School of
Electronics and Communication Engineering

Mini Project Report
on
Traffic sign board detection and recognition

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SCHOOL OF ELECTRONICS AND COMMUNICATION ENGINEERING

CERTIFICATE

This is to certify that project entitled " **Traffic Sign Board Detection And Recognition** " is a bonafide work carried out by the student team of **Harshit Sharma (01FE20BEC275), Manjunath D Sarwade (01FE21BEE404), Niharika K (01FE20BEC267), Shraddha S Dayannavar (01FE20BEC312)** . The project report has been approved as it satisfies the requirements with respect to the mini project work prescribed by the university curriculum for BE (V Semester) in School of Electronics and Communication Engineering of KLE Technological University for the academic year 2022-2023.

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-The project team

ABSTRACT

Traffic sign board provides important information to drivers like mandatory, cautionary, instructive information. Systems for detecting and recognising traffic signs are crucial parts of advanced driver assistance systems and self-driving cars. The goal is to develop an algorithm that can detect and recognise traffic sign boards. Many challenges exists for detection such as traffic signs are blurred, inverted, captured in dim light and foggy conditions. We tackle these challenges in this project. A customised traffic sign data is annotated in Makesense.AI. For the extraction of the region of interest, we suggested a variety of methods such as YOLO model, Faster R-CNN, SDD MobileNet. The classification of traffic signs is done using a deep learning system. SSD MObileNet is used to train the model. We use Raspberry Pi and Raspberry Pi camera for real-time detection and recognition.

Contents

List of Figures

Chapter 1

Introduction

In this chapter we are going to discuss about autonomous vehicles and importance of traffic sign board detection and recognition system, need statement, objectives, literature survey, project planning.

A vehicle that can sense its surroundings and navigate on its own is called an autonomous vehicle. Autonomous vehicles use a combination of sensors, cameras, and advanced algorithms to collect data about their surroundings and make decisions about where to go and how to avoid obstacles. These vehicles are often equipped with technology such as GPS, lidar, radar, and computer vision to help them navigate, and they are able to operate without the need for a human driver. Autonomous vehicles have the potential to greatly improve road safety, reduce traffic congestion, and make transportation more accessible and efficient. However, there are still many challenges to overcome before autonomous vehicles can be widely adopted, including technical, regulatory, and ethical issues. [4]

Traffic sign board detection is a critical aspect of autonomous vehicle technology. It involves using computer vision and machine learning algorithms to identify and interpret traffic signs in real-time. This allows the vehicle to understand and respond to various road rules and conditions, ensuring safe and efficient navigation.

In order to direct, warn against, and control the flow of traffic, including motor cars, bicycles, pedestrians, equestrians, and other travellers, traffic signs are placed alongside, above, or in other strategic locations along a highway, roadway, trail, or other route. Since customers are placing a greater emphasis on safety, traffic sign board detection and recognition is one of the current research topics seeking to increase driving safety. During a drive, the input is primarily made up of visual data. The driver performs the action of driving in accordance with those inputs.

There are several potential advantages to using autonomous cars over traditional cars. First, because they are able to drive themselves, autonomous cars can reduce the need for human drivers and make transportation more convenient and accessible. This is especially useful for people who are unable to drive due to disability or age, and it could also free up time for people to do other things while they are being transported. Second, autonomous cars are likely to be safer than traditional cars because they use advanced sensors and computer algorithms to detect and respond to their surroundings. This can help to prevent accidents and improve road safety, potentially saving lives.[5]

1.1 Motivation

The traffic sign placed at the side of the roads provides information about route guide, road condition and hazards. In adverse traffic condition the driver may not notice traffic signs which may cause accidents and loss of properties to avoid this many control device has been proposed which alert the driver about the traffic signs.The capability to identify traffic signs and act on them is one of the most important components of a self-driving automobile.

1.2 Need Statement

A traffic sign board detection and recognition system is needed to accurately identify and interpret traffic signs in real-time, in order to improve road safety and facilitate compliance with traffic regulations. By automatically detecting and interpreting traffic signs, this system can help drivers to make informed decisions and reduce the likelihood of accidents or violations. Furthermore, a traffic sign detection and recognition system can also provide useful information to traffic management systems and assist with the efficient flow of traffic.

1.3 Objectives

1. Create an algorithm that can detect traffic sign board from live video feed.
2. Detect the location of sign board in live feed.
3. Classify the detected sign board .
4. Display the annotated and labelled live feed.

