication and Intra-Communication.

The communication between signals at a particular road intersection is called Intra-communication while the transfer of data between signals at different road intersections is called Inter-communication. In order to achieve this, a database on Google Firebase is used. Firebase is a product developed by Google which is used to support the development of mobile and web applications. Google Firebase provides a number of services including: Cloud storage, ML kit, Performance Monitoring, Test Labs, Analytics and many more. For the communication between different nodes, each node will store data with a unique label based on the intersection. The storing and Reading of data will be done with the help of a NodeMCU. When the main controller has to read the data, it can directly access the data from the Web server.

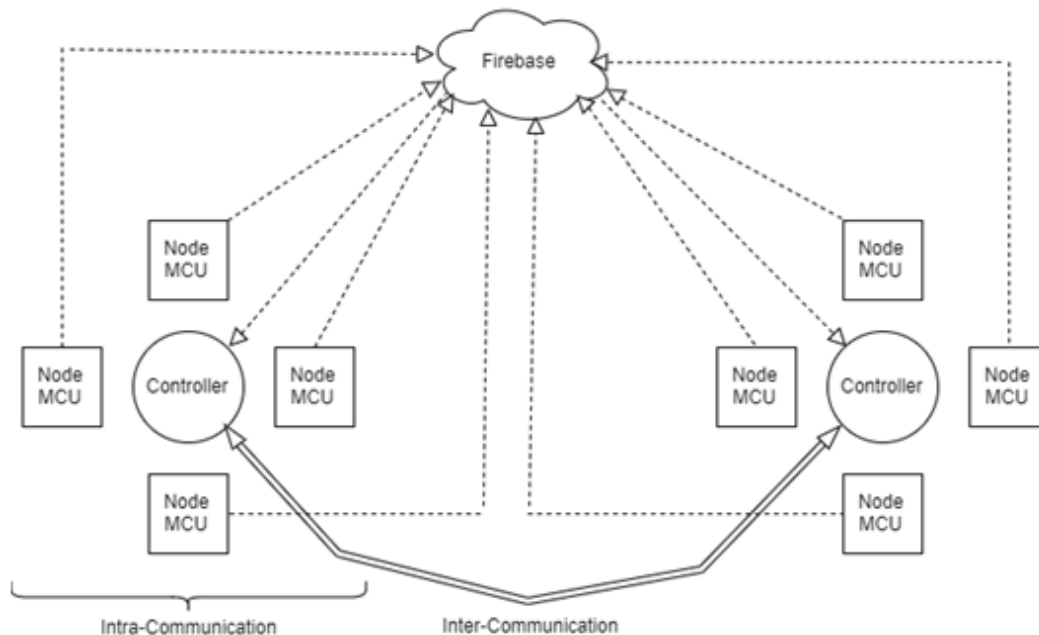


Figure 5 Communication

4.6 TomTom Maps.

In order to support the data recorded by the Object detection and Recognition AI model, live data from the maps is used. TomTom N.V is a multinational developer and creator of location technology and consumer electronics. TomTom provides a number of services for Navigation and also provide API for developers to develop various applications. The API's offered by TomTom are Search API, Routing API, Maps API and Traffic API. For

this application Traffic API is being used. The Traffic API is a suite of web services designed for developers to create web and mobile applications around real-time traffic. These web services can be used via RESTful APIs. The API results are in either of the two formats:

- **Traffic Incidents:** This provides an accurate view about traffic jams and incidents around a road network.
- **Traffic Flow:** This provides real time observed speeds and travel times for all key roads in a network.

