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YOLO BASED LICENSE PLATE DETECTION OF TRIPLE RIDERS AND VIOLATORS

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***Abstract*-Road safety is of prime importance as road accidents are among the biggest causes of deaths in the country. Road Accidents are majorly due to violators and lawbreakers of road safety rules like not wearing helmets, triple riding etc. Even though there are many smart systems to monitor these violations, it is complicated to keep a track of the data and view it efficiently anywhere. Also monitoring the permit details of other state vehicles is hard. A method was proposed to address this issue. based on Deep learning and Optical Character Recognition (OCR). Here we detect the riders not wearing helmet and triple riders using object detection by comparing YOLOv2 and YOLOv3. This simplifies the task of traffic police who can't continuously and efficiently monitor all the violators. We gathered our data from three different sources. Kaggle was used to collect the data set. A number of items can be recognized by the real-time object recognition system YOLO in a single frame. It recognizes object more precisely and faster than other recognition systems. It can predict up to 9000 classes and even unseen classes. It divides the image into m*m matrix and each grid detects objects within itself. The trained model is tested using a test dataset set after training in order to measure the performance. For Number plate detection we use OCR based character recognition. The recognized license plate images of violators are captured and stored in a database which is then sent to the concerned department. The stored data can be easily accessed using the developed mobile app. Metrics considered for evaluation is Accuracy. The average is utilized to assess object detection models like R-CNN and YOLO. The average calculates a score by comparing the detected box to the ground-truth bounding box. The better the score, the more precise the model's detections are. When compared to YOLOv2, YOLOv3 exhibits strong performance in terms of accuracy with 95.5%. Keywords—Deep learning; Object detection; Convolutional Neural Network; YOLOv2; YOLOv3**

I. INTRODUCTION

The most challenging task today is object detection. Artificial intelligence depends on it. To find items, a variety of methods can be utilized. The best result for recommendation systems comes from CNN-based deep learning for object recognition. The best character recognition system for object detection systems is ANPR technology, which offers good accuracy. Even if there are many traffic laws, people these days do not seriously abide by them, and while the police are there to observe them, it is very difficult for them to continuously observe. For this problem statement, there is a solution using ANPR and deep learning techniques[17]. The main focus of this study is the deep learning model, which offers us excellent accuracy for multi-class object detection. This will save up crucial government time and make the concerned department more convenient. Manual monitoring won't be more precise, though, and we might occasionally make mistakes. Therefore, identifying and recognizing lawbreakers will be made easier by employing deep learning algorithms to recognize the license plates of offenders.

A. Contribution

The Multi-class object detection using ANPR and deep learning algorithms is the project's key selling point. [18]This study analyses the accuracy and efficiency levels of the two algorithms and focuses on the process of data training using the YOLOv2 and YOLOv3 models. The following points could be used to categorize the total contribution to our project:

1. Compiling datasets of various violator classes and license plate data

2. Applied Roboflow to annotate the gathered datasets.

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3. Increasing the dataset size by Roboflow. Trained these datasets with two different models namely YOLOv2 and YOLOv3.

4. Analyze the performance and the accuracy of these two models.

5. Testing the model using the video input from CCTV.

B. Objectives

Multi-class item identification and character recognition are the main goals of this project. Aspects of the recognition process include locating the objects, determining the class to which they belong, and recognizing the character from the item. This study project uses a variety of experimental methodologies and method comparisons to identify the best algorithm with the highest accuracy level. Identification of non-helmet riders is an important objective among all the other traffic violations and extracting those violated vehicles license plate is also most concerned. The major objectives are listed below.

• Identification of Non-Helmet riders and Triple riders.

• Extracting License plate of violators.

• Alert the concern department about the violators using a mobile app.

II. LITERATURE SURVEY

S. Sanjana and V. R. Shriya1., [1] The author focusses on Helmet Detection using Deep Neural Network (DNN) as a method to visualize the tacit knowledge. In this paper, the author presents the performance of helmet classification using the TensorFlow framework. The author found that the performance of helmet classification results with a accuracy of 78.09 with VGG16 algorithm.

In September 2021, Taoufik Saidani1, [2] claimed that the sheer volume of vehicles on the road makes it harder for people to process incidents. Consequently, new methods and systems based on Fast R-CNN. In order to recognize the target license plate's modest size, we also add a deconvolution layer to the features extraction network.

