A DEEP LEARNING APPROACH FOR TRAFFIC SIGN DETECTION AND RECOGNITION USING IMPROVED YOLOV5s

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering

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APPROVAL

This Project titled "**A deep learning approach for traffic sign detection and recognition using improved YOLOV5s**", submitted by Name: Md. Ariful Hossain and Anwar Hossain ID: 191-15-12473 and 191-15-12699 to the Department of Computer Science and Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on **26-01-2023**.

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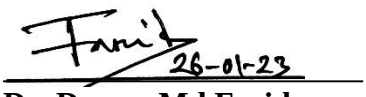

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DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Professor Dr. Md. Ismail Jabiullah, Professor, Department of CSE** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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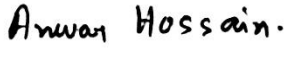

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ABSTRACT

Traffic sign detection is one of the most challenging tasks for autonomous vehicles, especially for the detection of different types of signs and real-time applications. Unmanned driving systems face a lot of problems to recognize traffic signs faster and more accurately. In this paper, we propose a model using improved YOLOv5 to detect Traffic signs and recognize them properly. Our dataset consists of 3500 pictures of the traffic sign and we have annotated all that pictures in YOLOv5 format. There is 39 classification of our dataset on all pictures based on the traffic sign. This system can be used for unmanned driving vehicles. Using this model a device can make which will help drivers who are driving a car. After the implementation of our dataset with the help of improved YOLOv5, the output shows an accuracy of 86.75% in different conditions such as low light, cloudy, rainy, and sunny.

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CHAPTER 1
INTRODUCTION

1.1 Introduction

Object detection has taken one of the most important places in this modern era which is getting a crucial part of this new world to make something innovative. That's why it took the attention of researchers in real-world applications and academic study purposes in the field of deep learning, neural network, computer vision, and so on. For example, autonomous driving, human detection, ensuring security, and robot vision with other important topics. Among all of them, autonomous driving is getting more important day by day because it provides accurate service in time with reducing human effort. Here autonomous vehicles [1] use the process of Traffic sign detection and many renowned companies in this world are willing to invest in the autonomous system for their car for their worldwide demand. To demonstrate Tesla, Cruise, Mercedes-Benz, BMW, Uber, Ford, Honda, Hyundai, and so on. Deep learning [2] helps in traffic sign detection in a timely response, perfect maintenance, making decisions overall getting a smart service where in previous times traffic sign detection had been done manually by using machine learning. Where the pictures of traffic signs were captured by a camera which was connected by vehicles. To recognize those pictures a human used to detect traffic signs manually by comparing presented databases. However today we do not need to use this manually because there has been some updated process using smart way with computer vision.

1.2 Motivation

Our main motive is to find any kind of traffic sign globally within a second. Even it can be any kind of traffic sign and it can be from anywhere in the modern world we are also ensuring the environment depending on the situation all over the world. We are also working on an autonomous vehicle that a car can detect the present stamp on the road. Recently autonomous vehicles are getting more famous day by day around the modern world. In this case, our thesis paper must have a paramount value surrounding the earth. Ultimately we must have various fields to do different jobs and show our work to the nation who want to do something innovative.

1.3 Rationale of the study

Traffic sign detection is one of the most challenging tasks for autonomous vehicles, especially for the detection of various types of signs and real-time applications. Unmanned driving systems face a lot of problems to recognize traffic signs faster and more accurately. In this paper, we propose a model using improved YOLOv5 to detect Traffic signs and recognize them properly. Our main dataset consists of 3500 pictures of the traffic sign and we have annotated all that pictures in YOLOv5 format. There are 39 classifications of our dataset on all pictures based on the traffic sign and this system can be used for unmanned driving vehicles.

Already there had done a lot of research work in this segment with Yolo V5s. Researchers work on different subjects for various topics. They had taken several types of datasets for done their job or make something new like maritime, traffic signs, human, animal, food, disease, etc. In different papers, they work for traffic sign detection for any particular country rules for example, German Traffic Sign Benchmark , Sweden Traffic Sign, Belgium Traffic Sign, The Netherland Traffic Sign, France Traffic Sign, The United States Traffic Sign and Iraqi Traffic Sign Detection Benchmark. However in this paper, we are contributing to building a model which can be used in the entire world to identify traffic signs and other important issues. However, in this paper, we are contributing to building a model which can be used in the entire world to detect traffic signs which is creating a huge role.

1.4 Expected Outcome

Using this model a device can make which will help drivers who are driving vehicles. After the implementation of our dataset with the help of improved YOLOv5, the output shows an accuracy of 86.75% in different conditions such as low light, cloudy, rainy, sunny, and other conditions depending on the weather. Object detection is two types. Two-stage detector and One-stage detector [3] where the Two-stage detector use object region proposal and object classification. A few detectors are Region-based Convolutional Neural Networks(R-CNN) [4], Fast Region-based Convolutional Neural Network (Fast R-CNN) [5], Faster Region-based Convolutional Neural Network (Faster R-CNN) [6], and Mask Region-based Convolutional Neural Network (Mask R-CNN) [7].

On the other side, one stage detector involves the bounding boxes predicted over the images without the region proposal. Many detectors are You Only Look Once (Yolo) [8], yolov2, yolov3, yolov4, yolov5, and M2Det [9]. From all of them, Yolov5 is the most famous one for this platform cause of its accurate result and perfect detection system. It is also good for real-time object detection. All those processes are well known but they are not good for the accurate result to find. Like we cannot use yolov3 because it is pretty much paused to reply promptly. In this paper, we use Yolov5 to detect traffic signs.

At this time the world working with digital videos or images. Artificial Intelligence (AI) is one of the most common topics to do this job for moderating any sector or getting any kind of recognition on a specific matter. Specifically, computer vision works for image or video processing in Artificial Intelligence (AI). In deep learning, the YoloV5[10] algorithm comes to identify objects perfectly.