1.4 Literature survey

The research done on traffic sign board detection and recognition in various scientific reports has helped us to learn more about those concepts and apply the similar learning in our project. Some papers are presented below:

Detect and Classify Road Signs Using TensorFlow is based on concept of convolution neural network for recognition , where they converted data set from RGB to color format of Gray scale for detection . For this accuracy on the test data set was 95% [1].

Recognition of Traffic Signs Using Computer Vision for Project-Based Learning is based on pattern classification in which they have used gray scale conversion and binary classification to detect the region of interest . They have used multiple class classification and clustering for recognisition of sign board [2].

Raspberry Pi-based Road Sign Recognition System uses of modern computer vision and pattern classification and K-Nearest algorithm . Raspberry Pi video-port capture,Multithreading for Image Capture and Processing, Speed Sign Detection , Features for Open CV Contour and Edge Detection.The system reached 80% accuracy [3].

Neural Network System of Traffic Signs Recognition is based on concept of Multilayer perceptron neural network, Canny edge detector, and colour filter with morphological operators are used to detect and recognise traffic sign boards. The algorithm demonstrated successful recognition in over 87 percent of examples during a test set. The developed device can detect traffic signs 20 cm in diameter from 1.5 to 2 metres away and is resistant to light changes. [5].

Using Deep CNN, autonomous traffic sign (ATSR) detection and recognition is based on concept of Traffic sign classification and recognition using Convolutional Neural Network and Support Vector Machines (CNN-SVM). This technique uses YCbCr colour space as its colouring, which is fed into a convolutional neural network to separate the colour channels and extract some unique properties. Later, SVM is employed for classification. Their suggested method recognised and classified traffic signs with an accuracy of 98.6%. The authors proposed a color-based segmentation method with feature extraction using Histogram Oriented Gradients (HOG) and classification using SVM. [6]

A visual system for recognising and detecting traffic signs based on Vertex and bisector transform techniques, the neural network concept, and bilateral Chinese transformation[7].

Raspberry Pi and OpenCV are used to recognise Indian traffic signs in real time. The suggested method uses dynamic thresholds in the HSV colour space to detect colour. The suggested method then employs simple, accurate, and adaptive techniques to extract the part of the image that contains the traffic sign. [8].

Road Sign Recognition System Using Image Processing and the Raspberry Pi with Additional Safety Parameters is based on a Raspberry Pi with a video capture port that can quickly capture a series of images using a JPEG encoder, image processing, and colour enhancing techniques. [9]

1.5 Problem Statement

Design and develop an algorithm to detect and recognize traffic sign board in real time.

1.6 Application in Societal Context

- Traffic sign recognition and detection is a technology that is used to identify traffic signs in real-time video feeds from cameras mounted on vehicles. This technology has many applications in the social context, such as improving road safety by alerting drivers to the presence of traffic signs and helping autonomous vehicles navigate roads more safely.
- The creation of intelligent transportation systems is one potential social setting for the use of traffic sign recognition and detection.
- Overall, traffic sign recognition and detection technology has the potential to improve road safety and make transportation systems more efficient. By helping drivers to better understand and follow traffic rules, and by providing assistive technologies for individuals with visual impairments, this technology can have a positive impact on society.

1.7 Project planning and Bill of materials

1.7.1 Gantt chart:-

Figure 1.1Gantt chart which is useful for teams to work according to deadlines. it shows activities displayed against time .

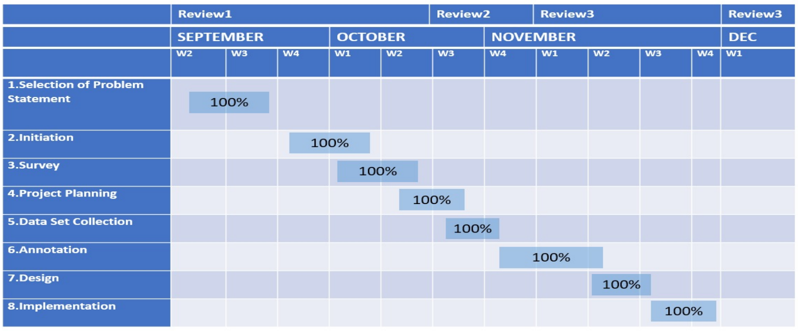

Figure 1.1: *Gantt Chart*

1.7.2 Bill of Materials:-

SI.No.	Materials	Quantity	Price (for one in Rupees)
1.	Raspberry Pi 3b +	1	8,000/-
2.	Raspberry Pi camera	1	500/-
3.	SD Card 128gb	1	1,000/-