The claim that many modern techniques for detecting car license plates are only relatively effective under certain circumstances or under the assumption of certain facts. Consequently, in February 2019, utilizing a timely intersection-over-union evaluation strategy and precise rotation angle prediction, Lele Xie's suggested method can gracefully handle rotational issues in real-time scenarios. [3]The performance of helmet classification using the TensorFlow framework is presented by the author in this paper.

For detection and recognition, the article recommends a single neural network named ALPRNet. Instead of using the optical character recognition (OCR) recurrent neural network (RNN) branches used by the majority of existing methods for automatic licence plate recognition (ALPR) that concentrate on licence plate type, object detectors output bounding boxes of LPs and characters with appropriate labels because ALPRNet handles LP and character in an identical manner.

Use the YOLO's seven convolutional layers to identify a single class, according to Rung-Ching Chena [5]. A sliding-window method is used by the detecting mechanism. The goal is to identify Taiwanese license plates for vehicles. We make use of a dataset from AOLP that included six-digit vehicle license plates. 4

Automatic licence plate (ALP) detection and recognition is essential to the functionality of modern urban life, parking management, and traffic monitoring systems. A pretrained CNN model, according to Naaman Omar [6], has greatly improved Arabic numbers' ability to identify cities. A brand-new dataset of license plates was also produced and used in the experimentation for the study.

Research in the areas of computer vision, image processing, and intelligent transportation systems has focused heavily on and continues to focus on automatic licence plate detection and recognition (ALPR). ALPR is used to increase the reliability and effectiveness of Zied Selmi's proposed detection and recognition operations in settings and backgrounds that are extremely complex. [7]

Developed by Felix Wilhelm Sieberta, Due to the expanding motorization of traffic, there are ever more deaths and injuries on the roads around the world. Using video footage and a deep learning technique, we have built an algorithm for the automated registration of motorcycle helmet use. A evaluation of the algorithm's performance on a set of annotated test data and a comparison to data on human-registered helmet use show that our approach has a high level of accuracy.

From the video's subtitles, Madhuchhanda Dasguptal, a juvenile rider, and numerous other cyclists without helmets may be recognized by an algorithm. [9] For the purpose of captioning motorbike rider videos, a deep neural network-based approach is recommended. Convolutional Neural Networks (CNN) and an optical flow guided technique are used in the encoder section of the proposed encoder-decoder based model to extract visual information.

The Traffic Rule Violation Monitoring System, according to Nikhil Chakravarthy Mallela1, [10] ensures that the regulations are strictly observed while needing the least amount of human work. This effort's main objective is to find the Triple Riding. The vehicle number will be verified by the transportation office. For the system to withstand poor or no internet connectivity, a GSM module is being added. If not, the deployed public internetwork's development boards, which serve as its hub, can access the vehicle-related data.

[11] This study's main objective is to spot drivers in traffic scenes who are wearing seatbelts and helmets. This will make it simpler for people to uphold the law and ensure that they drive safely, claims Divyansh Saini. Police will also be able to monitor traffic from a safe.

Traffic infraction monitoring and control are very important because of India's enormous population, expanding number of commuters, [12] Rider mindset and ineffective traffic light management. In order to concurrently monitor and track offences in such high traffic volumes, physical police-based traffic monitoring is obviously insufficient. As a result, R. Shree Charran, who has a 99.41 accuracy rate, has missed a lot of infringers.

[13] CongZhang claims that interest in licence plate detection and recognition (LPDR) has lately increased and that several algorithms have demonstrated competitive performance on a variety of datasets. This field still has three significant issues to address despite having a 98.1 accuracy rate.

[14] Modern traffic patterns in Pakistan have unusual license plates. According to Imran Shafi, private licence plate tracking and identification are essential for a number of reasons, including safety and a functioning traffic system. Finding and correctly identifying a specific number plate car with a 97.82 percent accuracy is difficult for the police.

Using CNN-Based Multi-Task Learning with YOLOV2 and RetinaNet, the author Hanhe Lin and Jremiah [15] built a model for helmet use detection of tracked motorcycles, and they achieved 89.9% accuracy in identifying riders that violate the system using the surveillance footage.

III.PROPOSED SYSTEM

The primary objective of the proposed system is to identify non-helmet wearers, triple riders, and also the cars that enter the state without the required authorizations. These violations are identified using object detection, and the details are reported to the relevant department via a mobile app. Fig.1 depicts the architecture diagram.