To manage our project we had done a different kinds of jobs. To demonstrate, we collect data from various online websites and use a particular portal. Most of the time it was pretty challenging for us but we managed. On the other side, we had a plethora of chances to capture our pictures from various places which was a critical part of our thesis. Maximum of the time we face a lot of natural issues when it was a storm and rainy season in our country. How we also managed various weather-related pictures or data from various kinds of filmy websites. Nevertheless, we follow different country bases web portals to find our desired data or pictures for our thesis. Now we are just getting our success to find our real data and those are very useful proved the last time when it’s time to play the real role.

We are just working for the next generation vehicle that they can easily drive on any road by using this system to cross all the problems and find the real issues. However, we know it was not much easy before our presenting system. But now it is getting so much more useful and easier to do this job properly with any kind of vehicle that they just have to use our system at their car, vehicle or something like that. Ultimately we are confident that our system is making it for the real world to find accurate results and fight the unwanted problems that we could not identify till now depending on various technology surrounding our environment and just not defining them properly. Lastly, we must follow the path to complete our research.

This model will recognize any kind of traffic sign globally and traffic signs can be national or international, that's why we should not be bound in any limited area to recognize them. Actually, our model works on this topic to find any kind of traffic sign nationally and internationally. This model will be helpful all over the world in different issues and many countries have similar traffic sign such as speed sign at all range, stop and traffic light color. As a result, we have focused on those signs to merge traffic signs to build a robust model.

1.5 Report Layout

Firstly we had done the identification part which was the most important part of our report. Then our target was to start writing on this paper. Embarking with the abstract which explains our overall job on this site. Then we planned out the introduction part which describes the motivation, rationale of the study, Research question, the outcome we expected, the finance part, and lastly layout that I am describing right now. Now it's time to background and it covers the preliminaries part, related work, comparative analysis and summary, scope of the problem, and challenges. After that research methodology covers some particular topics like research subject and instruments, data collection process, statistics analysis, proposed method, Implementation requirement, etc. Then we discuss the experimental result and discussion what explains the experimental setup, the experimental result and analysis, and lastly discussion. In the following stage, we explain the impact on society, the environment, and sustainability, and this part covers the impact on society, impact on the environment, ethical aspect, sustainable plan, and so on. The last part is the summary, conclusion, recommendation, and implication for future research which covers a summary of the study, conclusion, and implication for further study.

Even now all researchers doing their jobs on traffic sign detection only and they did not focus on autonomous driving strategy. Autonomous vehicle strategy followed the same strategy first but lastly, they could not find the real answer without any hesitation. But now we are using yolov5 to find the real answer so that we can easily eliminate the unnecessary things or data from the dataset given. In this paper, we are covering both sides in our paper. We have a class named 'Car' in our dataset which helps us to build the model or this model can detect cars from the real-time dataset which is very appropriate for our paper.

CHAPTER 2
BACKGROUND

2.1 Preliminaries

Till now there had done a lot of research work in this segment with Yolo V4, Yolo V5, and so on introduced. Researchers work on different subjects for various topic and they had taken several types of datasets for done their job or make something new for example maritime, traffic signs, human, animal, food, disease, etc. In our thesis, we are working on a traffic sign detection and recognition system to contribute to autonomous vehicle fields with other related fields. In our paper, we are working on traffic sign detection with a recognition system [11] to contribute to autonomous vehicle fields. In other papers, they work for traffic sign detection for any particular country rules like the German Traffic Sign Benchmark (GTSB) [12], Sweden Traffic Sign(STS) [13], Belgium Traffic Sign(BTS) [14], The Netherland Traffic Sign(NTS) [14], France Traffic Sign(FTS), The United States Traffic Sign(UTS) [14], Iraqi Traffic Sign Detection Benchmark(IQTSDB) [15] and so on.

2.2 Related Works

As we know, when we want to detect something new we must have a pre-prepared process to identify something new and the unknown. However, the system that tries to find a new object or something like that it must have a pre-knowledge to detect the real object in the present site or the segment. Apparently, we understand detecting something new is a process to match with the saved data that we already have in our system and we can easily manage with this structure.

In this present time, the world working with digital videos and images in the other side Artificial Intelligence is one of the most common topics to do this job for moderating any sector or getting any kind of recognition on a specific topic. Most of the time, computer vision works for image or video processing in Artificial Intelligence and in deep learning, the Yolov5 algorithm comes to detect objects accurately.

2.3 Comparative Analysis and Summary:

Finally, this model will define any kind of traffic sign in a global path and a traffic sign can be national or international, that's why we should not be bound in any limited area to recognize them. Here our model works on this topic to find any kind of traffic sign nationally and internationally all over the world. Even this model will be helpful all over the world in different issues where many countries have similar traffic sign such as speed sign at all range, stop and traffic light color. That's why we have focused on those signs to merge traffic signs to build a robust model.

When the world started thinking about this topic giant company like Tesla, BMW, and other famous companies were trying to make something innovative and they were just in this position. In this recent world tesla has just done a glorious job like they explain about the autonomous car and introduce the system to the modern world. No other company is just doing the same process to do this job properly and various new methods are inventing with new approaches.

After introducing a company to this part now the other company of the surrounding world starting this way to invent something new and they are trying this in a continuous process in their own way. But we have to explain a particular way to run this model that is not like so much an easy process to explore in this present world. YoloV5 is the latest way to introduce this present world with this particular system and identify the traffic sign properly.

2.4 Scope of the Problem:

Suppose a new way is introduced with a well-known company that is not only producing the way to make something innovative and they are not like the personal way. They are using modern technology like the innovative path. Ultimately they compete. As we know this present world always try to make something innovative and target new infrastructure to invent new thing to solve various problems with using new process and method. Sometimes they love to multi-tasking like invent new way to solve new issues and introduce new solution.

Recently all researchers doing their jobs on traffic sign detection only, they did not target on autonomous driving strategy and so on. However we are covering both sides in our paper and we have a class named 'Car' in our dataset which helps us to build the

model and this model can detect cars from the real-time dataset. And our total dataset was taken from various resources what is really an amazing part of this paper. Actually it contributes on different side to produce various environments.