Figure 1.2: *Bill Of Materials*

1.8 Organization of the report

- Chapter2 consists of information about hardware we used for real time detection that is Raspberry Pi 3 Model B and about the Raspberry Pi camera 5MP .
- Chapter3 consists of design planing, different types of traffic sign and information about customised data set, model alternatives, final model.
- Chapter4 consists of details about preprocessing, annotation of custom data set, specifications and final system architecture, TensorFlow.
- Chapter5 consists of introduction to optimisation, types of optimisation, selection and justification of optimisation .
- Chapter6 consists of result analysis of our model with accuracy of 94%.
- Chapter7 consists of conclusion and future scope which can be further implemented.

Chapter 2

Raspberry Pi 3 Model B+ and RASPBERRY PI 5MP CAMERA

In this chapter we are going to discuss about the hardware used for real time traffic sign board detection and recognition that is Raspberry Pi 3 Model B and its specifications, Raspberry Pi camera 5MP and its specifications.

2.1 Raspberry Pi 3 Model B+

A credit card-sized, open-source computer board called the Raspberry Pi runs on Linux and many other OS. The Pi is a fun and convenient way for people of all ages to develop their computer and programming skills. The Pi can perform many tasks that a desktop computer can, such browsing the internet and playing videos, by connecting it to a TV or monitor, a keyboard, and the appropriate programs. The Pi is also excellent for creative projects; newer models with more computing power are perfect for Internet of Things projects. Wireless LAN and Bluetooth Low Energy are also included with the Pi 3.Figure 2.1

2.1.1 Specifications :-

- Processor:-Chipset BCM2387 from Broadcom Bluetooth 4.1 and 802.11 b/g/n Wireless LAN on a 1.2GHz quad-core ARM Cortex-A53 processor (Bluetooth Classic and LE)
- GPU :- Multimedia coprocessor with dual core and VideoCore IV. offers 1080p30 H.264 high-profile decoding, hardware-accelerated OpenVG, and Open GL ES 2.0. capable of 24GFLOPs, 1GFLOPs, or 1.5Gtexels per second with DMA architecture and texture filtering.
- Memory :- 1GB LPDDR2
- Operating System :- Boots off a Micro SD card and launches a version of Linux or Windows 10 IoT
- Dimensions :- 85 X 56 X 17mm
- Power :- Micro USB socket 5V1, 2.5A

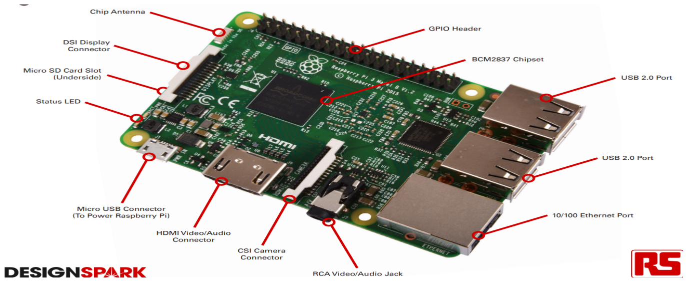

Figure 2.1: Raspberry Pi 3 Model B

2.2 Raspberry Pi 5MP Camera

2.2.1 Specification:-

- 5mp
- 2592x1944 pixels
- 1080p 30fps,720p 60fps,640x480p 90fps

Figure 2.2: Raspberry Pi 5MP Camera

Chapter 3

System Design

In this chapter we are going to discuss about functional block diagram, different types of traffic sign in India, customized data set with 4 classes, model alternatives, final model.

3.1 Functional Block Diagram

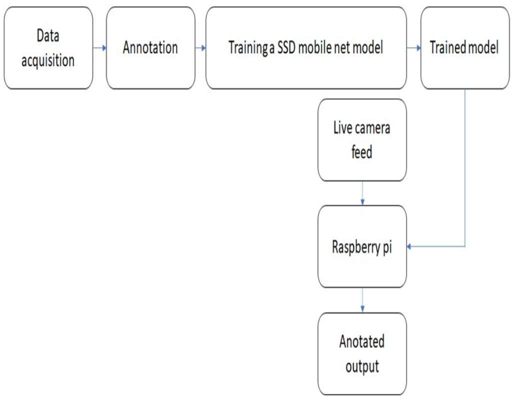

Figure 3.1: Functional Block Diagram

The Figure 3.1 explains functional block diagram of traffic sign board detection and recognition. A custom data set of 4 classes is collected and annotated using Makesense.AI. SSD MobileNet model is trained using this data set. The trained model is dumped on Raspberry Pi for real time recognition, through live camera feed input is sent to Raspberry Pi. The annotated output is displayed on the screen.