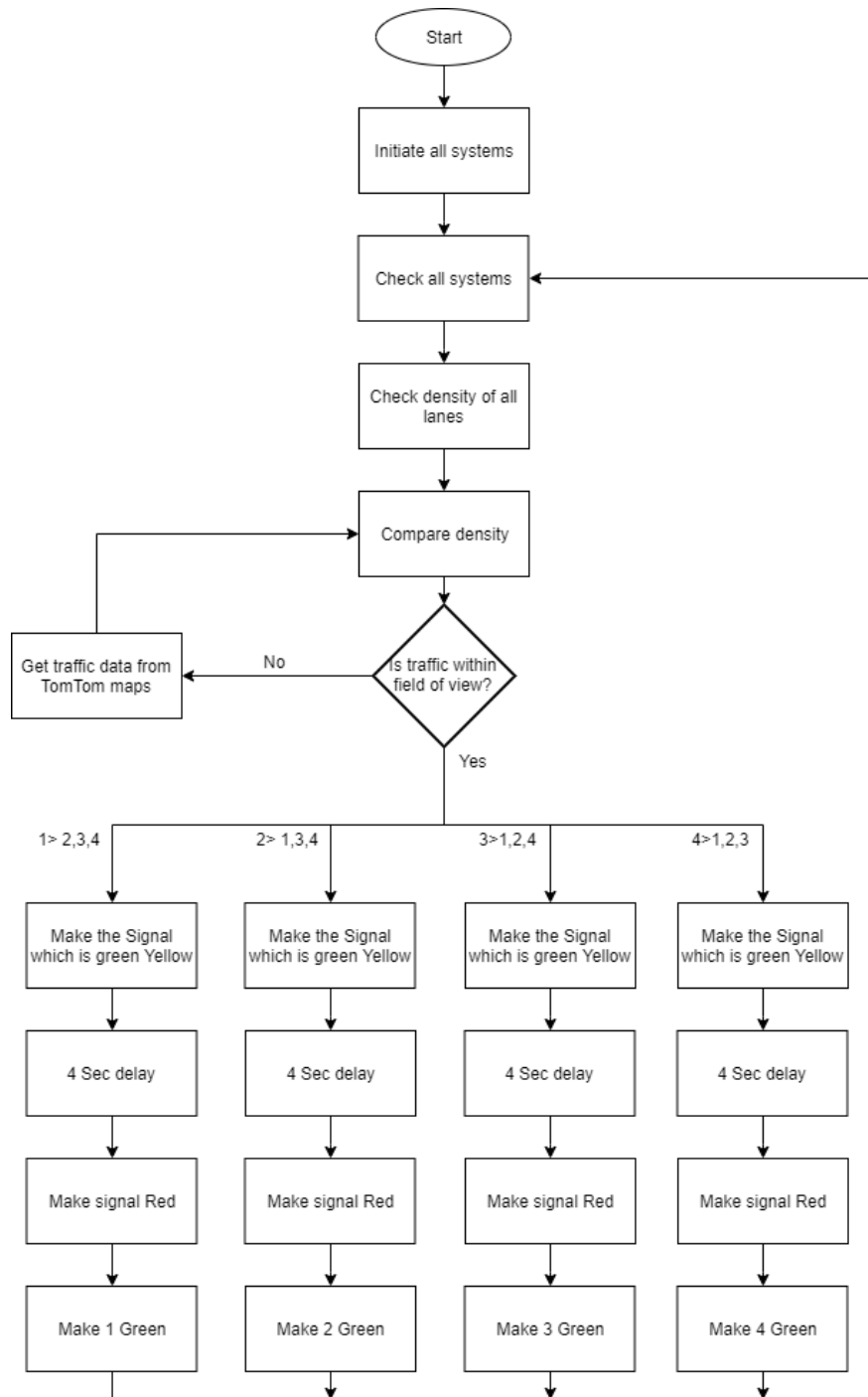
The Traffic Flow offering is used to get real time data from the Traffic API. This data is also affected internally based on the historic data gathered by TomTom maps. The data provided by TomTom maps will come into the picture only when the traffic density is greater than the Field of View of the CCTV camera.

4.7 Emergency Vehicles Recognition.

In order to detect emergency vehicles present in the traffic, the SSD AI model is used. The model will detect the emergency vehicles like Ambulances, Police Vehicles, and Fire Trucks etc. After detection of an emergency vehicle, the system will inform the signal at the particular lane to let the traffic go by making the signal GREEN. To let the people at the other lane know an emergency vehicle is present, the RED light will be ON along with which the YELLOW light will BLINK with a particular frequency.

CHAPTER V

FLOW CHART



6.1 Object Detection

The SSD model has been used for Object Detection. Figure 6,7 and 8 show the output obtained after applying the SSD model to a test video. Figure 9 shows the output of the SSD model with the Region of Interest. The region of interest was added to define the lane of a particular intersection.