There have some new scope to identify this approach with various way. When we started thinking about this process we face a lot of problems like we didn't have clear idea what to do, how to start the process, what to do next and so on. But at the peak point we find a huge information to do something new or maximum way to find the present problem. On the other side we can easily find the multiple options to make something new and use plethora of side to use various situations. After identifying the real time job process we measure the new problem to solve. We genuinely shocked that we can do plethora of things on our side to invent something new.

In our presented model we have used a dataset of the traffic sign and we collect our data from different sources on the internet with proper help of different country code. All these images and videos have been captured by the camera installed in vehicles and mobile cameras besides the vehicle or car. Most of the time these pictures are taken depending on various environments, conditions, time duration and so on. However here we used 39 classes of data for our dataset and there have 3324 high-resolution images. We have used 2315 images for training, 685 images for validation and 324 images for testing our dataset. Generally, traffic signs are divided into 4 categories such as Mandatory, Warning, Prohibitory and Directory. Moreover, we have used the image and videos augmentation technique here we find. That is the main cause that why our dataset volume extends more than before.

2.5 Challenges:

If I have to explain about the challenges that we face already when we are in a continuous process to do something with our paper. Firstly we didn't have proper information about this topic to start our thesis. But at a temporary point it was pretty much easy to explain this process with the appropriate data to run our process. But now we are literally starting our domain with this new job and identifying the traffic sign with any kind of bad situations or something like that. Truly to say, at the beginning of the period it was pretty much difficult to define this process with proper data and in an actual way. Afterward it got much easier to explain this world with the new civilization and start with appropriate data with proper explanation.

CHAPTER 3
RESEARCH METHODOLOGY

3.1 Research Subject and Instrumentation

We collect our data and other information from different sources on the internet globally. All these pictures are taken depending on different environments, conditions, and time duration on time. Actually here we used 39 classes of data for our dataset to run precisely and there have 3324 high-resolution images. In this proposed model we have used a dataset of the traffic sign detection and we used 2315 images for training, 685 images for validation, and 324 images for testing our model. Here all those images have been captured by the camera installed in cars and mobile cameras from various angle. As we know traffic signs are separated into 4 categories like Mandatory, Warning, Prohibitory and Directory. Even though, we used the image augmentation technique here and that's why our dataset volume extends more than before.

3.2 Data Collection and Procedure

Table 1: 39 class of traffic signs divided into four categories.

Category	Classes
Prohibitory signs	No Entry, No Over Taking Trucks, No Over Taking, No Stopping, No Waiting, Speed Limit 100, Speed Limit 120, Speed Limit 30, Speed Limit 50, Speed Limit 60, Speed Limit 70, Speed Limit 80, Stop, human, Car.
Directory signs	Give Way, Green Signal, Pedestrian, Red Signal, Truck Sign, Yellow Signal.
Mandatory signs	Turn Left, Turn Right, End of Right Road -Go straight, Go Left or Straight, Go Right or Straight, Go Straight.
Warning signs	Danger Ahead, Left Curve Ahead, Left Sharp Curve, Huddle Road, Traffic Signals Ahead, Snow Warning Sign, Slippery Road, Right Sharp Curve, Road Work, Right Curve Ahead, Cycle Zone, Deer Zone.

3.3 Statistical Analysis

In the following Yolo v5 structural way to build any model on any kind of dataset and Yolo v5 is known as a single-stage object detector. Those architectures are very important to follow because it can easily manage all those system to magnitude more easy process where it can follow a sequence a rule .Yolo v5 architecture there have three important parts for example:

1. Backbone stage
2. Neck (PANet) stage
3. Head stage

Finally we maintain this three-stage to run our model and Yolo v5 algorithm performs better in (416 * 416) dimensional images those are in a given process. Apparently, images are set in different dimensions and when we have resized the images from our collected dataset.Here resizing is the most important issue for this process where it can easily contain alll the data it given and annotate all the images. After that resized images passed through the three stages of Yolo v5.

Backbone stage: When we passing our images as input in the backbone stage extract all important features from the given pictures of our dataset at that moment our given images go through the focus layer of the backbone stage. This layer decreases resolution and increases the depths of images. After that the output overpass from Convolutional and BottleNeckCSP layers [16]. At meantime, feature extracts individually here for different pictures and lastly the end of this stage the output will go via the SPP layer. Actually this process can easily find the real problem of this issue and manage the stage properly. On the other side why this process called the backbone stage it is very important question for this part to understand but we have to be clear that we are using the main issues to maintain and processing with proper explanation on this topic. As a result layer is also called the pooling layer.

Neck stage (PANet): Output of BottleNeckCSP goes through SPP (Spiral Pyramid Pooling) block to expand the receptive field. Then distinguish the important feature and this SPP is comparatively better than other CNN (Convolutional Neural Network) based model layers cause it can process input images of any dimension. Finally the goal of

the SPP layer is to generate an output of fixed dimension and the SPP layer distinguishes important features by making its multi-scale version.When we are talking about the helping hand wr must have the knowledge on this topic to understand what will happen after the stage and what will given on the data to do something with proper explanation but it is clear to be understant the process with proper explanation and so on. Here SPP layer can make N number of multi-scale versions and these same features can be separated simultaneously in N number of blocks.

Here the PANet [17] stage stands for Path Aggregation Network. The sequence of network layers is responsible to mix and aggregate the features of images and PAN is an updated version of Feature Pyramid Network (FPN). The backbone contains a lot of layers because of the presence of the deep neural network. At the past, on FPN it had to go through a long path to flow features from low-level to high-level layers. However in PAN there have a shortcut to connect fine-grained features from the top and bottom layers and concatenation layers help combine the layers and give a shortcut for better and quicker performance.