3.2 Data Set

3.2.1 India's Various Traffic Sign Types:-

India's standard traffic signs are divided into three categories.:-

1. **Mandatory Traffic Signs:-** Mandatory signs must be obeyed and are of utmost importance. Figure 3.2 shows some of the examples for mandatory traffic signs .

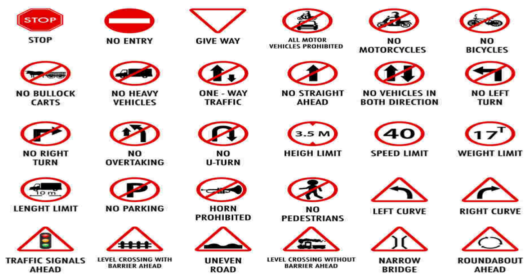

Figure 3.2: Mandatory Traffic Signs

2. **Cautionary Traffic Signs:-** Drivers are cautioned by warning signs regarding potential dangers or road hazards that may be present. Figure 3.3 shows some of the examples for caution traffic signs .

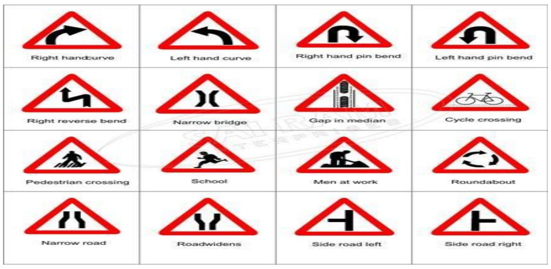

Figure 3.3: Caution Traffic Signs

3.Informative Traffic Signs:- Traffic signs that provide vehicles with information about facility areas even when they don't have a map are known as informative sign. Figure 3.4 shows some of the examples for informative traffic signs .

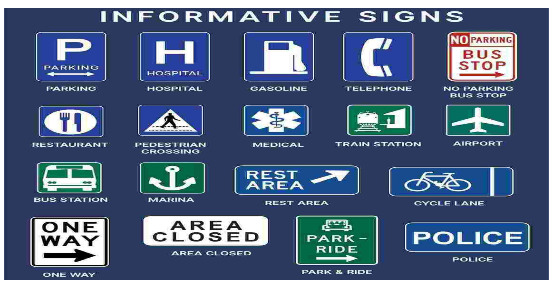

Figure 3.4: *Informative Traffic Signs*

3.2.2 Customised Data Set:-

We have chosen four classes , two from mandatory traffic sign and two from caution traffic sign

1.Left prohibited:- This sign directs driver not to turn left .We have created custom data set by collecting 256 images. Figure 3.5 is one of the image from our data set

Figure 3.5: *Left prohibited traffic sign*

2.Right prohibited:- This sign directs driver not to turn right. We have created custom data set by collecting 256 images. Figure 3.6 is one of the image from our data set

Figure 3.6: *Right prohibited traffic sign*

3.U Turn :- This sign directs driver that there is option for U turn. We have created custom data set by collecting 256 images. Figure 3.7 is one of the image from our data set

Figure 3.7: *U Turn traffic sign*

4.Three way junction :- This sign directs driver that 3 roads are getting connected here. We have created custom data set by collecting 256 images. Figure 3.8 is one of the image from our data set

Figure 3.8: *Three Way Junction traffic sign*

3.3 Model alternatives

Three different model from deep learning for object detection are :-
1.YOLO model (you only look once):-The YOLO algorithm divides the image into N grids, each of which has an equal-sized SxS region. These N grids are each in charge of finding and locating the thing they contain.
2.Faster R-CNN (Regions with convolution neural network):-

- RPN differentiate forground and background image.
- RoI pooling converts feature maps into same size.
- Softmax classifier classifies the object to that particular class
- Regressor refined the bounding box.