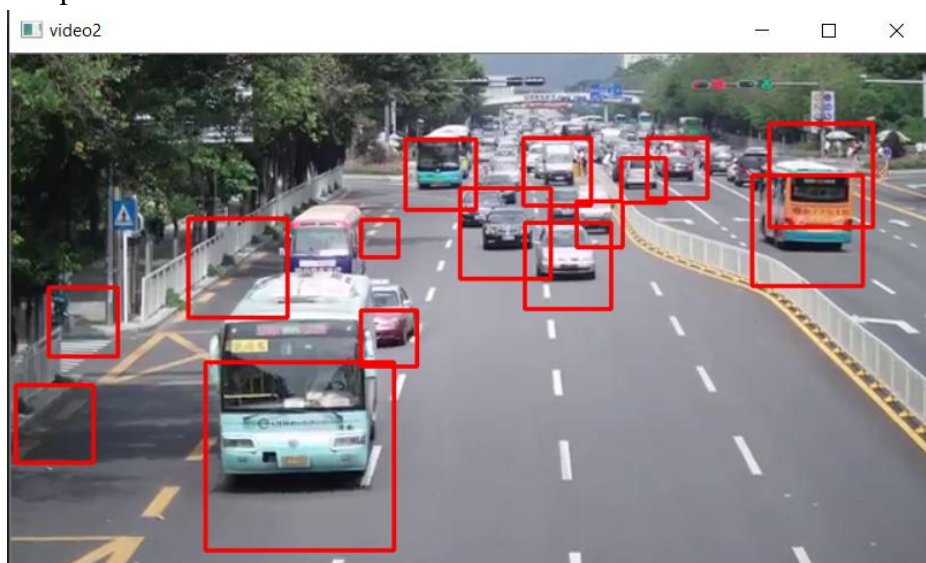


Figure 6 Output of SSD model

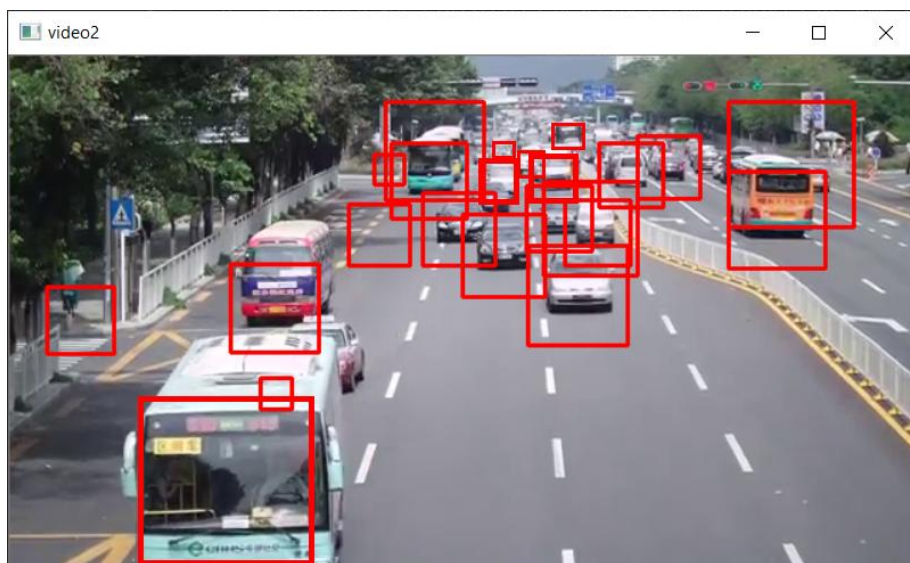


Figure 7 Output of SSD model

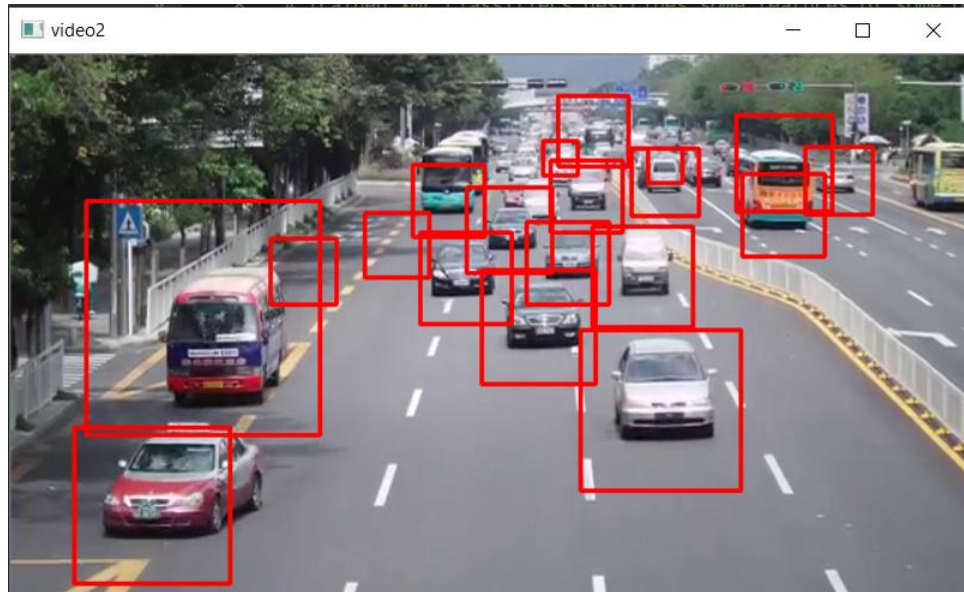


Figure 8 Output of SSD model

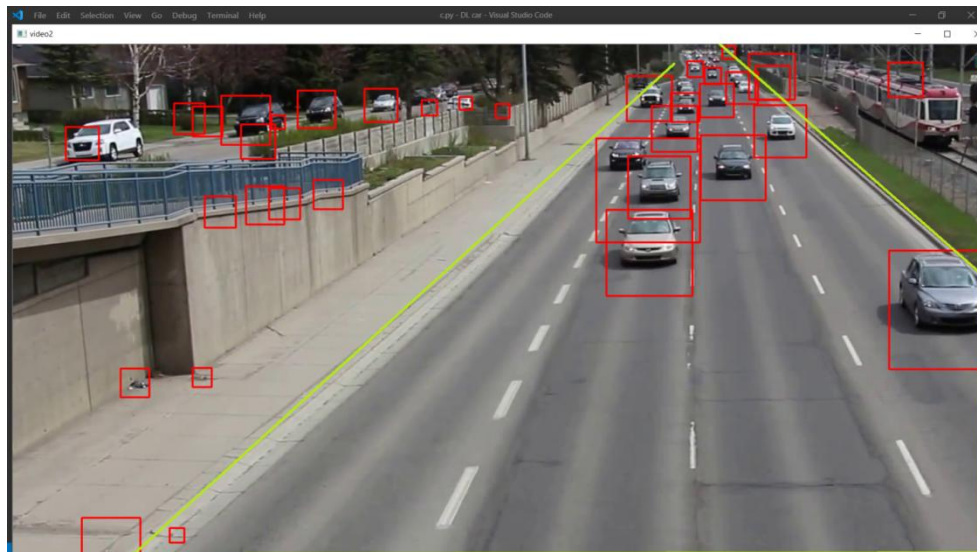


Figure 9 Output of SSD model with Region of Interest

6.2 TomTom Maps

Figure 10 shows the output of the TomTom Maps API. The API will return the value in xml format which can be later used to extract the necessary information. The input to the API is the co-ordinates of the point at which traffic data is required. The API returns values like Current Speed, Free Flow Speed, Travel Time and Confidence. The Confidence field is the accuracy level of the results.

```
<?xml version="1.0" encoding="UTF-8"?>
  <flowSegmentData version="traffic-service 3.0.010">
    <frc>FRC2</frc>
    <currentSpeed>6</currentSpeed>
    <freeFlowSpeed>25</freeFlowSpeed>
    <currentTravelTime>498</currentTravelTime>
    <freeFlowTravelTime>119</freeFlowTravelTime>
    <confidence>0.960000</confidence>
    <roadClosure>false</roadClosure>
    <coordinates>
      <coordinate>
        <latitude>18.540740</latitude>
        <longitude>73.881609</longitude>
      </coordinate>
      <coordinate>
        <latitude>18.539524</latitude>
        <longitude>73.880839</longitude>
      </coordinate>
      <coordinate>
        <latitude>18.539029</latitude>
        <longitude>73.880524</longitude>
      </coordinate>
      <coordinate>
        <latitude>18.538875</latitude>
        <longitude>73.880426</longitude>
      </coordinate>