Head stage: In this stage is situated to detect the last step in this process and the head stage is mainly used to perform the final detection part. Following this step, we apply anchor boxes to our processed data to resize them clearly. And finally it generates the output with different classes like objectiveness scores, probabilities, and bounding boxes as we had done the grid sells at the first steps.When it's' time to talk about the real matter to resize , actually it happen in this process to be clear and understand the probability and be clear on the part of the issues. There have some difficult jobs which actually happen in this process and here the main thing done by the autometic way to process the manager director of this system .However here are the final bounding boxes to recognize clearly and precisely. Here the main structure of this architecture is shown in Fig.1.

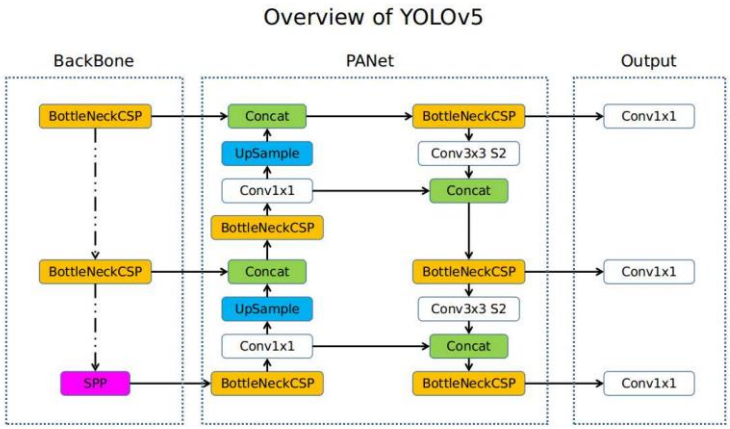
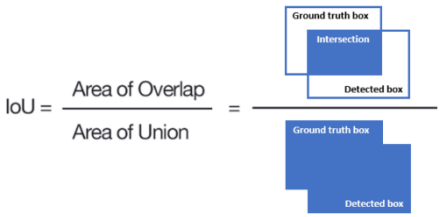


Figure 1: The structure of the stage architecture.

When digging deep into object detection with the important metrics of evaluation, some basic concepts need to be clear. What ever happen this stage follow those issues and manage the real process to be clear and understand the matter. On the other side we can easily manage all those issues and trying to be individual on those particular topics to be clear very well. However we start talking about object detection, several definitions that are useful listing in below:

Intersection over Union (IoU):

Here IoU, initially evaluates the intersection area from the two bounding boxes, the ground truth bounding box or the predicted bounding box. After divide the intersection area by the union area of those bounding boxes (In figure). Concerning all these the prediction can be categorized into True Positive or Valid and False Positive or Invalid.



True Positive (TP): TP denotes that the detection is correct and the IoU ratio is used to determine whether the prediction is Right or Wrong followed by a given threshold. In the typical way, the threshold is set at 50%, 75%, 85%, or 95% where the sing this threshold we can define the behavior of the outputs. To demonstrate, any object detector system can perform better at a 50% threshold however it will not be easy when the threshold is set at 95%.

False Positive (FP): It means the detection is incorrect. Here, the IoU ratio must have to be under the threshold.

True Negative (TN): The object detection model didn't detect anything. The model predicts that there is no object in the picture and it is correct.

False Negative (FN): It denotes the object didn't detect. The object is present in the picture but the model failed to detect that.

Maximum of the time of imbalanced classes, we use precision-recall which is a useful measure of success and here precision is the measure of relevant results and recalls measure the return of true relevant results. Ultimately the precision-recall curve illustrates the balance between recall and precision for different entrances.

Precision (P):

It is considered as the number of true positives (Tp) on the number of true positives and the number of false positives (Fp).

$$P = \frac{T_p}{T_p + F_p} \qquad (1)$$

Recall (R):

It is considered as the number of true positives (Tp) on the number of true positives and the number of false negatives (Fn).

$$R = \frac{T_p}{T_p + F_n} \qquad (2)$$

Harmonic mean (F1) of precision and recall [18]:

$$F1 = 2\frac{P \times R}{P + R} \qquad (3)$$

Average precision (AP):

It summarizes such a plot as the weighted mean of precisions achieved at each entrance, with the increase in recall from the previous entrance used as the weight:

$$AP = \sum_n (R_n - R_{n-1}) P_n \qquad (4)$$

Pn and Rn are the precision and recall at the nth entrance and a pair (Rk, Pk) is referred to as an operating point.

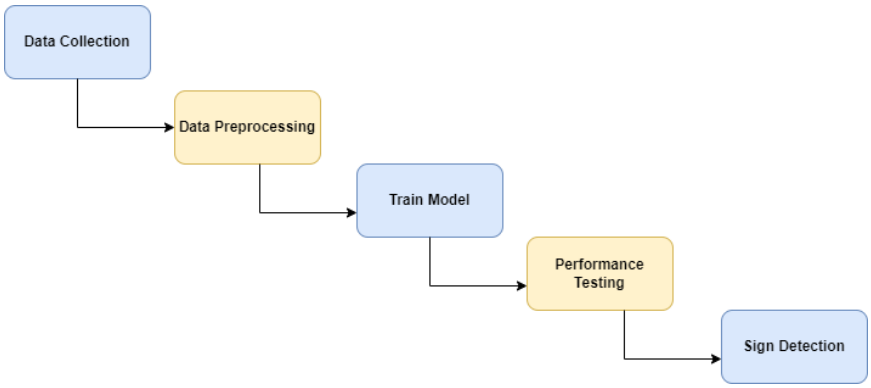


Figure 2: Workflow of our proposed model that we have used to implement traffic signs detection.