3. SSD mobile network model (single shot multibox detection model):-

- Light in size to optimize performance with less response time
- Point wise convolution
- Depth wise convolution

3.4 Final Model:-

We have selected SSD MobileNet over Faster R-CNN and yolo as it has faster response time in raspberry pi , less usage of memory and as small objects can not be detected in yolo.

3.5 SSD MobileNet :-

- In 2016, the Single Shot MultiBox Detector, a method for item detection in photos using a single deep neural network, was released.
- Single shot object detection, or SSD, uses a single shot to find and identify several objects in a picture.

- The detection box is predicted using multi-reference techniques using a group of anchor boxes with various sizes and aspect ratios defined at various positions in the image.
- Streamlined architecture that is simplified An effective approach for mobile and embedded vision applications is provided by Mobilenet, which builds lightweight deep convolutional neural networks using depthwise separable convolutions.
- It will calculate a total of 3000 bounding boxes.
- Further filter out bounding boxes using non-maximum suppression
- Non-maximum suppression will match the predicted boxes to the input give ground truth boxes and remove all the duplicates and keep one box which has higher accuracy.

Chapter 4

Implementation

In this chapter we are going to discuss about preprocessing of data set, annotation of data set using Makesense.AI, final model specifications, TensorFlow Lite.

4.1 Flowchart

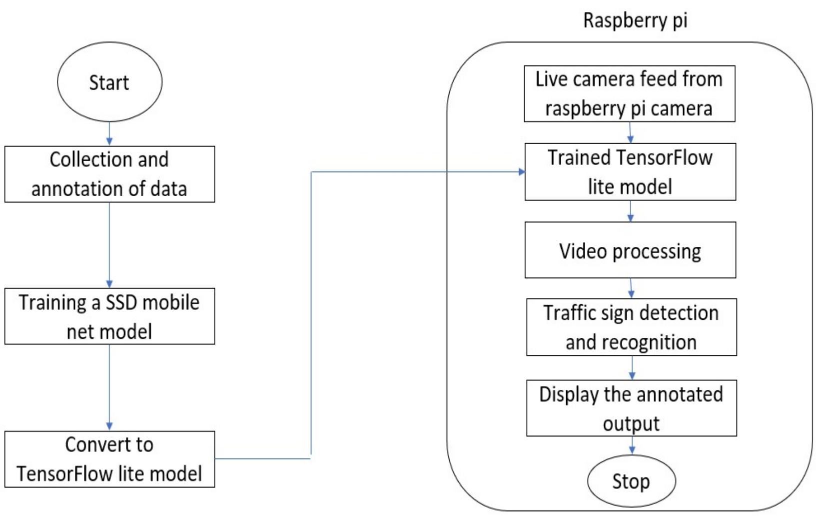

Figure 4.1: Flowchart

4.2 Preprocessing

As we are using Google colab for training data set , it provides only 12GB RAM for free users. But our data set was of 4.85GB , dimensions of each image was 3024x4032. Due to this colab was getting crashing ,there were 2 solutions:-

- To buy Google colab pro
- To resize the file

So we used File Minimizer through which we reduced our data set to 159MB , dimensions of each image to 768x1024.

4.3 Annotation

We have collected total 1025 images in which 820(80%) is used for training , 102(9.95%) is used for validation and 103(10%) is used for testing.

- Annotating digital photographs is a task that normally requires human input and, in some situations, computer assistance.
- As in this project we use 4 different traffic signs of 1025 images we label each of these images for training the model.
- For data-set annotation there are many open source like Labelimg, Labelbox, Make-Sense.
- In this project we are using MakeSense.AI. It is open source used for image annotation.
- Annotated images will be exported in xml format. xml file is converted into data file format called TFRecords which is used by TensorFlow for training .

Figure 4.2 is the Makesence.AI window which shows how we annotate.

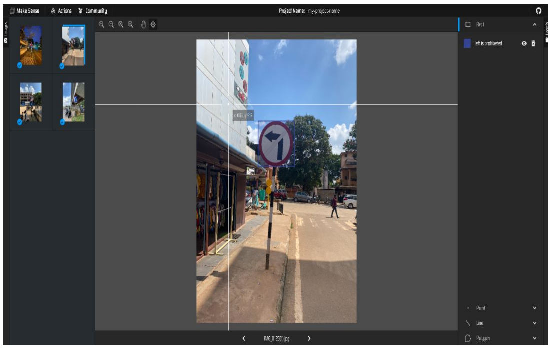

Figure 4.2: *Annotation example*

4.4 Specifications and final system architecture

4.4.1 VGC16

- VGG16 is used by SSD to extract feature maps. Then, an 8X8 spatial resolution object detection using the Conv4_3 layer is performed (it should be 38X38).
- A bounding box and 21 scores for each class make up each prediction (one extra class for no object).
- The highest score of the class for the bounded object. Totally 38 X 38 X 4 predictions are made by Conv4_3.
- SSD reserves the class "0" to denote that it does not have any objects.

