Department of Electrical and Computer Engineering
North South University

Senior Design Project

TRAFFIC SIGN DETECTION & CLASSIFICATION WITH MODEL COMPARISON

SHADMAN SAKIB **ID# 1813190642**

TALUKDER ABDULLAH AL TALHA **ID# 1813193642**

MD. SHARUKH FARDIN **ID# 1821463042**

Faculty Advisor:

Dr. Mohammad Ashrafuzzaman Khan

Assistant Professor

ECE Department

Spring, 2023

LETTER OF TRANSMITTAL

June, 2023

To

Dr. Rajesh Palit
Chairman,
Department of Electrical and Computer Engineering
North South University, Dhaka

Subject: **Submission of Capstone Project Report on "Traffic Sign Detection & Classification With Model Comparison"**

Dear Sir,

With due respect, we would like to submit our **Capstone Project Report** on **"Traffic Sign Detection & Classification With Model Comparison"** as a part of our BSc program. The report deals with Traffic Sign Detection & Classification System. This project was very much valuable to us as it helped us gain experience from practical fields and apply in real life. We tried to the maximum competence to meet all the dimensions required from this report.

We will be highly obliged if you kindly receive this report and provide your valuable judgment. It would be our immense pleasure if you find this report useful and informative to have an apparent perspective on the issue.

Sincerely Yours,

Shadman Sakib

.....

Shadman Sakib

ECE Department

North South University, Bangladesh

Talukder Abdullah Al Talha

.....

Talukder Abdullah Al Talha

ECE Department

North South University, Bangladesh

Md. Sharukh Fardin

.....

Md. Sharukh Fardin

ECE Department

North South University, Bangladesh

APPROVAL

Shadman Sakib (ID # 1813190642), Talukder Abdullah Al Talha (ID # 1813193642) and Md. Sharukh Fardin (ID # 1821463042) from Electrical and Computer Engineering Department of North South University, have worked on the Senior Design Project titled "Traffic Sign Detection & Classification With Model Comparison" under the supervision of Dr. Mohammad Ashrafuzzaman Khan partial fulfillment of the requirement for the degree of Bachelors of Science in Engineering and has been accepted as satisfactory.

Supervisor's Signature

…….

Dr. Mohammad Ashrafuzzaman Khan

Assistant Professor

Department of Electrical and Computer Engineering

North South University

Dhaka, Bangladesh.

Chairman's Signature

…….

Dr. Rajesh Palit

Professor

Department of Electrical and Computer Engineering

North South University

Dhaka, Bangladesh.

DECLARATION

This is to declare that this project is our original work. No part of this work has been submitted elsewhere partially or fully for the award of any other degree or diploma. All project related information will remain confidential and shall not be disclosed without the formal consent of the project supervisor. Relevant previous works presented in this report have been properly acknowledged and cited. The plagiarism policy, as stated by the supervisor, has been maintained.

Students' names & Signatures

1. Shadman Sakib

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2. Talukder Tbdullah Al Talha

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3. Md. Sharukh Fardin

ACKNOWLEDGEMENTS

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Furthermore, the authors would like to thank the Department of Electrical and Computer Engineering, North South University, Bangladesh for facilitating the research. We would also like to thank my friends for helping us in this project. The authors would also like to thank their loved ones for their countless sacrifices and continual support.

ABSTRACT

Traffic Sign Detection & Classification With Model Comparison

In the modern era of vehicles, road accidents have increased significantly. So in this generation of modern technology and automation, intelligent agents can be applied in various ways for reducing traffic accidents. The role of object detection in automated vehicles and notifying drivers can't be denied. This work is on traffic sign detection and classification, so this is in the computer vision sector. In this project, two different computer vision models have been applied and then compared with each other. They are YOLOv5 (You Only Look Once), Faster R-CNN (Faster Region Convolutional Neural Network). To increase the accuracy level of the models, proper development and alteration has been applied.