3.4 Proposed Methodology

Properly make a model for detecting objects from images or video firstly it is important to annotate images precisely. The way annotating images model can classify and recognize the object precisely and more clearly. Actually image annotation is one of the toughest part on this system that annotate the image with proper importance and then do the main job which it deserve. Well it is the part where we can easily understand the real matter of an image or video that how actually it is happening there and the processing system on this system. On the other side there have various problem with an image or a video that already we have as in our dataset like it can be unwanted size, it can be not clear and so on their different problems we can face. However in this process we can easily manage this system to understand the real image or data we already have. Overall we can say that it is a very important part for us to annotate images in grid sells where we can clearly understand the picture and data very clearly and sharply. To manage this system it is very important to refresh these images to resize. When an image get the system firstly it have various issues like, it must have a clear size to the module. After getting the resized plan the annotate image call the system and then it easily manage the process that last stage to understand the image with proper clearance. We also annotate our images to run our model properly and here we used LabelImg Software to annotate all traffic sign images. By using this software we had done two parts of the job to annotate images, they are class labeling and bounding boxes that we had done these two jobs manually. At the peak moment of image annotation, we create a rectangular box around the traffic sign and while it faces multiple object images we

label them individually. Afterward labeling all the bounding boxes the file save in XML format at that and then we convert this file into YoloV5 PyTorch txt format. Now we can start our process more easily and accurately which must have genuine way to start properly this model and run it in a good way.

3.5 Implementation Requirements

Firstly we collect the picture of signs from multiple resources and to preprocess all the images we annotated and classify them in different classes.Well truely to say firstly we had two dataset first one was the traind model and the second one was the real dataset thae we already have.But we had to manage all those issues to be clear very properly. We run those two dataset on the series all the dataset and the main important part is the two dataset cointain almost a huge data that can easily manage and run properly. But lastly we faced a problem on our issue to contain all the data properly. In train model stage, modify the YOLOv5s algorithm to train our model and the following phase test the performance of the traffic sign model using test dataset. Ultimately, the actual goal of this model is to recognize or detect traffic signs properly.

CHAPTER 4
EXPERIMENTAL RESULTS AND DISCUSSION

4.1 Experimental Setup

In our thesis, we have used Google Colab Pro as our working environment also Python Language with PyTorch for coding and instead of using the pre-trained COCO weights, we make our custom model by changing the value of the number of classes, data path. To stable the average loss using a momentum value of 0.85 and then started our training using our custom model with 1000 epochs. By the use of Intel (R) Core(TM) i7-8565U CPU @ 1.80GHz(CPU) and also Intel(R) UHD Graphics 620(GPU) [19] in windows 10 with Anaconda environment throughout the testing phase, on the other side our dataset contains a total of 3324 high-resolution images and used 2315 images for training, 685 images for validation lastly 324 images for testing properly.

The result is too much satisfied for us because it proved the overall system that it can easily find all the data with its proper desire value. Here we can see the mAP carve or the metrics curve on the graph. However it is too much easier to understand the curve with the proper explanation and the visual with the graph. The calculation value of the Map of the model totally clear the graph with the result. On the other side the precision metrics are too much fluctuated with the value of the overall graph which contain all the value of precision and recall of our training data or model on the final epochs. Now to present the accuracy rate using the following matrix of each class to follow the desire result and so on. So it was the main result that could easily handle all those data for the final epochs.

4.2 Discussion

To fulfil our total system firstly we started our job with Google colab normal version which was easily useable for any machine learning process. When any person want to do something big with this site they are not eligible to work with properly and the most important part is to understand the real issues with this software and how to work with. However we started our machine learning process with Google colab but ultimately we could not manage this properly with this version. By the way we find all those codes for internet for yolov5s. If we want to run our dataset with other options like yolov4,

yolov3, yolov2 and so on it could be not much tough because they all have their individual code with the real dataset at online.

Now it's time to talk about ours one we genuinely started with Google colab normal version but it was pretty much hard for our system to run this with our whole dataset. On the other side our dataset is too much big it almost covered a huge amount of picture as an overall view. Embarking the time it could not load the total dataset even though it has a good internet connection. So we felt bored at the beginning of time but at the main point we stopped out thesis and wait for something new to do this job. At the peak point we decided to use Google colab pro version and then we thought it must have a guarantee to make this work easily or precisely. Finally we could do this job with our proper job facilities and managed all the data in this process. Actually Google colab pro is a paid version of their own side but not like the simple Google colab. It can manage the whole dataset with the real one and control all the permanent dataset in its own dataset and so on. The ultimate result is it through us a good result and help us to maintain all the real time data and get all the result properly which was very important for our system. At the end we could able to make our total system run in the Google colab pro and it was amazing for our final solution and good to use for the overall system. I can assure that this Google colab pro is good to use any kind of machine learning system.

4.3 Experimental Results & Analysis

We have used the mean Average Precision (mAP) as the main component to measure the performance of this detection model and the larger percentage or rate of mAP indicates the best accuracy of object detection in the following experiment. Now, the value of mAP can be calculated using the formula given below:

$$mAP = \frac{1}{N} \sum_{i}^{N} AP_i \qquad (5)$$

Given, N is the total number of object classes and i denotes the label of a class and apart from that, in the Precision-Recall Curve (PRC) APi provides the region of that curve. APi provide the value of Average Precision for each i. Those two points 0.5 or 50% or 0.95 or 95% has set as the threshold of IoU to calculate the mAP value and after finishing the final epoch we get the mAP value is 86.75% at IoU 0.5 but 60.1% at IoU

0.95. Whenever the threshold point value IoU is set at 0.5 and 0.95 Figure.3 represents the best value of mAP in our traffic sign model and again, we have also got a Precision value of 76.2% and a Recall value of 82.9%. Figure.4 shows the curve of Precision and Recall of our training model at final epochs. In the opposite, to inspect the prediction of the model and look for any chance to enhance the model performance a confusion matrix has been used with the validation dataset and while training the model validation data was used to evaluate the model performance at each epoch. Again the table.1 presents the value of precision equal to 77%, Recall equal to 89%, and F1- Scores equal to 83% at the time of validation at each class and in the experimental result, we see that prohibitory and Directory signs provide the best mAP among all the categories of signs. Here thhe table.2 shows the mAP comparison of all the categories of traffic signs at (IoU=0.5). At the last, the figure.5 presents the final predicted result of traffic signs using the model that we have built.