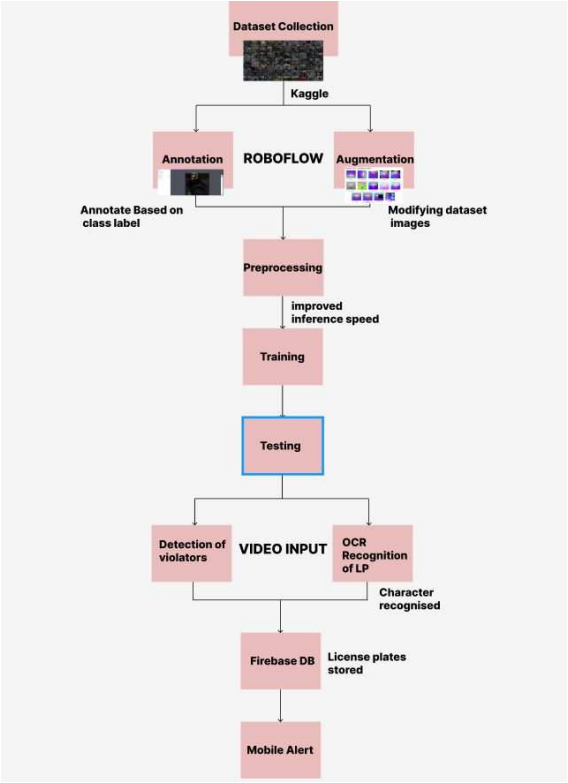

Fig 1. Architecture

A. *Object Detection*

The YOLO algorithm employs the following three tactics[19]:

a) Residual blocks
b) Bounding box regression
c) Intersection over Union (IOU)

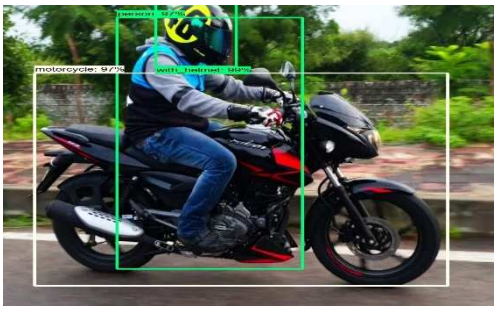

Fig 2. Image is split into Grids Residual Blocks

Figure 2 demonstrates how the image has been divided into a unique matrix. Each matrix has a S x S component. The same characteristic is present in many lattice cells. Each matrix cell's contents will contain unique objects that stand out from the others. For instance, the lattice cell designated as the position of an object will be in charge of identifying the object.

a) Bounding Box Regression

A bounding box is a representation of the location of a certain object within a photograph. The following information is contained in each image's bounding box.:

1. Dimension (b_w)
2. Measurements (b_h)
3. Class, which is represented by the letter c (helmet, non-helmet, triples, license-plate).
4. Bounding box location (bx, by).
5. Class Probability (Pc).

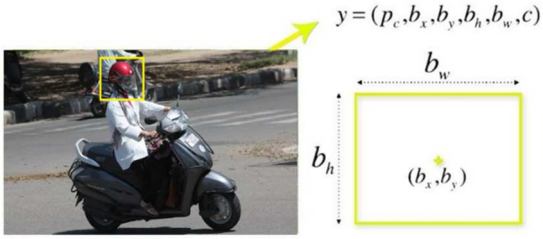

Fig 3. Bounding Box

In order to determine an entity's height, width, central location, and class, as shown in Fig. 3, YOLO employs a single bounding box regression.

b) Intersection over Union

As evidenced by the intersection over union (IOU) image features abnormality, boxes cross over. YOLO [20] builds an identical result boxes for the item using IOU. Each lattice cell makes a prediction about the bounding box dimensions and its level of confidence. If the actual box's age matches that of the predicted box, the IOU is equal to one. Incorrect boundary boxes are removed using this technique. Figure 4 provides a concise explanation of how an IOU works.

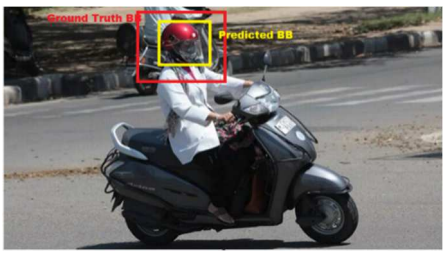

Fig 4. Ground Truth box and Predicted box

In Fig. 4, two border boxes, one of these in red and another in yellow, are shown.