Figure 4.3 shows the architecture of SSD MobileNet .

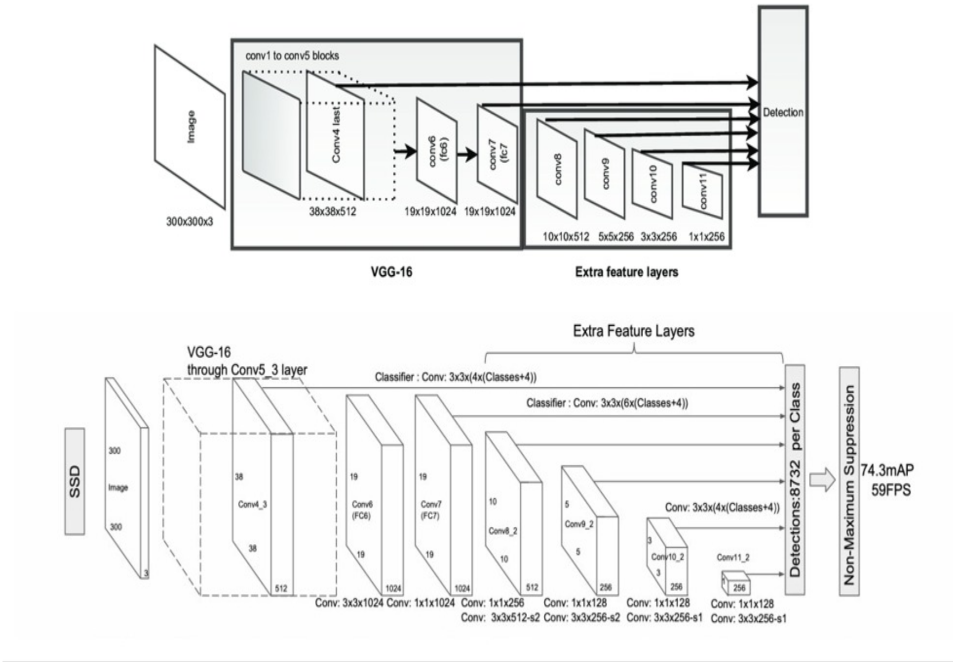

Figure 4.3: *SSD MobileNet architecture*

4.4.2 Extract Feature Layers

1.Multi-scale feature maps for detection:- After the VGG16, SSD adds six more auxiliary convolution layers. For object detection, an additional five of them will be added. In three of those layers, we make six predictions as opposed to four. In total, SSD employs 6 layers and generates 8732 predictions.

2.Default boundary box:- With just one prediction per default box, SSD restricts the number of default boxes to 4 or 6.

3.Choosing default boundary boxes:- Each feature map layer in SSD has a scale value specified. Conv4 3 identifies things at the smallest size of 0.2 starting from the left.

4.Matching strategy:- Positive matches and negative matches are two categories for SSD predictions. The localization cost for SSD is only calculated using positive matches.

5.Hard negative mining:- Positive matches are far outnumbered by bad matches. A class imbalance results from this, which is bad for training.

6.Data augmentation:- Enhancing data is crucial for increasing accuracy. Add flipping, cropping, and colour dithering to the data.

4.4.3 Specification

- Weight=0.00004
- Classification weight 1

- Localization weight 1
- IOU threshold 0.6
- Number of steps 1000000
- Batch size 16
- Epochs 6250

4.5 TensorFlow Lite

- Figure 4.4 Google created the open source machine learning framework called TensorFlow. It is commonly used for training and building ML and DL models. It uses variety of algorithms.
- One key advantage of TensorFlow Lite architecture is its ability to run on wide range of platforms including CPUs, GPUs and TPUs.
- TensorFlow Lite models can run quickly and efficiently on mobile devices without sacrificing accuracy.
- Tensorflow offers a variety of operations for machine learning applications across various sorts of datasets, including object detection, object segmentation, and even text spell checking and pattern recognition.