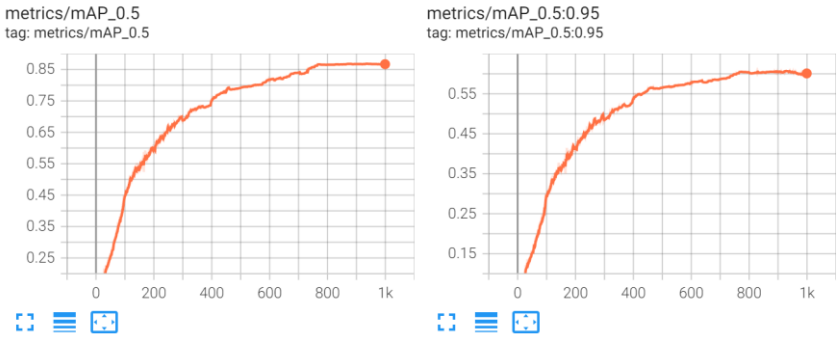


Figure 3: The greatest value of mAP of the model means it show the highest accuracy that model provide on any epochs.

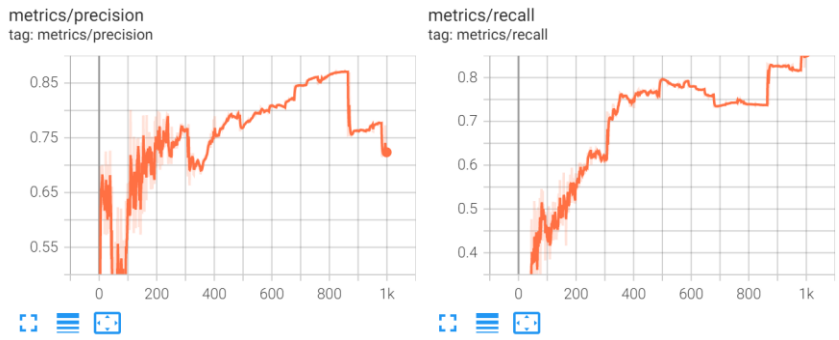


Figure 4: The curve of Precision and Recall of our training model at final epochs.

Table 2: To present the accuracy rate using the following matrix of each class.

Classes	***Scores***		
	Precision	Recall	F1-score
Car	0.81	0.96	0.88
Danger Ahead	0.53	0.71	0.61
End of Right Road -Go straight	1.00	1.00	1.00
Give Way	0.85	1.00	0.92
Go Right or Straight	0.92	0.40	0.56
Go Straight	0.63	0.86	0.73
Green Signal	0.72	0.96	0.82
Huddle Road	1.00	0.84	0.91
Left Curve Ahead	1.00	1.00	1.00
Left Sharp Curve	0.49	0.85	0.62
No Entry	0.95	0.91	0.93
No Over Taking Trucks	0.74	0.88	0.80
No Over Taking	0.87	0.86	0.86
No Stopping	0.60	1.00	0.75
No Waiting	0.40	1.00	0.57
Pedestrian	0.98	0.88	0.89
Red Signal	0.69	0.83	0.75
Right Curve Ahead	0.77	0.74	0.75
Right Sharp Curve	0.44	0.69	0.54
Slippery Road	0.79	0.91	0.85
Snow Warning Sign	0.74	1.00	0.85
Speed Limit 100	0.89	0.72	0.80
Speed Limit 120	0.83	0.98	0.90
Speed Limit 30	0.86	0.96	0.91
Speed Limit 50	0.91	1.00	0.95
Speed Limit 60	0.86	0.98	0.92
Speed Limit 70	0.78	0.98	0.89

Speed Limit 80	0.88	0.97	0.92
Stop	0.96	1.00	0.98
Traffic Signals Ahead	0.64	0.83	0.72
Truck Sign	0.89	1.00	0.94
Turn Left	0.12	1.00	0.21
Turn Right	0.56	1.00	0.72
Yellow Signal	1.00	0.66	0.80
human	0.75	0.88	0.81
Total/Avg	0.77	0.89	0.83

Table 3: When IOU= 0.5, comparison of mAP between Categories.

Category	YOLOV5(our model)
Mandatory signs	78%
Warning signs	80%
Prohibitory signs	95%
Directory signs	94%
mAP	86.75%

Figure 5: The final output of our model which showing the accurate prediction.

CHAPTER 5
IMPACT ON SOCIETY, ENVIRONMENT AND SUSTAINABILITY

5.1 Impact on Society

Traffic sign detection and recognition plays an important role in expert systems. To demonstrate, traffic assistance driving systems and automatic driving systems and it instantly assists drivers or automatic driving systems in detecting and recognizing traffic signs effectively. On the other side signal detection theory is a method of differentiating a person's ability to discriminate the presence or the absence of a stimulus or different stimulus intensities from the criterion the person uses to make responses to those stimuli properly.

As we know, traffic sign detection technology comes to the rescue by showing the current speed limit. So we don't have to remember again and when it comes to accidents there must have strong advantages and disadvantages to traffic signals where traffic signals can reduce certain types of car accidents and the most commonly broadside collisions. One of the fundamental disadvantages of traffic signals is that they lead to an increase in rear-end vehicle collisions without proper connections.

Traffic signs provide valuable information to drivers and other road users where they represent rules that are in place to keep you safe. Again it helps to communicate messages to drivers and pedestrians that can maintain order and reduce accidents which is the most important part here to manage the whole situation to the next generation and the present world without any kind of single hassle.

Safety signs and symbols are used as safety communication tools and they help send clear messages, instructions, and warnings without the use of many words. Again they speed up the level of understanding of individuals which is must be important to the vehicle world. They are useful especially in scenarios where a quick response is needed that is much important to realize the modern system.

Again we mean by that is that we can look at something. Let's say, the color red and conclude that it represents not the color red itself but something beyond it. Like, passion, love or devotion. And maybe the opposite: infidelity. It really mean this system properly and the most important thing is to identify the real picture.

