DAYANANDA SAGAR UNIVERSITY

MACHINE LEARNING PROJECT REPORT

ON

“INTELLIGENT TRAFFIC CONTROL SYSTEM FOR EMERGENCY VEHICLES”

BACHELOR OF TECHNOLOGY

IN

COMPUTER SCIENCE & ENGINEERING

Submitted by

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BONAFIDE CERTIFICATE

This is to certify that the project titled **“Intelligent Traffic Control System For Emergency Vehicles”** is a bonafide record of the work done by **KUNAL SHARMA (ENG18CS0143)**,**SASWATH (ENG17CS0196)** in partial fulfillment of the requirements for the award of the degree of **Bachelor of Technology** in **Computer Science and Engineering** Specialization of the **DAYANANDA SAGAR UNIVERSITY, BANGALORE,** during the year **2021-2022.**

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Teacher

ABSTRACT

Traffic is a significant issue in our nation, particularly in urban ranges. Aftereffect of this, activity clog issue happens. Emergency vehicles confront bunches of issue to achieve their goal on account of congested driving conditions, coming about loss of human lives. The project aims to develop an Intelligent Traffic Control System for the emergency vehicles by recognizing siren sound and the image of emergency vehicles. This consists of a ML service running in Raspberry Pi. The sensors installed in the Traffic Poles will pick up the siren sound, the image and sends it to the AI system for recognition, which in turn clears the respective signal. Poles with sound sensors will be attached at farther distances from the traffic pole. The system will be trained to recognize and provide solutions for ambulance siren sounds in different traffic situations.

ACKNOWLEDGEMENT

I express my sincere thanks and gratitude to my university DAYANANDA SAGAR UNIVERSITY for providing me an opportunity to fulfill my most cherished desire of reaching my goal and thus helping me to make a bright career.

I am grateful to my project guide **Dr. Rajesh T M,** Department of Computer Science and Engineering, DSU, Bangalore for his valuable guidance, encouragement and for extending all possible help in timely completion of the project.

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Finally, I am thankful to my parents and friends, who helped me in one way or the other throughout my project work.

KUNAL
SASWATH

DECLARATION

We Kunal and Saswath, students of 7th semester B.Tech in Computer Science and Engineering, Dayananda Sagar University, Bengaluru, hereby declare that titled “Intelligent Traffic Control System For Emergency Vehicles” submitted to Dayananda Sagar University during the academic year 2020-2021, is a record of an original work done by us under the guidance of Dr. Rajesh T M, Department of computer science engineering, Dayananda Sagar University, Bengaluru. This project work is submitted in partial fulfilment for the award of the degree of Bachelor of Technology in Computer Science. The result embodied in this thesis not been submitted to any other university or institute for the award of any degree.

KUNAL

SASWATH

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Chapter 1

1.1 Introduction

INDIA is one of the fast growing economies in the world and it is second most populous Country. In India traffic congestion problem happens frequently. Day by day number of vehicles are increasing exponentially but to cope up with this exponential growth India does not have any traffic control mechanism. Also, the traffic in Indian is disordered and it is non lane based. For solving such problems it required very accurate traffic control system.

Homo sapiens are evolving as time moves on, making our life simpler is a part and parcel of the term evolution, satisfaction is a behavior which every individual wants, this behavior is only exhibited when our needs are fulfilled, to fulfill these requirements each and every organization in modern world extract data from every individual and analyze the requirements on a large scale, these data gathering requires some structured and well defined process like survey, conferences and many other, by concatenating all data that are collected from various resources the firm will come to a conclusion in which the outcome exactly gives what society wants based on this result the organizations start building the solution.

In India due to high population density there are lot of challenges that needs to be addressed, in that one of major issue is “Traffic”, due to traffic congestion many problems arises the major problems are global warming, ozone layer depletion in global level, but it is also determined that due to the toxic gases that are liberated into the open environment humans are suffering from various diseases, all these occurrences will impact the standard of living which is a bad sign for overall growth of a society or nation, one of the main reasons for the traffic congestion for emergency vehicles is haphazard way of parking the vehicle in our society this has been proved by the survey that was conducted by various resources.

The project aims to develop an Intelligent Traffic Control System by recognizing siren sound and image of emergency vehicles. This consists of a ML service running in Raspberry Pi. The sensors installed in the Traffic Poles will pick up the siren sound, the image and sends it to the AI system for recognition, which in turn clears the respective signal. Poles with sound sensors will be attached at farther distances from the traffic pole. The system will be trained to recognize and provide solutions for ambulance siren sounds in different traffic situations.