      <coordinate>
        <latitude>18.538556</latitude>
        <longitude>73.880215</longitude>
      </coordinate>
      <coordinate>
        <latitude>18.538295</latitude>
        <longitude>73.880040</longitude>
      </coordinate>
    </coordinates>
  </flowSegmentData>
</xml>
```

Figure 10 Output of TomTom Maps API

REFERENCES

- [1] CHEN Wenjie, CHEN Lifeng, CHEN Zhanglong, TU Shilian, “A realtime Dynamic Traffic Control System”, 2005
- [2] Yi Tian, Dongbin Zhao, and Jianqiang Yi, “A Fuzzy Logic Controller with Adaptive Dynamic Programming Optimization for Traffic Signals”, 2008
- [3] Wei Wu and Wang Mingjun, “Research on Traffic Signal Control Based on Intelligence Techniques”
- [4] LilinZang, Yonggang Luo and Lei Jia, "An Intelligent Control Method for Urban Traffic Signal Based on Fuzzy Neural Network", 2006
- [5] OmkarRamdasGaikwad, Anil Vishwasrao, Prof.Kanchan Pujari and TejasTalathi, “Image Processing Based Traffic Light Control”, 2014
- [6] Sarath S and Deepthi L.R, "Priority Based Real Time Smart Traffic Control System Using Dynamic Background", 2018
- [7] Md. Munir Hasan , GobindaSaha , AminulHoque and Md. BadruddojaMajumder ,“Smart Traffic Control System with Application of Image Processing Techniques”, 20114
- [8] Md. Fahim Chowdhury, Md. Ryad Ahmed Biplob, Jia Uddin, "Real Time Traffic Density Measurement using Computer Vision and Dynamic Traffic Control", 2018
- [9] Paul Jasmine Rani. L, Khoushik Kumar. M, Naresh. K. S and Vignesh. S , "DYNAMIC TRAFFIC MANAGEMENT SYSTEM USING INFRARED (IR) AND INTERNET OF THINGS (IoT)", 2017