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Chapter 1 Introduction

1.1 Background and Motivation

Now-a- days traffic accidents are a common occurrence in this modern world. On average 3,700 people are dying around the world everyday in road accidents and the number reached more than 1 million if we consider the time period of a year. [1] One of the main reasons behind these accidents is not seeing the traffic signs properly due to bad daylight or bad weather and thereby not recognizing the traffic signs. Another main problem is many drivers don't know the meaning of road signs. That is why we were interested and encouraged to do this project.

1.2 Purpose and Goal of the Project

The aim of our project is to build a system which will help drivers ,passerby or AI to recognize the traffic signs even in bad light. Moreover, it will also help the drivers and passerby who have bad eyesight. There are few works which have similarities with our project. Some of them worked with YOLOv2 but in our project we will use YOLOv5 instead of YOLOv2 because of its capacity of reducing inference speed.

Again, we found different precision results and thereby got different comparison data. Beside this, there are some similar works on individual models among our two. We tried to achieve improvement on our individual models too.

In the future, we plan to develop our project for automated cars also. We will use two different models and compare their accuracy. The models we plan to use are YOLOv5 and Faster RCNN. Our system may face some barriers during the implementation such as bad lighting, different camera angles, corrupted data in the dataset etc.

1.3 Organization of the Report

Chapter 1 Presents the **Introduction**, Chapter 2 Presents **Research Literature Review,** Chapter 3 Presents **Methodology ,** Chapter 4 Presents **Investigation/Experiment, Result, Analysis and Discussion,** Chapter 5 Presents **Impacts of the Project** , chapter 6 presents **Project Planning and Budget,** Chapter 7 Presents **Complex Engineering Problems and Activities** ,Chapter 8 Presents Conclusion

Chapter 2 Research Literature Review

2.1 Existing Research and Limitations

In this paper, they discussed a method of traffic sign recognition and compared three different models (YOLOv2,SSD,faster RCNN) to determine which has the best accuracy. They trained all the different three models with five different classes of objects and then tested them. They used Tensorflow2 and for the dataset they used ‘German Traffic sign dataset’. They used mAp, FPS as evaluation parameters. As a result they found that the accuracy of YOLOv2 is better than Faster RCNN and SSD by 3.5% and 21% respectively. Besides, YOLOv2 was 3 times quicker than Faster RCNN .[2]

In this paper, they worked with Railway Traffic Signals. Here they followed a procedure that consisted of two steps for detecting the static and the blinking states. They used YOLOv5 for detecting the railway signals. For dataset they used FRsign dataset which was consisted of almost 100,000 pictures of traffic signals. [3]

In this paper, they detected traffic signs based on YOLOv5. For implementation, they used the Iraqi Traffic Sign Detection Benchmark (IQTSDB) dataset. According to the experiment, YOLOv5 showed high efficiency in different weather conditions and was also efficient in detecting different sizes of traffic signs such as small, medium and large. They Compared the mAp value to YOLOv2 and YOLOv3. [4]

Here they detected traffic signs using Faster R-CNN. The most positive part of this project is they did not extract image features manually and could segment the pictures to automatically get candidate region proposals. Their mAp value was 0.3449. [5]

Chapter 3 Methodology

3.1 Analysis Of The Design Principles

Here are some factors we thought about while doing and designing our project:

- **Variety of traffic signs :**

As a dataset we had used the German traffic sign dataset. We had 48 different types of traffic signs in our dataset. Although most of them were familiar to us, some of them were not that much familiar. We had to handle all of them.

- **The Environment :**

We also had to think about the environment conditions because the lighting conditions depend on the environment. At night time and lousy weather a low amount of light has been present. So at that time it is really difficult to detect the traffic signs for our system.We also had to deal with it.

- **The accuracy and speed requirements :**

  A large amount of people's life is directly and indirectly dependent on the accuracy of our system. So we had to make sure that our system is accurate enough and respond quickly.

- **The Dataset and quality of data :**

  There were some unclear images in our dataset and some meanings traffic signs were not even understandable. So we had to cut out those images from our dataset.

- **The Models to use:**

  As mentioned earlier, we used two familiar deep learning models which are Yolov5 and faster-Rcnn

- **The computational power:**

  As we had used google colab regular version as our coding platform, it has limited computational power, so we also had to think about it.