1.2 Motivation of the Project

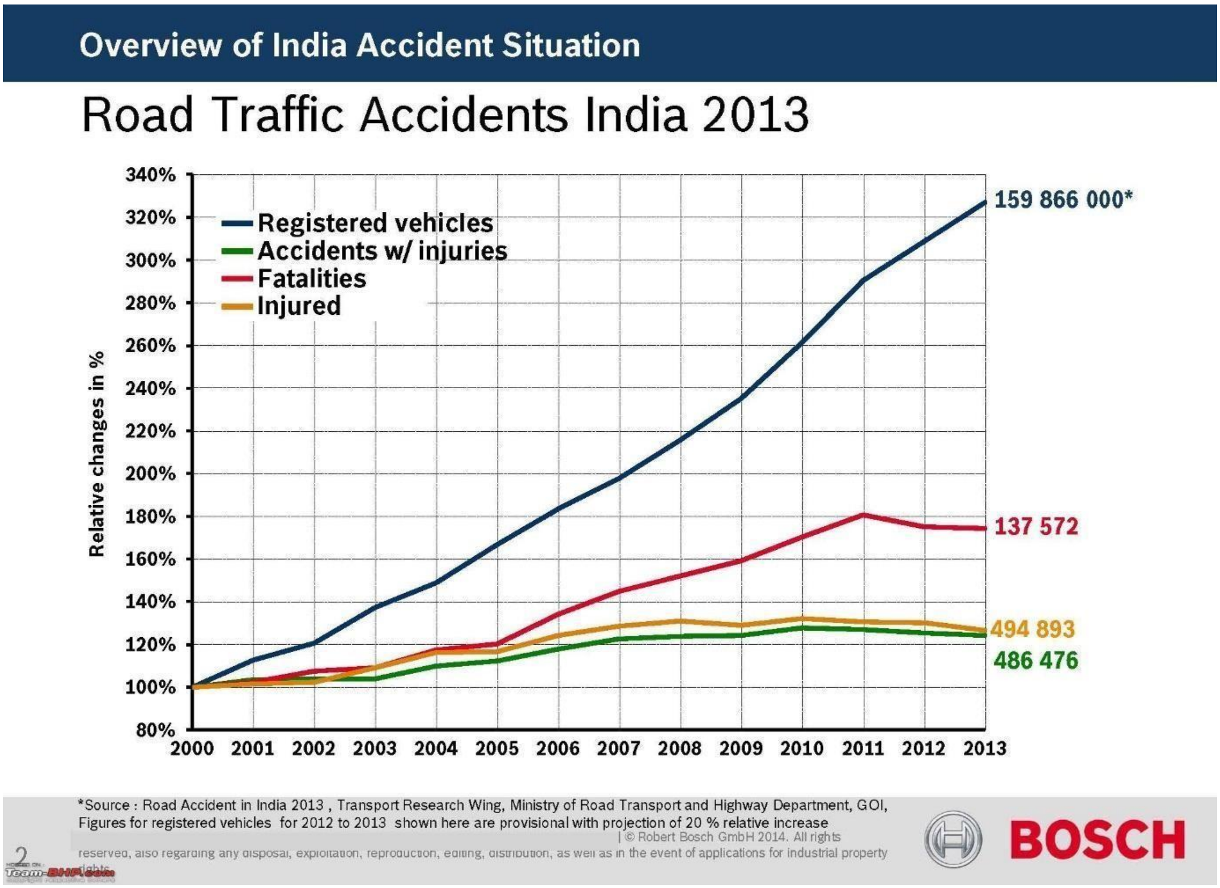

Figure 1. A Survey conducted

The above graph visually represents the data for accident rates in India as the years progresses. The count of vehicles increases, thus building up the chance for accidents. People tend to skip signals on normal driving to save time as well as on the approach of an Emergency Vehicle. The former can be taken up by the law and order of the region by the latter needs some attention from all sides. Emergency vehicles need to be given way immediately to prevent loss of life or property. But skipping signal in such situations causes accidents. The motivation for this project comes from the above observations to develop a better traffic management system for crowded metro cities.

1.3 Objective of this project

This project aims at the following goals :

- Serve as efficient and automated Traffic Management System
- Clear way for Emergency Vehicles

Chapter 2

Problem Statement

This system records sound and image every 3 seconds. The sound and image is processed and classified into emergency vehicle or non-emergency vehicle. If it is emergency vehicle sound and image the traffic signal ischanged to green to pass the emergency vehicle.

Chapter 3
Literature Survey

The road is divided into two lanes. RFID reader in each lane track the vehicles passing through it. Every vehicle has a RFID enabled device that stores a vehicle identification number (VIN). VIN number that provides the information regarding the priority of the vehicle and type of the vehicle.[1] Readers collects the information regarding the vehicles approaching towards the junctions. The Central processing unit calculates the volume and speed of vehicles on each road according to information collected by readers.

Vehicle-to-Vehicle (V2V) wireless communication has gained a considerable attention in the past few years from both the academic community and the automotive industry, due to its applicability in a wide range of promising applications such as safety, non-safety applications and transport efficiency. Modern vehicles are equipped with GPS, wireless cards and several types of sensors allowing them to collect and share traffic flow information with other surrounding roadside units and wireless devices.[2] This can enable a more efficient management of road environment. In this context, the traffic light pre-emption system is considered as one of undergoing active research fields. The purpose of such a system is to provide the vehicles with a clear right-of-way until reaching their destination by dynamically adjusting traffic signals through their trajectories using V2V or Vehicle to-Infrastructure (V2I) communication, which reduces the EVs traveling times and enhances traffic safety.

Upon being interrupted by an emergency signal, the system automatically retains the state of the normal sequence and gives the corresponding road a green light signal as long as the emergency signal is high.[3] As soon as the emergency signal becomes low, the system instantly jumps back to the retained state of the normal sequence. Emergency Signal detection is RFID based. The system is designed using Programmable Logic Controller (PLC) ladder logic program.

The ITSC system consist of high-performance, low power AVR_32 microcontroller with 32kbytes of in-system programmable flash memory and in-built 8-channel, 10-bit ADC which is required to process the IR input from sensor network.[4] The ITSC system will able to deal two basic problem of traditional traffic light system: i) Detection of traffic volume by using genetic algorithm. ii) Emergency vehicle detection such as ambulance, police etc by using wireless sensor network (IR) embedded at the signal intersection.

The various steps of our proposed system are described in Fig 1. A camera is fixed on polls or other tall structures to overlook the traffic scene as seen in Images extracted from the video are then analysed to detect and count vehicles. Then depending on the signal cycle (we have taken it to be 3 minutes), time is allotted to each lane.[5] For example, if the number of vehicles in a four-lane intersection is found to be 10, 30, 20 and 20,then time allotted to each lane is in the ratio 1:3:2:2. The system also takes into account the emergency vehicles at the intersection. If such a vehicle is detected, the lane is given priority over the others.

We use RFID reader, NSK EDK-125-TTL, and PIC16F877A system-on-chip to read the RFID tags attached to the vehicle. It counts number of vehicles that passes on a particular path during a specified duration.[6] It also determines the network congestion, and hence the green light duration for that path. If the RFID-tag-read belongs to the stolen vehicle, then a message is sent using GSM SIM300 to the police control room. In addition, when an ambulance is approaching the junction, it will communicate to the traffic controller in the junction to turn ON the green light.

With the advancement of the wireless communication technologies, the global positioning system, and the development of the vehicle to vehicle (v2v) and vehicle to infrastructure (v2i) systems, called Connected Vehicles (CV), there is an opportunity to simultaneously identify and prioritize multiple vehicle requests for priority service.[7] This paper addresses a decision framework for prioritizing requests for service from multiple modes within an integrated traffic signal control framework.

A system for controlling traffic lights to clear intersections in advance of the approach of an emergency vehicle, in which a directional radio transmitter and antenna are provided on the vehicle, which transmits one or the other of two selected coded signals in the direction of movement of the vehicle.[8] An omni-directional radio antenna and receiver are positioned at the intersection to receive the radiated signal from the vehicle approaching that intersection. The first coded signal includes a first pair of frequencies, and the second coded signal includes a different pair of frequencies, which are decoded by two similar pairs of filters. The signals cause a sequence of events including a closing of an interrupter relay which opens all circuits leading from the traffic light controller to all of the traffic lights, and controls the closing, alternately, of two sets of selected circuits, to apply power alternately to two selected sets of traffic lights.

The proposed RFID traffic control avoids problems that usually arise with standard traffic control systems, especially those related to image processing and beam interruption techniques. This RFID technique deals with a multivehicle, multilane, multi road junction area.[9] It provides an efficient time management scheme, in which a dynamic time schedule is worked out in real time for the passage of each traffic column. The real time operation of the system emulates the judgment of a traffic policeman on duty. The number of vehicles in each column and the routing are proprieties, upon
which the calculations and the judgments are based.

This invention relates to traffic control means for emergency-type vehicles including an on-board plotter screen having a diagram of streets, roads, highways and the like displayed thereon.[10] A light pen is used to draw the preferred route which is then either accepted or rejected in part or as a whole by a computer based on a current street condition program. Once the route has been accepted a traffic signal map program can be activated that will automatically control traffic along the route to the destination of the emergency vehicle.

Chapter 4
System Analysis and Architecture

4.1 System Analysis

System analysis is conducted for the purpose of studying a system or its parts in order to identify its objectives. It is a problem solving technique that improves the system and ensures that all the components of the system work efficiently to accomplish their purpose. Analysis specifies what the system should do.

4.1.1 Introduction to System Analysis

The above defined system records audio and image at every given interval and sends the processed sound and image to prediction system for predicting the class it belongs to. A microphone and a camera fixed to the system does the recording on command from the system and sends the input to the prediction program for getting the prediction. This result is then used to change the signal accordingly.