The red box serves as a representation of the actual box while the yellow box illustrates the planned box. This Intersection Over Union (IOU) method is used to evaluate the performance. The IOU aids in deciding whether or not a given location is where an object is kept. The IOU is visible when the connection and converging areas of the boxes are separated by one another, as can be seen in this example. The situation gets better as the IOU grows. According to equation (1).

$$IOU = \frac{\text{Area of Intersection of two boxes}}{\text{Area of Union of two boxes}} \quad (1)$$

Fig. 5. shows a diagrammatic illustration of IOU

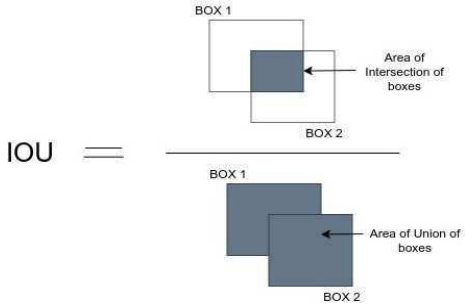

Fig 5. Illustration of IOU

B. Dataset Description

The datasets images collected from Wikipedia and Kaggle, and Rob Flow is used to enhance and annotate them..

They are images of a licence plate, a helmet, a non-helmet, and triples. There are more than 150 pictures in each of the dataset's four classes. The total number of photographs in the collection is 3748, and there are 9000 after augmentation. The number of images for each class is shown in Table 1.

TABLE I. NUMBER OF IMAGES IN EACH CLASS IN DATASET

Class Name	No of Images
Helmet	893
Non-Helmet	1161
Triples	1284
License Plate	410

C. Performance Analysis

The YOLO method offers a lot of benefits over classifier techniques since it can tell them apart. One image can display a lot of items..

a) Validation Loss

An indicator of how well a deep learning model performed on the validation set is called validation loss. The dataset's validation set is a section set aside to examine the effectiveness of the model.

b) Validation accuracy

The percentage of predicted values (yPred) that coincide with actual values is what accuracy measures.

c) Loss

A poor prediction will lead to failure. In other words, loss reflects how poorly the model anticipated a single case. The loss is 0 if the model's forecast is accurate; otherwise, it is larger.

d) Accuracy

When ranking categorization models, accuracy is one aspect to take into account. The percentage of forecasts that were correctly anticipated by our model is called accuracy. The following is what accuracy is officially defined as: The total number of right guesses matches the total number of right guesses..

TABLE II. TIME SPENT TRAINING THE PROPOSED APPROACH AND ITS EPOCH

Algorithm	Epoch	Training Time	Accuracy(%)
YOLOv3	30	3 hours	95.5
YOLOv2	30	2 hours	48.3

D. Optical Character Recgonition (OCR)

Text recognition is another name for optical character recognition (OCR). Data is extracted and reused from scanned documents, camera photos, and image-only PDFs by an OCR application. The original content can be accessed and edited by using OCR software, which isolates letters on the image, turns them into words, and then turns the words into sentences. Furthermore, it does away with the need for manual data entry.

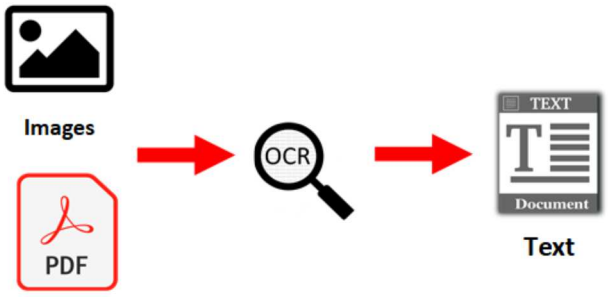

Fig 6. Detected license plate

a) License plate recognition

The Automatic Number Plate Recognition (ANPR) or Automatic License Plate Recognition (ALPR) technology uses optical character recognition to read a vehicle's license plates from a picture or a video clip. Thanks to recent advancements in Deep Learning and Machine[16] Vision, these tasks can now be completed in a few milliseconds.

Fig. 7. Violators license plate is detected and saved as a separate image; we can use it to extract text.

Fig 7. Detected license plate

E. Extraction of data to database

The violators of non-helmet and triple riders are detected using object detection and the detected images are then passed to OCR for character recognition, these character are then sent to firebase database, the license plate images are also captured and also these images are stored into the database. The predicted text is converted and stored into Json file which then will be used here to find the other state vehicles who got permission or not. Firebase data storage is used to store all these data and these data are stored in the cloud storage. This stored data will then be sent to the mobile app which is used to view all the details of violators.