3.2 System Design

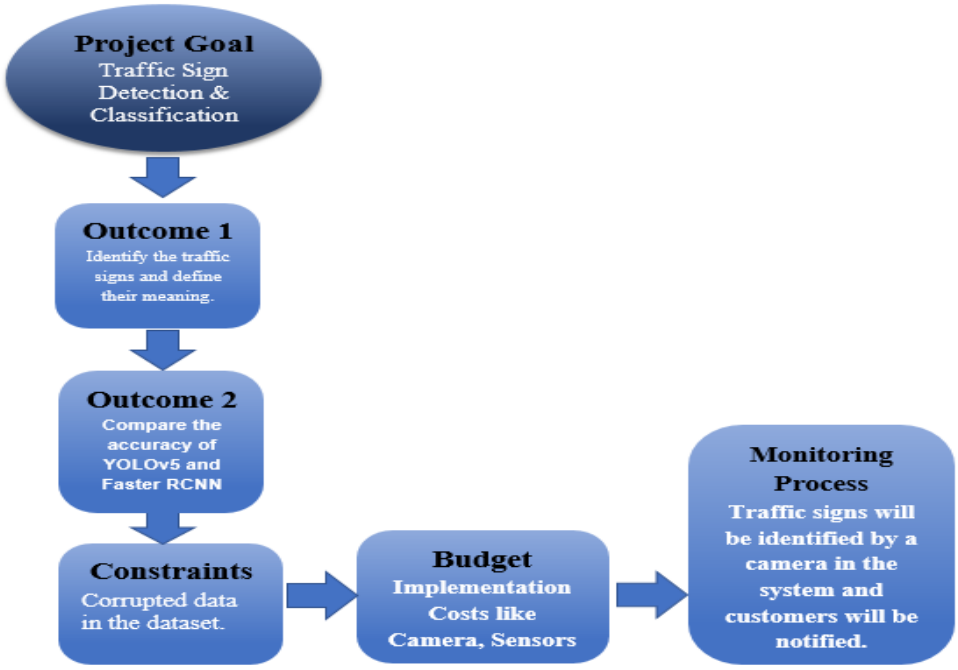

Fig 1: System Design Flow Chart

3.3 Software Components

Every deep learning project needs some software tools to complete each step of the project. In our project, we have also used some tools which have significantly reduced the associated complicacies.

Roboflow: There is a website called Roboflow which has helped us throughout the whole project. At first, when we were done with the dataset collection, we annotated and labeled our images in the dataset by Roboflow. It has a built in annotation and labeling system by which we have done these steps in a very easy process, which was also less time consuming. After the annotation , labeling and pre-processing, we have also preprocessed the data by Roboflow and after dataset pre-processing, we have used augmentation process to increase the number of images in our dataset because initially we did not have sufficient amount of images in our dataset for a good training process. Finally, this website helped us to generate our whole preprocessed dataset and export it in the suitable version which is supported by the familiar deep learning

models like YOLO , SSD , Faster RCNN etc. So, as modern day analysis, Roboflow helped us a lot to do our project which is a great invented modern tool.

Google Colab: We all know that google colab is an online jupyter notebook which runs on cloud. In our case, we have used google colab to write our necessary codes and to train our models on a custom dataset. By using google colab, we can train our models on different numbers of epochs and batches. We also can test the accuracy of our models by it. It also loads the tensor boards and other necessary results like mAP values to evaluate our models. So, as modern day analysis, Google Colab helped us with lots of resources to complete our project.

Clearml & Tensorboard: We have used Clearml and tensorboard to visualize all of our necessary graphs and variables.

VS code: We have used VS code to visualize and handle the yaml file which was necessary for training.

Git & Github: Github has been used for version control.