4.1.2 Existing System

The Existing version of the above mentioned system is implemented using RFID and other sensors primarily to detect emergency vehicles and also track vehicles passing through the signal. RFID sensors attached at the signal poles scan the RFID tags on the vehicle windshields.

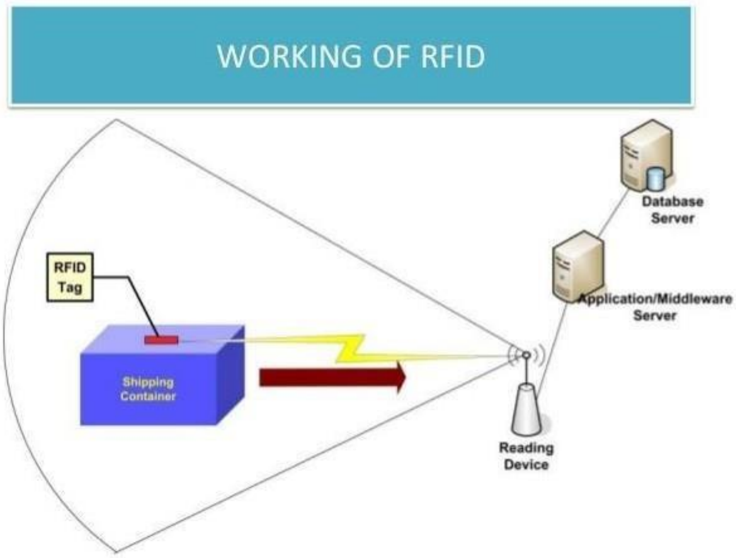

Figure 2. Existing System

Disadvantages :

- Absence of damage of RFID tags can cause error in functioning of the system
- Brings in extra cost to public
- Blockage of emergency vehicles by bigger vehicles in front can cause RFID tag to be invisible to sensor
- The functioning of the system won't be accurate when there are many lanes of vehicles

4.1.3 Proposed System

The Proposed system rules out the above disadvantages by using implementation method as sound recognition rather than RFID. This just requires the system at the traffic pole with interface to signal lights. The microphone and camera installed picks up the sound and image at every interval. The recorded inputs is processed and classified if its emergency vehicle or not. There are no sensors involved in the system and controller co-ordinates all the operations of the system.

4.1.4 Feasibility Study

For the system to be practical in implementation, there requires a few conditions to be satisfied during the construction of the system and during the implementation phase.

- The system should be trained enough using a good dataset to prevent false predictions.
- Since in uses sound as criteria, a study of the environment should be conducted to ensure that sound travels as expected , taking obstructions in the environment into consideration.

4.1.5 System Architecture

The system consists of the following components in action :

- Controller
- Microphone and Camera
- Interface to signal lights

The controller controls and coordinates the working of all components. It contains the prediction system running in it.

Microphone records the audio and Camera captures the image at given intervals upon signal from the controller.

Interface to signal lights takes the control signals from the system and changes the signal lights accordingly.

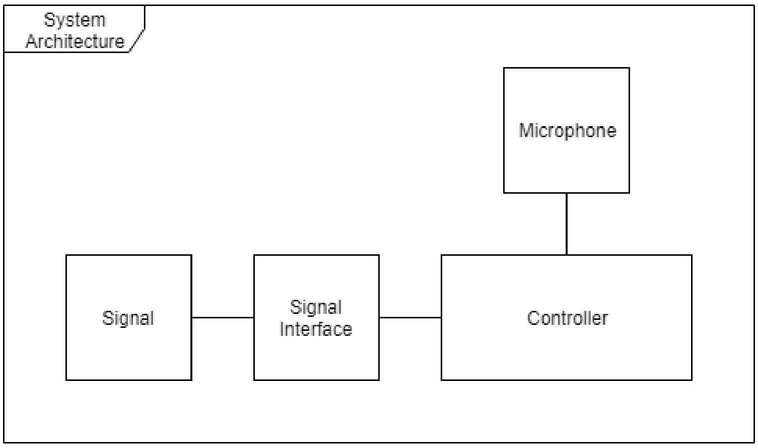

Figure 3. System Architecture

4.1.6 System Requirements

Hardware Requirements

- Raspberry Pi as Controller
- Microphones and Camera
- LED Lights for Signal

Software Requirements

- Python for coding the program
- TensorFlow for Machine Learning and generating predictions
- OpenCV for image processing

Chapter 5
Methodology and Algorithm Design

5.1 Methodology

The core methodology used in this project is Machine Learning. Processed sound clips are send to generate predictions. Though in less amount, Embedded systems also comes into place when controller comes into picture. Controller has connections with Microphone and Signal Interface.

5.2 Algorithm Design

The algorithm is as follows :

1. Start

2. declare spectrogram, pred, sound

3. sound = record_sound(3) //3 refers to 3 seconds time

4. spectrogram = generate_spectrogram(sound) //Processing audio clip for spectrogram

5. pred = predict(spectrogram)

6. if(pred == “Ambulance” or pred=”Firetruck”)

change_signal(green)

else

change_signal(red)

7. goto step 3

8. Stop

Chapter 6
Design

6.1 System Design

Systems design is the process of defining the architecture, modules, interfaces, and data for a system to satisfy specified requirements. Systems design could be seen as the application of systems theory to product development.

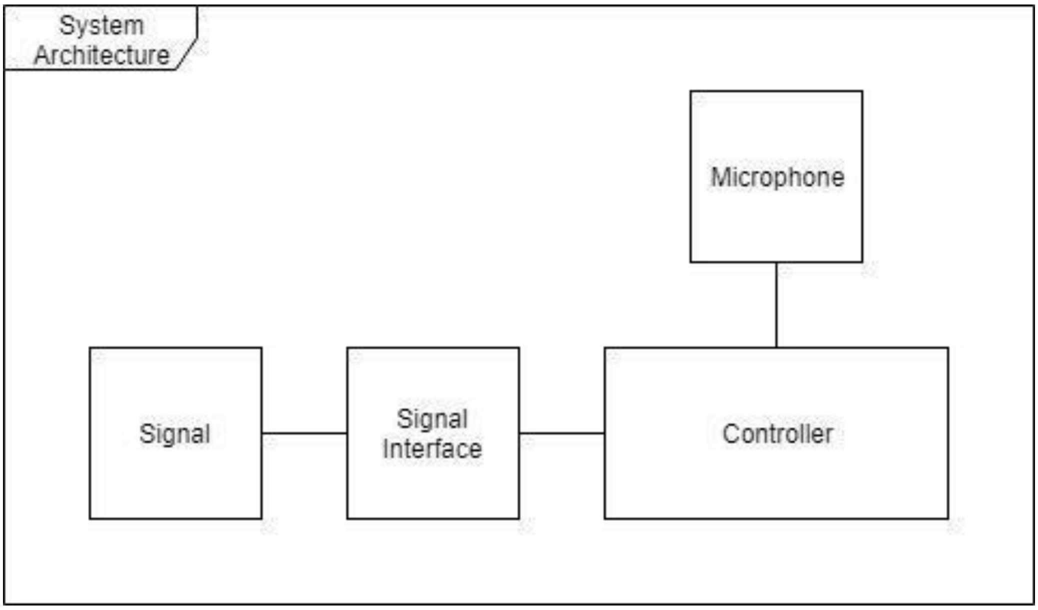

Figure 4. System Design

6.1.1 Logical Design

Logical design pertains to an abstract representation of the data flow, inputs, and outputs of the system. It describes the inputs (sources), outputs (destinations), databases (data stores), procedures (data flows) all in a format that meets the user requirements.