Figure 4.4: *TensorFlow*

Chapter 5

Optimization

In this chapter we are going to discuss about optimisation, different types of optimisation available, selection and justification of optimisation

5.1 Introduction to optimisation

The optimization technique is a process that optimises the algorithm in relation to our specifications in order to reduce the error percentage and improve the accuracy of results.

Our model accuracy was around 60% and we faced FPS drops in Raspberry Pi. Model was not able to detect traffic sign in different environment and if there is obstructions to detect the sign board.

5.2 Types of Optimisation

- Raspberry Pi 3 Model B+ can be upgraded to Raspberry Pi 4 which results in higher FPS and high response time.
- By enhancing our model training steps.
- Collecting images from different environment and also with some obstructions.

5.3 Selection and Justification of optimisation methods

- By upgrading our Raspberry Pi 3 Model B+ to Raspberry Pi 4 we can increase the FPS and response time but it will increase budget of our project and our model accuracy will remain same.
- By enhancing our model training step from 40000 to 100000 our model accuracy will increase from 60% to 94%.
- To recognise the traffic sign in different environment and also with some obstructions we collected images in such cases.

Chapter 6

Result and Discussion

In this chapter we are going to discuss about result and its analysis.Model is able to detect and recognise the four classes of traffic sign in different test cases.

6.1 Results

Figure 6.1: *Right Turn Prohibited is detected with obstructions*

Figure 6.2: *Left Turn Prohibited is detected in shadow condition*

Figure 6.3: *U Turn is detected while vehicle is moving.*

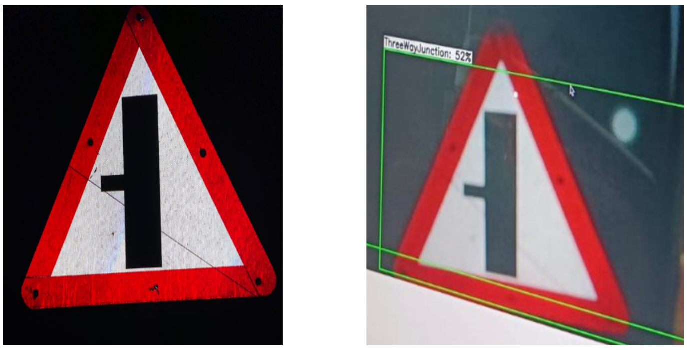

Figure 6.4: *Three Way Junction is detected in night condition*

Our model was able to detect and recognise different traffic sign board successfully under different environments and with some obstructions.

6.2 Result analysis

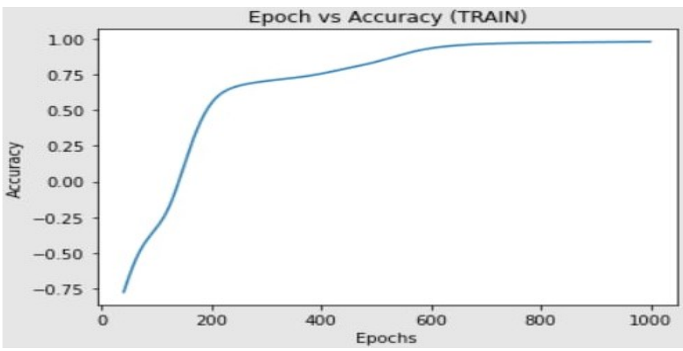

Figure 6.5: *Epochs vs Accuracy*

Our model accuracy is 94% for different test cases.

Chapter 7

Conclusion and Future Scope

In this chapter we are going to discuss about conclusion and future scope of traffic sign board detection and recognition.

7.1 Conclusion

- The single shot detection(SSD) algorithm allows it to accurately identify objects in an image or a video.
- The model is able to accurately identify different traffic signs through live video footage in various environment.
- The TensorFlow Lite model can run on a wide variety of hardware , including PCs , embedded systems and phones .
- TFLite models are great for running on the Raspberry Pi , as they require less processing power.

7.2 Future Scope

- To improvise this model we can increase the classes.
- Google coral Edge TPU USB accelerator can be added to the Raspberry Pi and improve the performance , response time and FPS .
- By upgrading from 5MP to 12MP Raspberry Pi camera we can detect traffic signs from far distance and with higher clarity.
- Further Raspberry Pi can be interfaced with motor drivers and actuators to alter the driver and control the car.

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