Table I. List of Software Tools

Tool	Functions	Other similar Tools (if any)	Why selected this tool
Roboflow	**Dataset annotation, preprocessing, augmentation**	**-**	**User friendly**
Google Colab	**Coding environment for any machine learning codes**	**-**	**Provides GPU power**
Clearml & Tensorboard	**Graph and parameters visualization**	**-**	**User friendly**
VS code	**For yaml file of the dataset visualization and editing**	**-**	**User friendly**
Git & Github	**For version control**	**-**	**This is a must for any deep learning project**

3.4 Software Implementation

We have implemented our system both for images and videos so that if a driver or passerby on the road takes a picture of a traffic sign our system will classify it and tell the meaning of that traffic sign.

Also, if a driver sets a camera in front of his/her vehicle and goes on a trip, our system will detect the traffic signs and teach the meaning if he/she does not know it.

Here the sample images how our system has been implemented both for model YoloV5 and faster-RCNN

Fig2: Yolov5 implementation

Fig3 : faster-Rcnn implementation

Chapter 4 Investigation/Experiment, Result, Analysis and Discussion

After implementing our project, we have experimented with the model on various test images. We had 48 different types of traffic signs. We have augmented our dataset so that the data size could get bigger. We have many different traffic signs but the instances of their repetition are not the same. For example, the traffic sign ‘priority road’ and all the speed limit signs are there for the most number of instances in our dataset. Where other signs which are not so popular like, ice or roadworks are repeated the least number of times. Therefore, the signs which have the most instances are trained better. So when detecting, those signs were getting detected with more accuracy. 85-90% or more. But there are also many signs which are getting low accuracy for the reason mentioned earlier.

Beside this, some images on our dataset were blurred. We tried our best to cut out those images but still some remained. While detecting those images, our two models also performed not so good, sometimes even not recognizing the sign at all. But in most cases our model performed well and detected the signs with 85-90% accuracy or more. Although, as we used two different models, for some signs one model performed better than the other and vice versa.

After analyzing the performance of our two models, we have noticed that yolov5 has performed better in most cases than faster RCNN, But for some signs detection, faster RCNN performed better. We trained yolov5 on 200 epochs while training a faster RCNN model on 800 iterations. The training mAp value of Yolov5 is 0.41 on the 200 th iteration.

Yolov5 was a more user-friendly and convenient model to use than the faster RCNN. We faced some difficulties with faster RCNN at first. Then we used the detectron2 platform for finalizing our faster-RCNN model.

Below, we are giving the graphs we gathered from faster RCNN and Yolov5. We used clearML for yolov5. We tried to run our faster RCNN model on clearML but somehow it was not

connecting. That's why we used the tensorboard of tensorflow2 in that case. We also have the tensorboard graphs for the yolov5 as well. The graphs are given below -