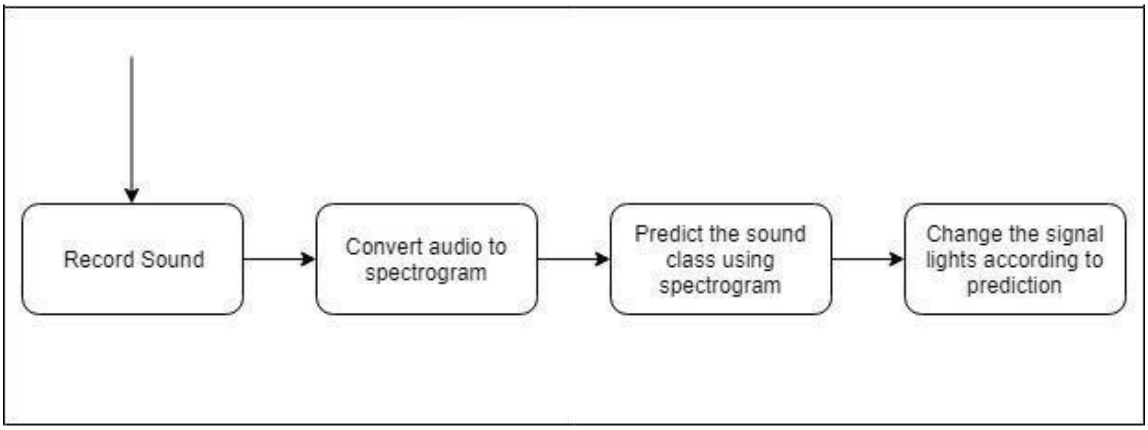

Figure 5. Logical Design

6.1.2 Design Goals

- Correct – does what it is supposed to
- Robust – recover from an error and should not crash
- Flexible – adaptable to shifting requirements
- Reusable – cut production costs for code
- Efficient – good use of processor and memory.