5.2 Impact on Environment

It is argued that the majority of car accidents happen due to human errors and self-driven cars will reduce these human errors or result in a safe driving environment. On the other side it is anticipated that there are be fewer car accidents and the roads will be a lot safe for drivers as well as pedestrians and other depend on other issues which is really thinkable for the real world. The modern world already thinking about this topic very crucial way and maintaining the developed country. So it must be a serious issue. When a can drive automatically but the systems are not able to detect the traffic sign it going to be a serious issue and now we can easily manage with our new invented system which we implemented by the help of Yolov5s.

It is really thankful to the fact that the automobile will be autonomous and will require practically no human interaction for its operation and people with visual or hearing disabilities will not be able to have one. Actually they will become inclusive. As we all know it is a very important issue to illustrate all over the world to process this system properly and it going to be a serious issue to the present world. That's must be amazing to them. An autonomous car can make its decision when it is properly trained by the system of traffic sign detection but if it is not able to detect the real traffic sign properly it going to be the serious problem and it will be seriously harmful to the world and must be with mankind.

5.3 Ethical Aspects

When the first motor vehicles were born and the automotive industry has not stopped evolving. Now the present world with the launch of the first electric cars on the market and this pace has accelerated even more important. Here the automotive industry has shown a dynamism in line with the trends and demands of present and future society precisely. As the history tell it must be a good side to the real world to invent something new and generate the innovation.

Apparently this capacity for adaptation on the part of the automotive industry has led it to seek new forms of speed. At the end it has sought to combine new technologies like, artificial intelligence and the internet of things, leading to the new great revolution in the industry. On the mean side, the emergence of autonomous vehicles is too much important for the present world. People are getting lazy day by day. They don't love to

drive with their own confidence and they actually adore to use the automatic system which can help them properly and in an easy process.

If we have a look at the advantage of autonomous vehicles. At first 360° vision. Time to thanks high-precision technology and autonomous vehicles possess the ability to view the environment in a 360° range with twice as much as humans who have a viewing angle of only 180° horizontally which is an amazing process to implement all over the world to maintain all the traffic system in this way.

Again it reduced accidents. Thanks to 360° vision and vehicles being interconnected with each other and in constant communication and accidents will be significantly reduced by the autonomous system. Though accidents will not be reduced to zero and they will be much less than accidents caused by human driving. Highest traffic efficiency is important to the present world. Apparently it is estimated that their speed in big cities will be lower and their traffic efficiency will be higher to the all vehicle system.

When all the system get access to the disabled and people with reduced mobility. Now it's time to thanks the fact that the automobile will be autonomous. It will require practically no human interaction for its operation also even people with visual or hearing disabilities will be able to have one and they will become inclusive.

The most important advantage is sustainable vehicles. Actually it is expected that these vehicles will operate based on clean energy. So carbon and greenhouse gas emissions will be practically zero which is the most valuable part for the environment that helping to the green world to maintain all the bad issues to enjoy the perfect weather with this issues. To be satisfied it must be an important issue to maintain all the generation to do something innovative.

Now if we have a look at the disadvantage of autonomous vehicles. Firstly data protection issues. The first problem that arises is in that being connected all the time with the whole environment and it can become a cyber-problem of data protection which is the main issues in the real world and present situation to all Car Company and mankind to make something new. Even though the correct handling of road networks can be compromised and that must be a serious problem to the present generation.

On the other side, high cost of implementation is the crucial problem for the modern world. As autonomous vehicle infrastructure revolves around 5G network coverage which is still expensive. So it may take government's considerable time to invest and charge in sufficient infrastructure for optimal performance of autonomous vehicles. When we are thinking for the world this issue getting a serious condition for the mankind and the world accept this with a humble honor.

5.4 Sustainability Plan

High cost of vehicles is the another problem arising. Although significant progress has been made in reducing the cost of producing their implements and these cuts are not low enough to make them a financially viable alternative for the average family and also it will be some years before they become an everyday reality in the reach of the middle class families who can not bear the total amount of money for the rest of the life. As we know it is a thinkable issue to the mankind.

At the ending debates on autonomous vehicles but as cutting-edge as this technology may seem. It is still far from perfect and this assumes that there will be failures at some point. Since this happened the problem will be to define the responsibility for the accident and whether the vehicle, the driver or the vehicle manufacturer. Actually this is a debate that has yet to be resolved for the launch of autonomous vehicles on a massive scale all the surrounded world.

Obviously this system must be too much important for our environment because we know environment always play the role to manage our lifestyle. When it's totally out of control we feel that our life must be is a critical situation and we lead to manage it with our own interest and our invented way and so on. But it get much more critical to control and manage in a good or well decorated way to handle all the problem that arise in this present world. As we know it must be a serious issue to make control all the accidents and manage them in a precise way. So we can say that it must be a good solution to the real world to manage all those problem arise with the vehicle system that related with traffic sign and on the read. Finally we are able to face various issues even they can be bad or something like that.

CHAPTER 6
CONCLUSION

6.1 Summary of the Study

In our paper, we proposed a method of traffic sign detection system based on modified YOLOv5, which provide better performance for recognizing any traffic sign and here we describe the traffic sign detection and recognition system by focusing on 39 classes for the overall autonomous vehicle concept. We have used to gather images from different sources that have been captured in various weather conditions depending on the weather. In our trained model we measured our result depending on mean Average Precision (mAP) and the threshold value has been set at IoU= 0.5 or IoU= 0.95 for the model. Our implimented model will contribute to the field of autonomous driving systems. In the upcoming years, a mobile application can be implemented to detect traffic signs and also using Raspberry Pi a real-time detection and recognition system can be made to help modern society which must be a crucial part in those field.

Actually YOLOV5 work for finding something objectives. Here we are working on a process like detecting the traffic sign. On the other side, it can also help us to match the real picture with the reserved dataset which already we have. It must be so much effective for our daily life style and we are totally dependent on this visual side to identify something easily.

Again, it can help in the side of autonomous vehicle that it can easily manage all those part easily again and again. The scale will affect the learning rate and detection time and if we use a significant number for scale, the identification time will decrease, however, the accuracy will fall. We can conclude from the experiment result: the system can be applied the original scale if we want the best precision and if we're going to increase the identify time more quickly, scale can be used properly.