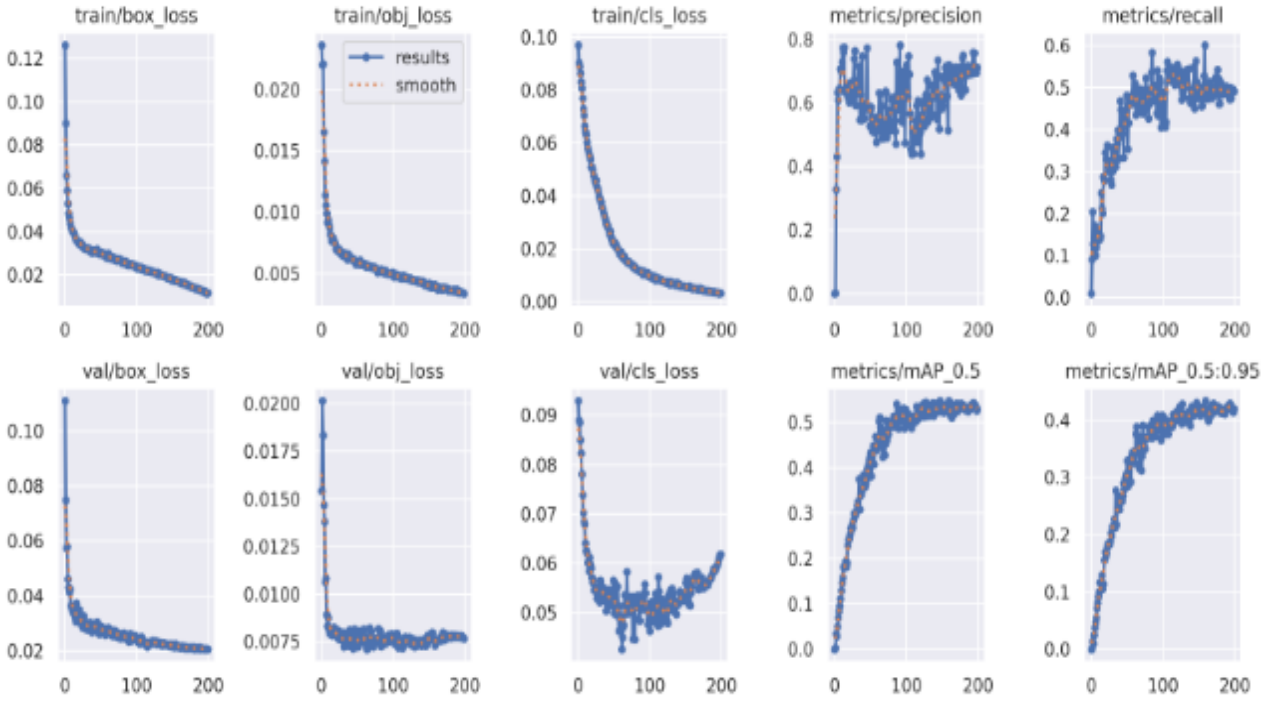

Fig 4 : Graphs of Yolov5

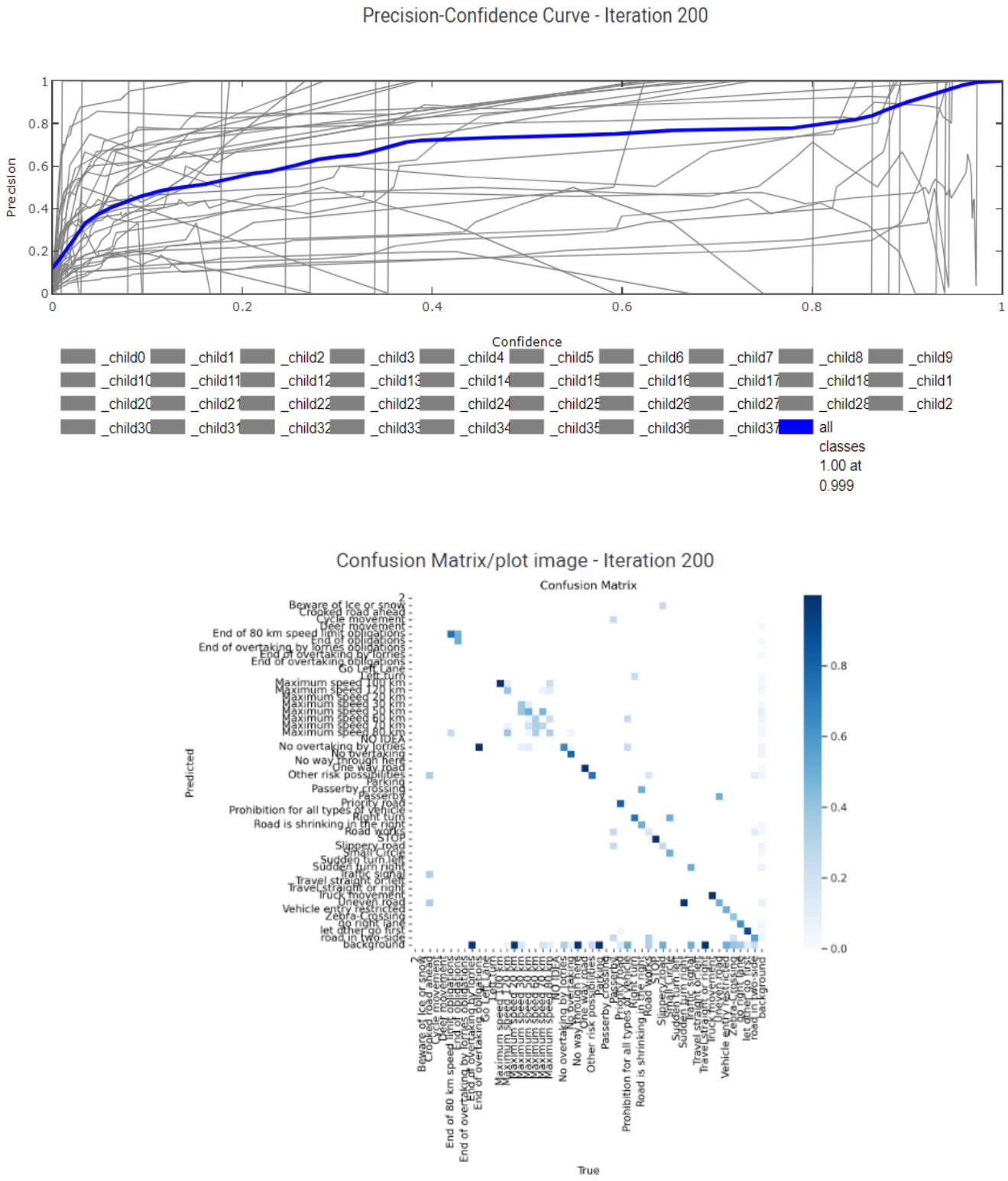

Fig 5: Precision Confidence Curve And Confusion matrix of Yolov5

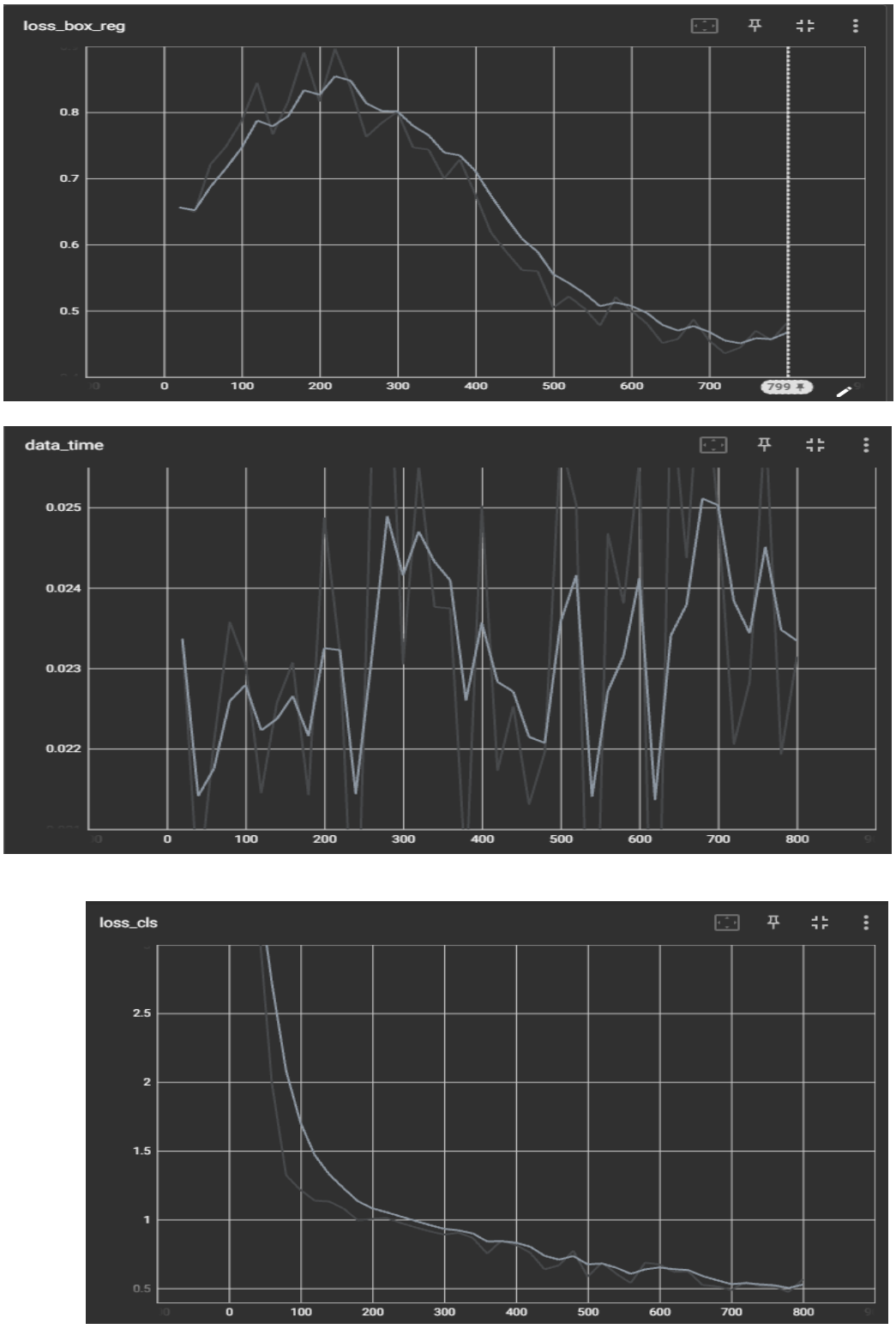

Fig 6: Graphs of faster-Rcnn

Chapter 5 Impacts of the Project

5.1 Impact of this project on societal, health, safety, legal and cultural issues

Road Safety: One of main reasons for road accidents is not recognizing the traffic signs properly. Also it's not always possible to detect traffic signs on a busy road for the drivers. Our system will ensure the safety of the mass community while they are on the road by reducing road accidents. It will be applicable both for passerby and the drivers.

5.2 Impact of this project on environment and sustainability

There are both positive and negative environmental effects of our system.

Positive effects :

Traffic Jam Reduction: Nowadays in cities all over the world, traffic jams are one of the biggest causes of people's headaches. Every day lots of working time all over the world are wasted due to traffic jams. Our system will help the people to reduce traffic jams by teaching the meaning of traffic signs and helping them to detect them.