6.2 UML Diagrams

Use Case Diagram

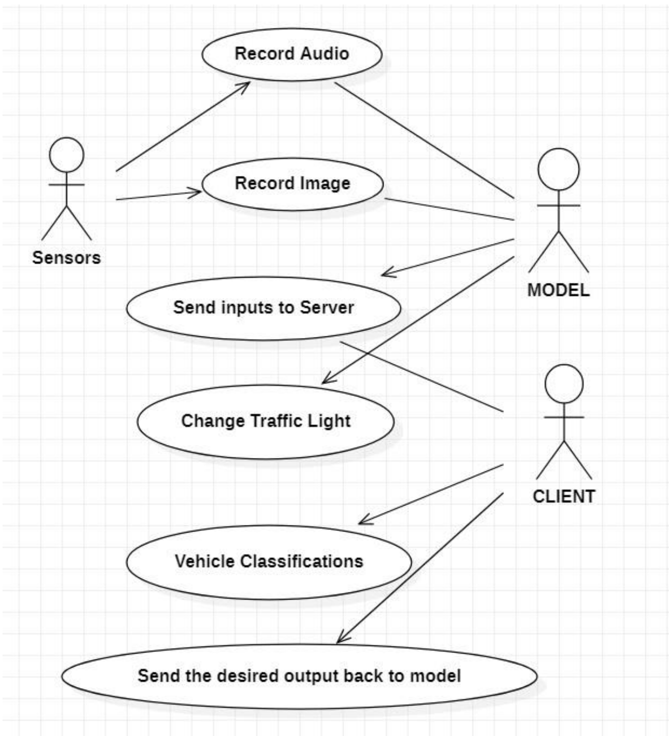

Figure 6. Use Case Diagram

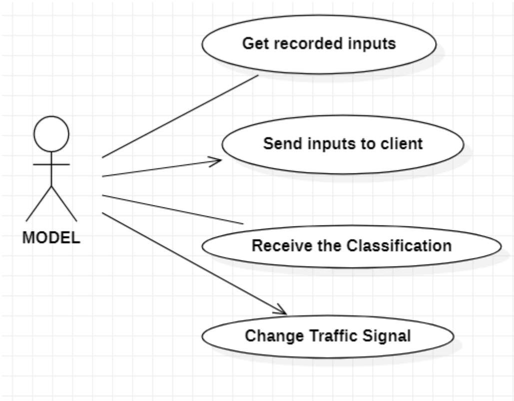

Figure 7. Model Use Case Diagram

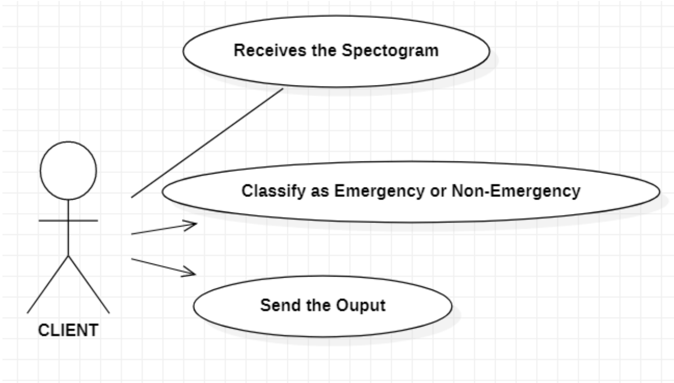

Figure 8. Client Use Case Diagram

Class Diagram

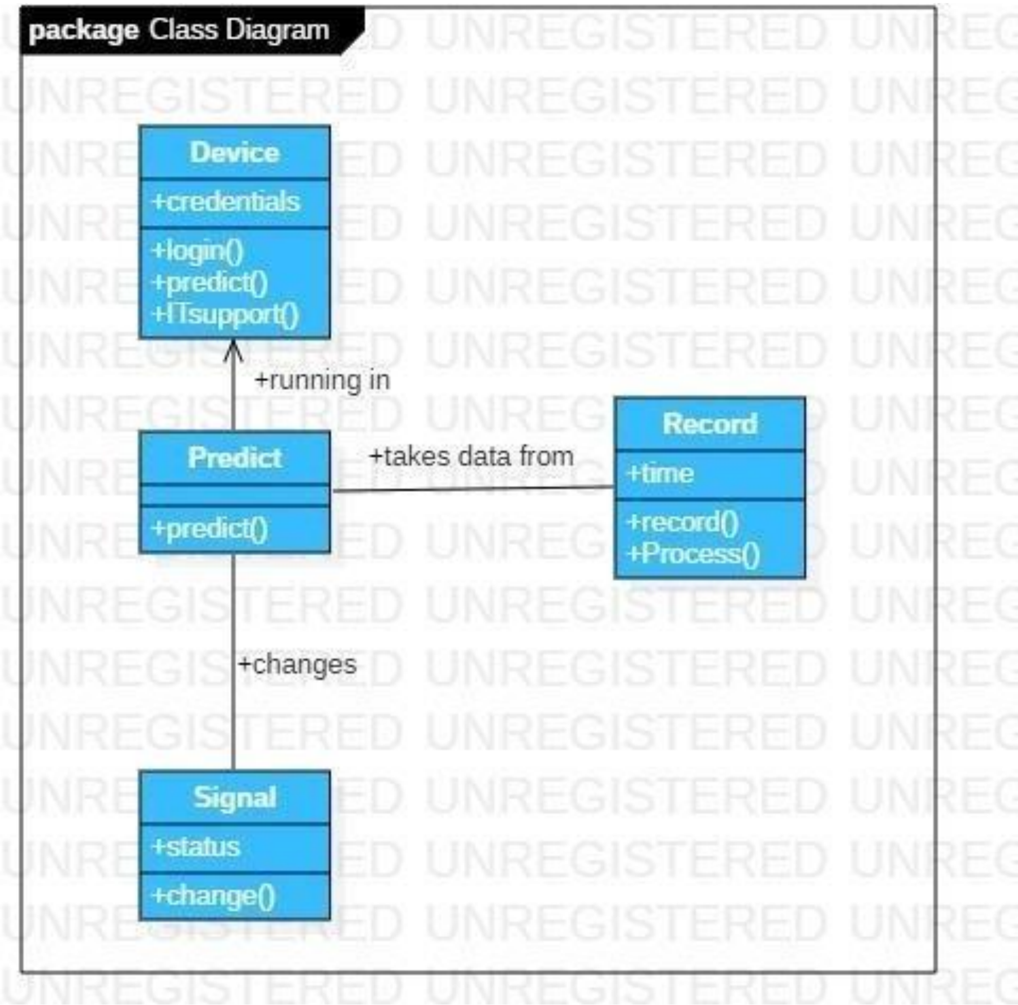

Figure 9. Class Diagram

Activity Diagram

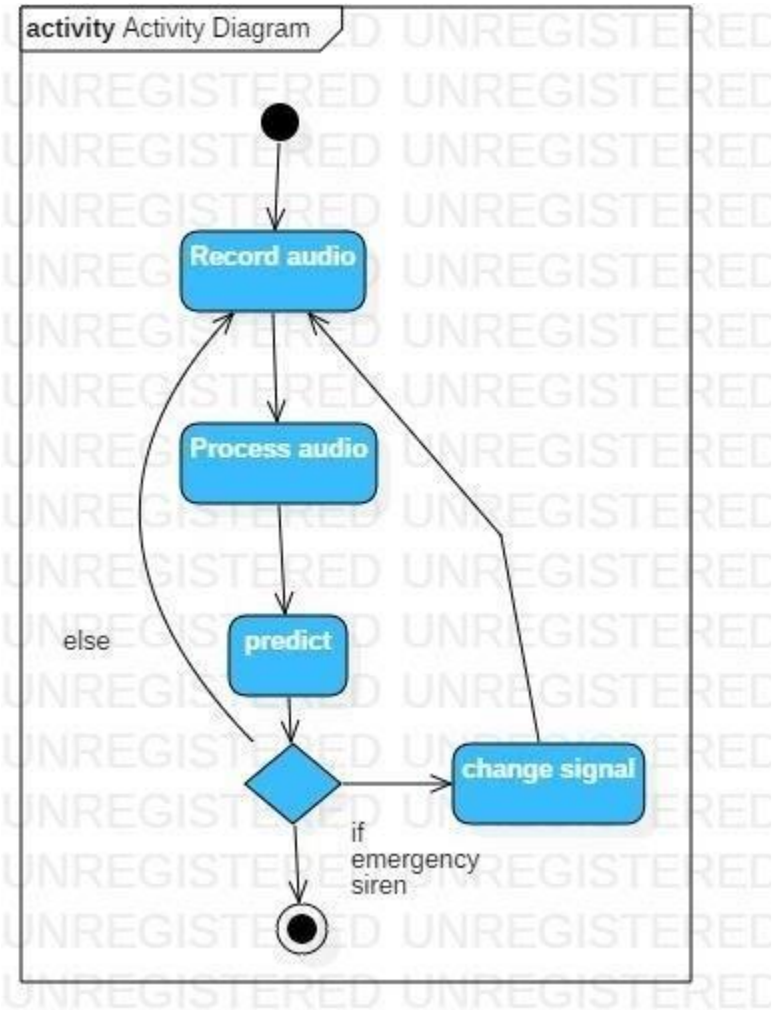

Figure 10. Activity Diagram

State Chart Diagram

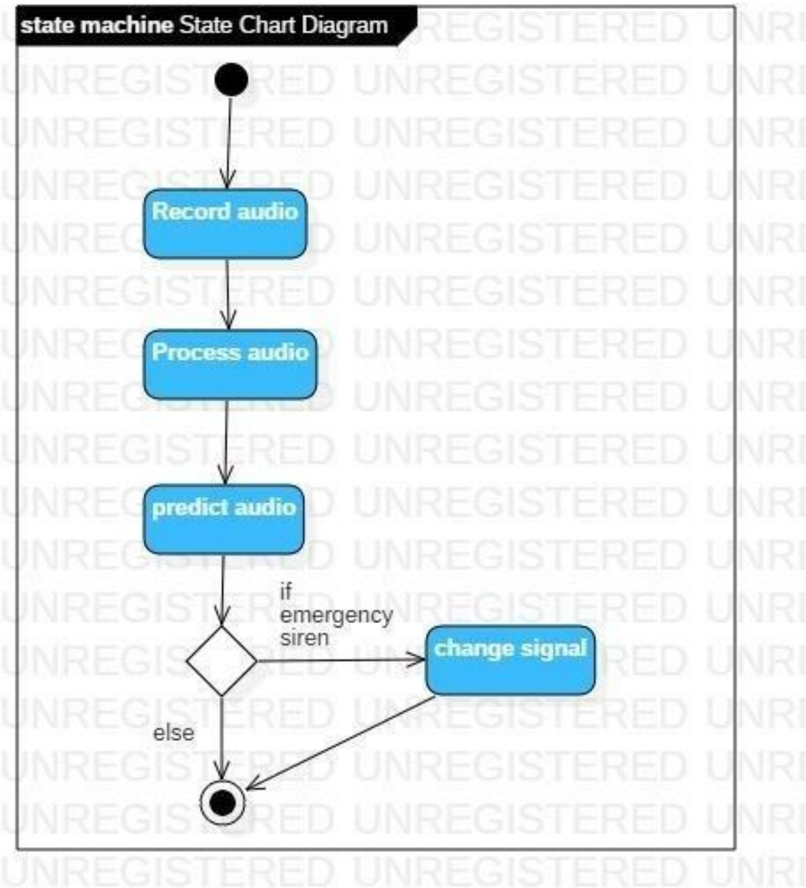

Figure 11. State Chart Diagram

Component Diagram

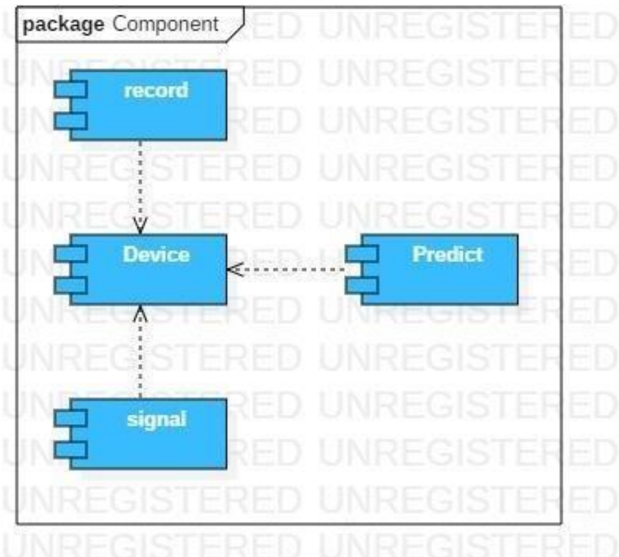

Figure 12. Component Diagram

Deployment Diagram

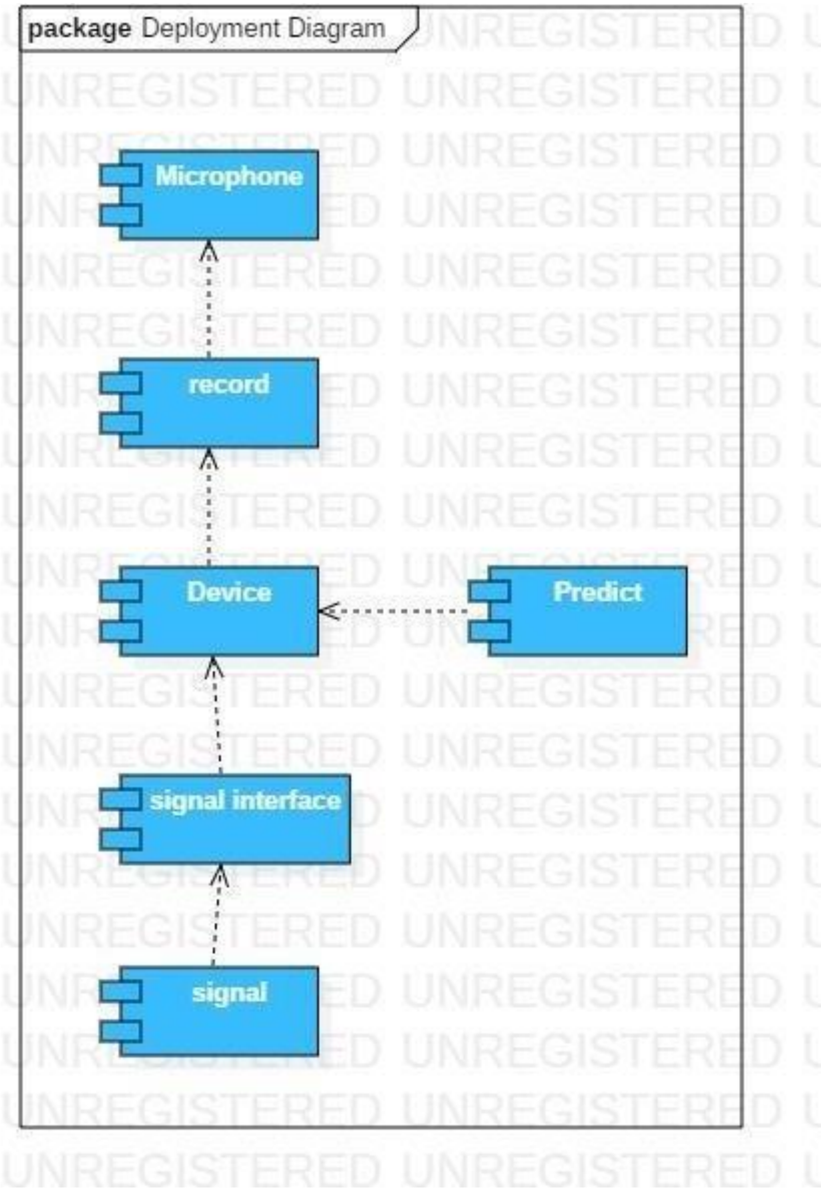

Figure 13. Deployment Diagram

Chapter 7
Implementation

7.1 Technologies Used

The core technologies used are as follows

- Machine Learning : Machine learning here predicts if a recorded sound sample belongs to the class of Emergency siren or not