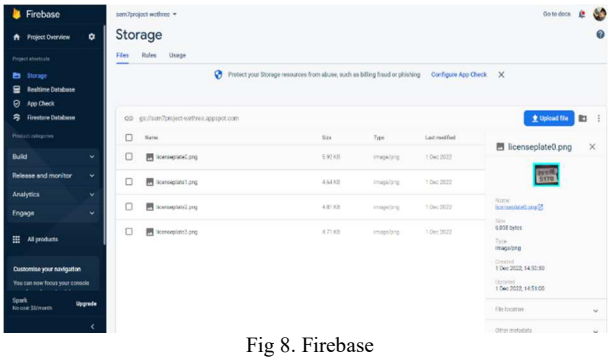

Fig 8. Firebase

Fig. 8 Extracted image is collected and uploaded in google firebase.

F. Mobile app using flutter

Flutter is a tech stack used here to develop a mobile app, The name of the developed Survilators. This app collects the data from firebase and displays the details of violators. The flutter app displays both the recognized texts from OCR and also the captured images of the violators license plate is displayed in the app is shown in Fig. 9.

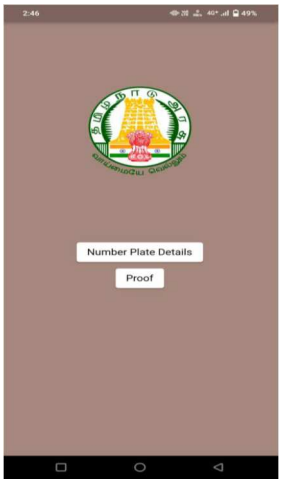

Fig. 9 Mobile Home page - Flutter

III. RESULTS AND DISCUSSION

. After 2 hours of training, the suggested model for YOLOv2 earned 45.5% Accuracy. Each of the dataset's 5 classes has a distinct accuracy and truth count. Each class has True Positives, and False Positives. In our dataset, there were 8500 total detections, while 2267 unique truths were found. After 3.30 hours of training, YOLOv3 achieved a accuracy 95.5%. In the test image, finding the items in the YOLOv2 model takes 18 milliseconds while doing so in the YOLOv2 model requires 28 milliseconds. Because it has fewer layers than YOLOv3, the YOLOv2 model is suitable with embedded devices like microcontrollers. It is crucial in a real-time context to have better real-time accuracy than inference time. When compared to other versions, the YOLOv3[21] model is small, but the YOLOv2 model is made primarily for embedded and Internet of Things (IoT) devices.

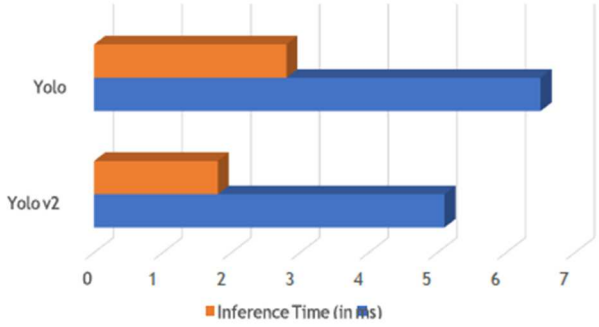

Fig 10. Inference comparison

Fig. 10. Represents the comparison of inference time of algorithms.

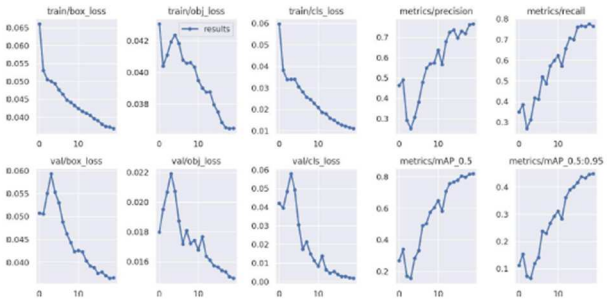

Fig 11. metrics

Fig. 11. Represents the results that are obtained by using YOLOv3 algorithm.

IV. CONCLUSION

The goal of this research is to effectively identify traffic safety violators using object detection and OCR. Riders without helmet and triple riders are detected and their respective number plates are captured successfully. The captured number plate’s data is stored in a cloud database which is then sent to the concerned department. The YOLOv2 and YOLOv3 model was chosen for comparison. For YOLOv2 the Accuracy value is 45.5 and for YOLOv3 is 95.5. The YOLOv3 model has got higher score. When comparing YOLOv2 with the YOLOv3 model, YOLOv2 gives a lesser score but the prediction time

is comparatively low. After this analysis, we found that YOLOv3 model is able to correctly detect the violators more efficiently than YOLOv2. YOLOv2 is particularly designed for embedded devices due to its lightweight. Thus For our problem statement there is no need to incorporate our model with embedded devices. we chose YOLOv3 over YOLOv2[22].

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