Automated vehicles: In this era of modern technology, automated vehicles are making the human task easier. For the automated vehicles, they need to maintain the traffic rules to run on the street. So our system will be needed in this case.

Negative Effects:

Resource consumption: As our system is a software based system, it needs lots of electronic energy. Also, our system has to store all the data when implemented so it also needs lots of storage. So it's one of the environmental disadvantages of our system.

Electronic Waste: When we are going to implement our device on any kind of system it will require lots of electronic wires and devices like cameras, sensor to be implemented. So it will produce lots of electronic wastes which are not good for the environment.

Indirect Effect: As our system makes people's life easier on the road, it may encourage a lot of traffic on the road which will increase the environmental pollution.

Sustainability

Different light: Our system may face a challenge of different lighting conditions. During night and lousy weather, there might be a low light so that it would be really difficult for our system to detect the traffic signs.

To face this problem, we have trained our dataset with images with low light by reducing the brightness of some training images during dataset preprocessing.

Shortage of images: Another issue is the shortage of images in the dataset, as we are doing an object detection project, we need to train our models really well for a good accuracy and performance. Which needs lots of images. To face this problem, we have followed a data augmentation procedure to increase images in our dataset.

Usability

Accuracy: As we are detecting and classifying roadside traffic signs, accuracy is really necessary in our case because a lot of lives on the road are dependent on our accuracy level.

Moreover, if our system cannot direct the drivers accurately they may get in the wrong direction and drive in that way which causes accidents, traffic jams and many other problems.

In case of increasing our accuracy, we have increased and pre-processed our dataset.

Speed: Speed is also another important factor while thinking about the usability of our system.

While detecting and classifying the traffic signs, it is important how fast our system is because if our system detects and classifies the traffic signs but cannot return a quick response it will be really difficult for the people to use this system.

Good Quality of devices: To implement our system in a real time environment, good quality of cameras, sensors, wires etc. are essential. Without these items, good accuracy and speed are not expected.