- Embedded Systems : The recording system, signal system and prediction program all depends on a central controller. This unit controls and coordinates the working of the system.
- Image Processing : Image processing is used to convert the audio to its visual representation knows as spectrogram. The dataset consists of these images.

7.2 Dataset Description

The dataset consists of pre-generated spectrogram images with .png format of size 28 x 28. The dataset can be classified into 3 classes – Ambulance, Firetruck and Traffic.

The dataset as a whole consists of 600 spectrograms divided among 3 classes. Each class has 200 spectrograms out of which 170 goes for training and 30 goes for testing. The test set contains a total of 90 items – 30 for each class.

The spectrogram for each class is shown below :

Ambulance :

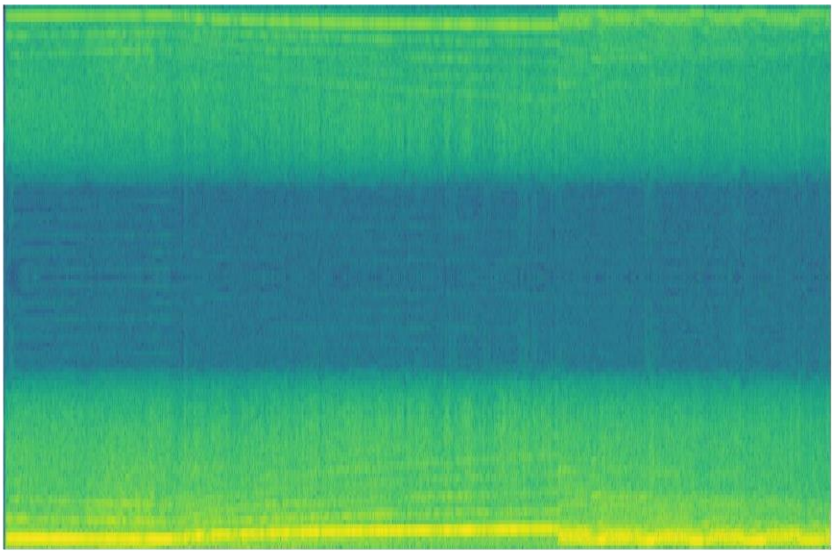

Figure 14. Ambulance Spectrogram

Firetruck :