6.2 Conclusions

As autonomous vehicle can easily manage all those situation that can maintain the real problem in all the part properly. It not depend on the weather and any kind of environment that can find any needs. However it is too much important to manage all the crucial part to find all those things precisely. Our concept always prefer all the

manageable thing in this field to maintain the total system in this proper way and following any particular path.

In this basic path autonomous story we can find all the car or vehicle problem that can be easily controlled by the autonomous system and then it can maintain the stair from the driving sit. Even though driver should not do any single job to find any kind of risk or skill. As we know that a can should be control by the driver and it's owner but in this case like autonomous car a system can solve all the problem with the proper solution and solve the issues. Here the pictures of traffic signs were captured by a camera which was connected by vehicles. For recognize those pictures a human used to detect traffic signs manually by comparing presented databases. However today we do not need to use this manually because there has been some updated process using smart way with computer vision.

In our investigation we are just trying to find an important way to manage all the particular job by the system with the proper evidence. It is important to detect all the sign properly and we can be successful when we are able to find all the way to detect properly. YOLOv5 is a way to find all the process properly and we just need to detect all the system properly which is paramount all the time to detect identity and maintain all the environmental way which must be crucial to detect all the nature properly and we just have to ensure all the system with the particular system and this algorithm can easily find all the identical problems.

Well, truly to say there are so many object detection algorithm are surrounded all over the present world. Now a question can arrive that , why we are using this algorithm for our manual decision . No actually it is not like that, we had a huge study on this topic but we are not only researching on this particular way we are also working on the way to find any king of object in a very easy way and it can be profound for all the situation. Here it is too much important to measure the particular way to find the real object that we really need. For this present era we identify that YOLOv5 is the only path the follow find any particular way and identify the real need.

Traffic sign detection is now getting the most challenging tasks for autonomous vehicles, especially for the detection of various types of signs and real-time

applications. A driving systems face a lot of problems to recognize traffic signs faster and more accurately. In this paper, we propose a model using improved YOLOv5 to detect Traffic signs and recognize them properly. The main dataset consists of 3500 pictures of the traffic sign and we have annotated all that pictures in YOLOv5 format. There are several classifications of our dataset on all pictures based on the traffic sign and this system can be used for unmanned driving vehicles

To manage our project properly we had done a different kinds of steps. Like, we collect data from various online websites and use a particular portal. Most of the time it was pretty challenging for us but we managed. On the other side, we had a plethora of chances to capture our pictures from various places which was a critical part of our thesis. Most of the time we face a lot of natural issues when it was a storm and rainy season in our country. How we also managed various weather-related pictures or data from various kinds of filmy websites. Nevertheless, we follow different country bases web portals to find our desired data or pictures for our thesis. At this time we are just getting our success to find our real data and those are very useful proved the last time when it's time to play the real role.

In the future studies we will emphasize the dataset focus from Taiwan prohibitory signs to all Taiwan traffic signs with the different condition including occlusion, multiple view, illumination, color variation, multiple weather conditions including heavy rain and snow depending on the environment. Furthermore, future studies can extend the data set over the generative adversarial network (GAN) to create a synthetic image, video and obtain better results where we will test different scales and learning rates in the Yolo V3 SPP configuration file the newest Yolo V4.

To improve the safety and efficiency of train operation and autonomous driving train have developed rapidly in recent years, on the other side among them, the signal detection is one of the most basic functions. But due to the little size of signal light and the complicated of the railway environment and the signal detection is still a big problem. This existing methods like the approach based on Hough circle transformations are hard to meet the practical application requirements and a real time railway signal lights detection based on Yolov5 is introduced where a lot of experiments were conducted to prove the effectiveness of the proposed technique.

Here this experimental answers show that the method gain something for both average recall rate and average accuracy rate besides that the detection speed of the proposed method reached astonishing and so on. Moreover, the detection style and accuracy both meet the practical requirements properly.

6.3 Implication for Further Study

Apparently are working for the next generation vehicle that they can easily drive on any road by using this system to cross all the problems and find the real issues. But, we know it was not much easy before our presenting system. However now it is getting so much more useful and easier to do this job properly with any kind of vehicle that they just have to use our system at their vehicle or something like that. Nevertheless we are confident that our system is making it for the real world to find accurate results and fight the unwanted problems that we could not identify till now depending on various technology surrounding our environment and just not defining them properly. Finally, we must follow the path to complete our research.

After that we use the test set to confirm model detection effect and we found that the signal lights detection model trained by Yolov5s has an average recall rate and accuracy of every single part, while running speed can reach 100FPS. At the same time, Because of high robustness and the model can basically adapt to railway signal lights detection tasks in all environments as like as we adore.

Now all researchers doing their jobs on traffic sign detection only and they did not focus on autonomous driving strategy. On the other side autonomous vehicle strategy followed the same strategy first but lastly, they could not find the real answer without any hesitation. However now we are using yolov5 to find the real answer so that we can easily eliminate the unnecessary things or data from the dataset given. In this paper, we are covering both sides in our paper. We have a class named ‘Car’ in our dataset which helps us to build the model or this model can detect cars from the real-time dataset which is very appropriate for our paper.

Here we use CV to extract signal lights where the traditional way depends on its color and shape, using feature matching, color matching and other methods to extract signal lights. In recent years, deep learning has attracted most attentions and along with the development of hardware and compute power required by deep learning has been reached. More and more researchers are trying to solve problems with deep learning. It

has been used in various fields, such as autonomous driving, medicine and finance where railway signal lights detection is a standard small object detection problem in deep learning which many predecessors have proposed numerous object detection networks for small that. This paper proposes a new signal lights detection method, namely the railway signal light detection based on Yolov5 neural network and our first construct a dataset consisting of subway scenes with signal lights then start training to get the Yolov5 model.

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A DEEP LEARNING APPROACH FOR TRAFFIC SIGN DETECTION AND RECOGNITION USING IMPROVED YOLOV5s

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