Manufacturability

Maintainability: To look about the maintainability of our system we first will have to make sure that our system is very easy to use for people of all ages. Also, we have to keep limited hardware and software requirements for our system to reduce the complicacies.

More than that, we have to keep an auto update system so that it will not be updated manually.

Cost Efficiency: As we are planning to make a non-profitable system**,** our system has to be cost efficient so that people of all kinds of financial ability can have an entrance to our system.

For this reason, we have to ensure that, to make our system cost efficient the required devices will not be that much costly.

Extensibility: Extensibility is also essential for every project which is for the welfare of the society.

As our project is to help the society and the environment we will also extend our project on a large circle if the customer demand increases.

Chapter 6 Project Planning and Budget

Project planning:

Week	Task	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23
1	Project Planning, Necessary Research									
2	Problem Finding									
3	Prepare & Submit Project, Proposal									
4	Dataset collection, annotation, pre-processing									
5	Dataset Augmentation									
6	Yolo V5 training									
7	Yolo V5 Validation									
8	Yolov5 testing									
9	SSD training (failed),faster rcnn training, testing									
10	All the models testing, video Implementation									
11	Final PresentationProject Demonstration									
12	Final Report									

Fig 7 : Grant Chart

Budget: As we have implemented all of our projects by dependending on free software components, we luckily did not need any kind of budget plan.

Chapter 7 Complex Engineering Problems and Activities

7.1 Complex Engineering Problems (CEP)

Table II. Complex Engineering Problem Attributes

Attributes		**Addressing the complex engineering problems (P) in the project**
P1	Depth of knowledge required	This Project Required knowledge about object detection & Classification, Yolov5, faster-RCNN, and some knowledge about traffic signs.
P2	Range of conflicting requirements	There are some conflicting requirements for our projects like our system has to detect traffic signs in low light at night or bad weather.
P3	Depth of analysis required	Models need to be trained well to get a good test result from it.
P4	Familiarity of issues	Many types of camera sensors
P5	Extent of applicable codes	We need about 250+ lines of codes to complete the whole thing
P6	Extent of stakeholder involvement	Some stakeholders like drivers, passerby, the traffic authorities and engineers will be involved with this project.
P7	Interdependence	This project needs some tools to be implemented like sensors, camera,monitors and wires to connect.

7.2 Complex Engineering Activities (CEA)

Table III. Complex Engineering Problem Activities

Attributes		**Addressing the complex engineering activities in the project**
A1	Range of resources	This project consumes resources like storage, electric energy etc.
A2	Level of interactions	This project will be integrated with traffic authorities, engineers, drivers etc.
A3	Innovation	Our project has been implemented before but we wanted to improve the previous results.
A4	Consequences to society / Environment	It will help the environment by reducing traffic accidents and traffic jams
A5	Familiarity	To address the familiarity, one needs to know about traffic signs, usage of cameras and the whole ecosystem of this project.

Chapter 8 Conclusions

8.1 Summary

By the detection and classification of the traffic signs on road we will try to help the mass population by reducing accidents, increasing traffic awareness, motivating drivers to drive safely, encouraging authorities to implement more signs on the road and many other motives are working behind our system, so that the various causes of road accidents can be resolved. In short words, we plan to make our system useful in the real world and help to reduce traffic accidents and educate the ignorant people about the social awareness about road safety. Also, We determined the best model among the two mentioned in this paper by comparing them at the end of our task. We found Yolov5 is giving more precise values than faster Rcnn while testing. Also, in terms of training values, Yolov5 is giving better values and taking shorter time to be trained than faster-Rcnn.

8.2 Limitations

Some limitations of our project are in low light our system does not respond accurately, some signs had lower instances in the dataset so that in that case the performance on those signs are not so good. Also, as we did not have any external GPU we had to depend on google colab so that we did not train our models on higher epochs.

8.3 Future Improvement

In the future, we are planning to implement our system for automated cars. Also, we will collect more images of those signs which had lower instances in our current dataset and train our models.

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