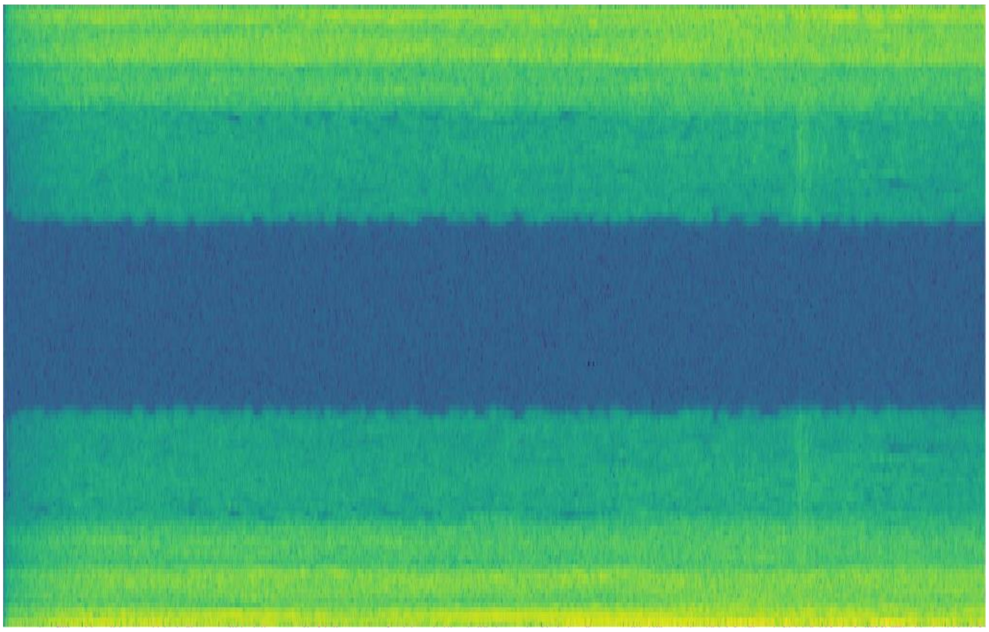

Figure 15. Firetruck Spectrogram

Traffic :

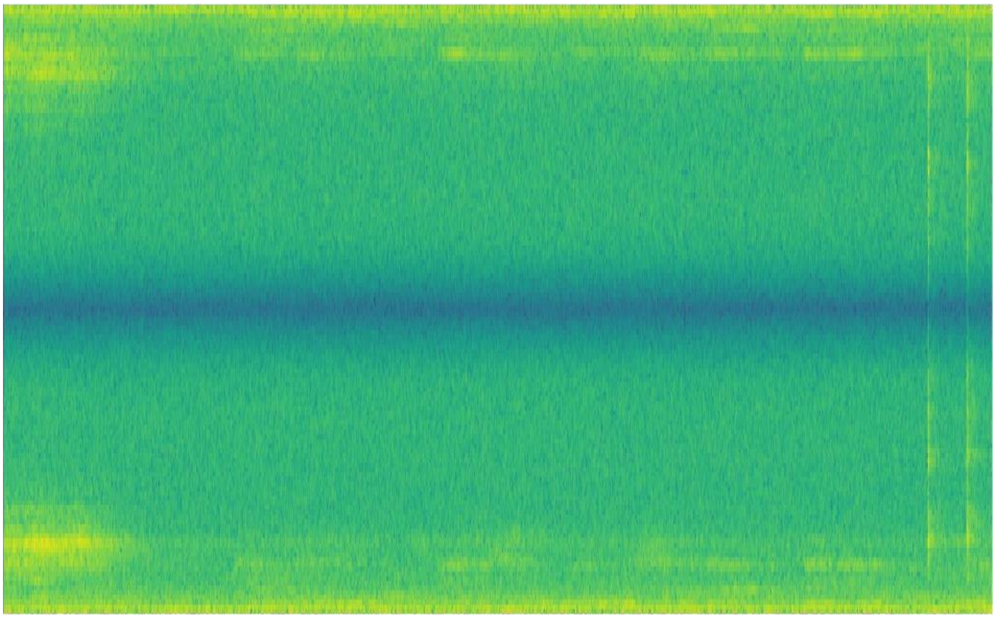

Figure 16. Traffic Spectrogram

7.3 Neural Network Structure

The Neural Network is a Feed Forward Neural Network with the following configuration :

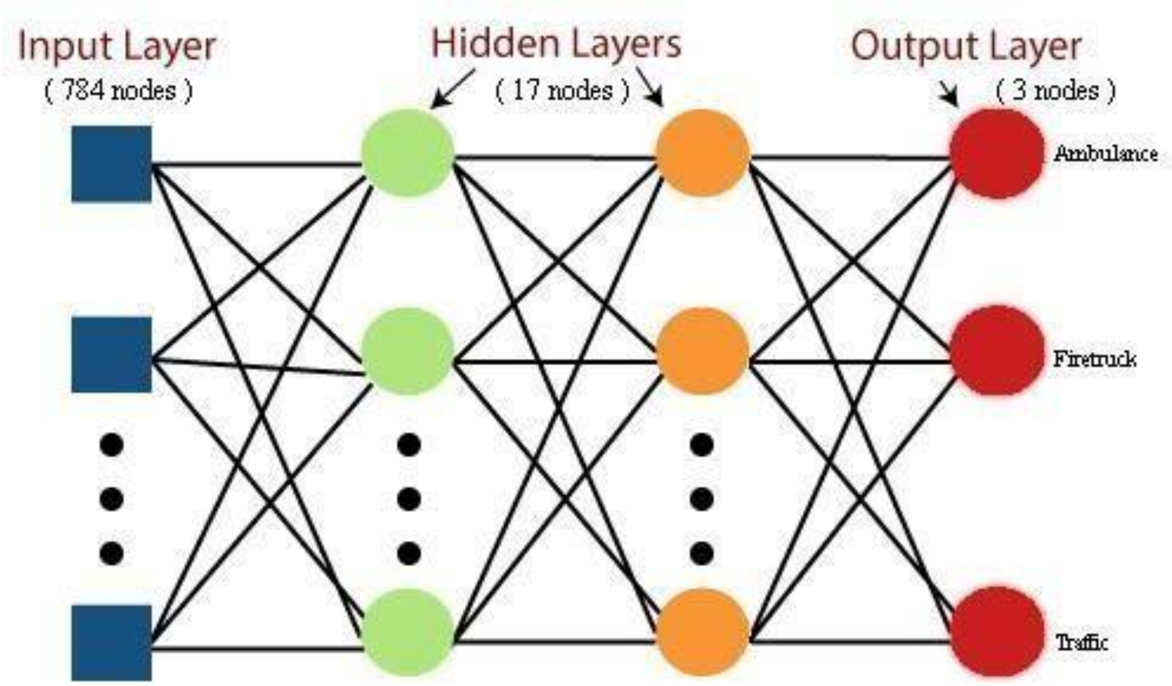

Figure 17. Neural Network Structure

7.4 Sample Coding

```
import warnings
warnings.filterwarnings("ignore")
import numpy as np
import tensorflow as tf
import cv2
class_reference=["Ambulance","Firetruck","Traffic"]

ip=0
print("Enter category : ")
ip=input()
img = cv2.imread(ip+".png",cv2.IMREAD_GRAYSCALE)
img = img / 255.0
img =  np.expand_dims(img,0)

# Load TFLite model and allocate tensors.
interpreter = tf.lite.Interpreter(model_path="MP_model.tflite")
interpreter.allocate_tensors()

# Get input and output tensors.
input_details = interpreter.get_input_details()
output_details =  interpreter.get_output_details()

# Test model on input data
input_data = img
input_data = input_data.astype('float32')
interpreter.set_tensor(input_details[0]['index'], input_data)

interpreter.invoke()

# The function `get_tensor()` returns a copy of the  tensor data.
# Use `tensor()` in order to get a pointer to the tensor.
output_data = interpreter.get_tensor(output_details[0]['index'])

#predictions_single = model.predict(img_t)
#prediction_result = np.argmax(predictions_single[0])
output_data = np.argmax(output_data)
print(class_reference[output_data])
```

Chapter 8
Testing

Testing software is a critical element of software quality assurance and represents the ultimate review of specification, design and code generation.
Testing Objectives
1. Testing is a process of executing a program with the intent of finding an error.
2. A good test case is one that has a high probability of finding an undiscovered error.

8.1 Unit Testing:

Sub-System	Functionality	Result
Microphone	To record sound	Sound Recorded
Camera	To record image	Image Recorded
Prediction System	To predict category	Predicted Successfully
Raspberry Pi Controller	To run the system	Running Successfully

8.2 Integration Testing

Each subsystem that was tested individually was finally put into as a single unit and then the entire system was subjected to white box testing and the system worked successfully without any errors thereby yielding the result of the test as positive.

8.3 System Testing

System Testing is a level of software testing where a complete and integrated software is tested. The purpose of this test is to evaluate the system's compliance with the specified requirements. The results were positive on testing the system.

8.4 Validation and Verification

Verification is the process of evaluating products of a development phase to find out whether they meet the specified requirements. Validation is the process of evaluating software at the end of the development process to determine whether software meets the customer expectations and requirements.

The verification and validation phase returned success on evaluation.

Chapter 9
Output Screens and Result Analysis

9.1 Output Screens

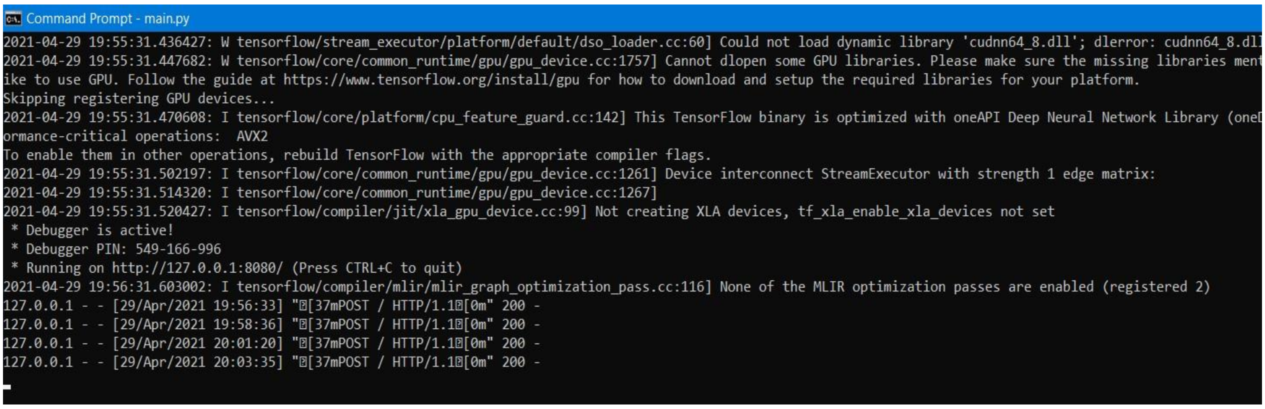

Figure 18. Client Server Screen

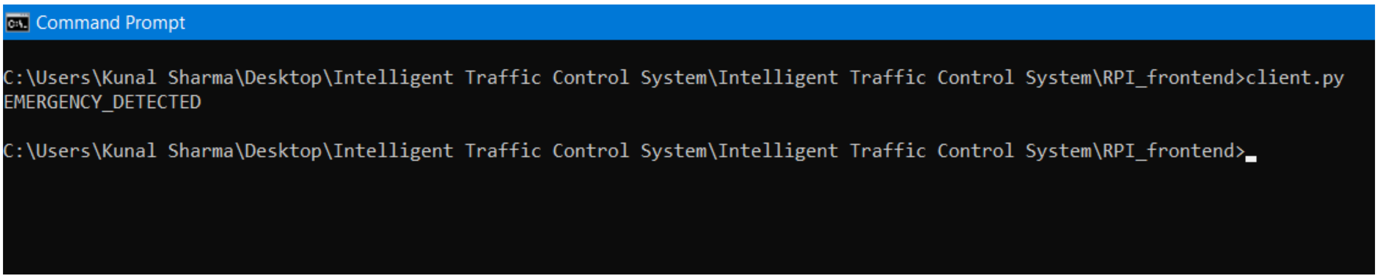

Figure 19. Emergency Vehicle Detected

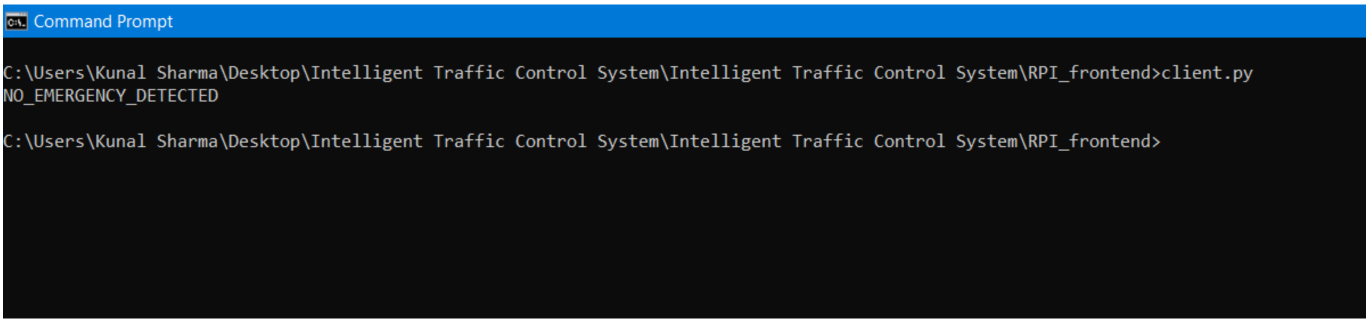

Figure 20. Non-Emergency Vehicle Detected

9.2 Analysis

The result analysis section focuses on the accuracy of the model and its predictions. A model should be as accurate as possible to generate accurate predictions and also should not overfit or underfit to the data provided.

A good result can be obtained by choosing an optimum number of data in dataset and also by choosing correct model and choosing a correct learning rate.

For the chosen model and dataset for this particular project an accuracy of 87% with a loss of 0.4 has been obtained for a learning rate of 0.0001 and 369 epochs.

Chapter 10
Future Works and Conclusion

Due to extensive research in the field of artificial intelligence and machine learning our lives are becoming simpler on daily basis, from converting speech to text to creating new thing all are automated and human intervention is considered as burden in modern world, considering that one of the thing that really impacts our day to day life is driving the vehicle, self-driving cars are becoming more popular as it reduces human intervention and in the meantime it also reduces accidents. Also the system can be extended for a wide variety of emergency vehicles. Better training of the system with better sound and a good dataset can bring out good results in prediction of the sound classes.

Thus, the developed system serves as a Traffic Management System for crowded junctions where emergency vehicles might face traffic congestion. This system creates way for them by changing the signal light to green temporarily until the vehicle has passed through.

Chapter 11
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