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Automatic Traffic Rules Surveillance using YOLOv3 and OCR

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Abstract - Nowadays, the number of two-wheelers are increasing day by day and people are violating the traffic rules quite frequently. So, the detection of traffic rule violators is essential in order to maintain safety measures. The traditional system of detection is manual which is less productive and also time consuming. Moreover, it requires more manpower and it is impossible to catch all the traffic rule violators manually. So, there is a need to develop a system that will automatically detect the person violating the traffic rules. We have proposed a system that will detect a motorcyclist driving without helmet automatically from pictures, pre-recorded surveillance videos as well as at real-time through IP camera using object detection. In recent times many research have been done on object detection algorithm like CNN, MobileNets, R-CNN, YOLO but we have preferred YOLOv3 algorithm due to its efficiency and faster detection speed. In the proposed approach, we tried to eliminate the manual task of detection by automatically detecting Helmet and Non-Helmet motorcyclist, then detecting and extracting number plate. The main principle used in our system is Object detection using Deep Learning. The detection works at three level: Firstly, motorcycle with person is detected. Secondly, whether the person is wearing a helmet or not is detected and lastly, number plate of violator is detected and extracted using OCR (Optical Character Recognition). All the detection are performed using YOLOv3.

***Key Words*: YOLOv3, OCR, CNN, Deep Learning, Object Detection,**

1. INTRODUCTION

According to World Health Organization, around 1.3 million people die due to accidents around the world and more than 20 million suffer injuries due to this. Approximately, more than half percent of the total accidents are caused by the motorcycles, which is a serious problem. WHO also states that road accidents cost around 3% of their country GDP, which is a whooping amount. In fact, India ranks 1st in the number of deaths occur due to road accidents, around 11% of the world deaths due to accident are from India and most of them are due to not following the traffic rules and most people are having ignorance following it. The main reason people are not following the rule is due to not having proper surveillance system and not fining the individual who break it. Most of the death in India are due to over-speeding of motorcycle and not wearing the helmet as most people don't have knowledge and benefit about wearing helmet. According to the report by Tamil Nadu government titled "Road Accident Analysis in Tamil Nadu March 2019", about 52% to motorcycle accident are due to not wearing helmet and people don't wear them because there is not proper fining system and manual surveillance is practically impossible to detect each and every violators. Motorcycle accidents are mainly due to over-speeding and at the same time not wearing helmet. So, whenever sudden brake is applied due to inertia the rider is thrown from the motorcycle and can cause severe injuries to the head and in worst cases even death. But if the riders is wearing the helmet the impact on the skull might not be large and it protects the head from damaging. So, if proper fining and surveillance is done people will start following traffic rules and road accidents can be reduced. In recent times Government has started the surveillance of the road by installing CCTV cameras but the detecting process is manual and it is not only time consuming but also not reliable for large number of detection due to humans inefficiencies. So we proposed a solution to overcome the existing system by making the detection process automatic with the help of deep learning which will detect the violators with YOLOv3 and extract the number plate with the help of OCR.

2. LITERATURE SURVEY

Detection and classification of moving Thai vehicles based on traffic engineering knowledge. [1]

According to A. Leelasantitham and W. Wongseree, the system consist of detection and classification of the roaming vehicles taking traffic rules into consideration. It is divided into two main parts which is explained below. First part of the technique is detecting the vehicles using image processing methods i.e. background and foreground (BF/GF) detection and blob tracking. Above listed method provides vehicle feature values like its length (L), position and width (W). Another part of the technique is classification of vehicle considering the traffic understanding which is managing the traffic for controlling the traffic lights on the crossroads and also finding the volume/capacity ratio and length of the queue. This is the reason why vehicles are separated into 5 categories i.e. 1) Bicycle, motorcycle and motor tricycle ;2) Passenger car, pickup, van and passenger pickup; 3)Six

wheel truck and mini bus ; 4)Ten vehicle truck and big bus; 5)Eighteen vehicle truck and trailer. By above mentioned causes we can say that, the second portion applies the key feature of size, i.e. W, L and W/L ratio from every categories who undergoes decision-tree methodology for classifying vehicle category. The output define that with input feature is enough to differentiation between other 4-group with all-inclusive accuracy of 97.37%.

Detection of helmets on motorcyclists. [2]

The usage of motorcycles has increases day by day that leads into rapid increase in accident as well. Although, best preventive measure or safety equipment for motorcyclist is helmet but people do not prefer to wear it. According to Romuere R. V. e Silva, Kelson R. T. Aries and Rodrigo de M. S. Veras, they proposed a method for detection of motorcycle and classification and also for detecting the motorcyclist without helmets. For classification purpose, they have used the wavelet transform (WT) method as the descriptor and for classification they have used random forest method. And for the helmet recognition purpose, the circular Hough transform (CHT) and histogram of oriented gradients (HOG) descriptor was used to take out the image attributes, and also the multilayer perceptron (MLP) classifier was applied to categorize the objects. The classification of vehicle has achieved an accuracy ratio of 97.78%. The helmet detection module has an accuracy rate of 91.37%.

Detection of Motorcyclists without Helmet in Videos using Convolutional Neural Network. [3]

For the ensuring the safety measures, the detection of violators of traffic rule is much needed but it is highly challenging task due to several problems such as occlusion, illumination, poor video quality for surveillance, varying weather conditions, etc. According to C. Vishnu Singh, C. Mohan and Shobhan Babu, they presented an automated system for detection of motorcyclists without helmets from surveillance videos. In this below mentioned approach, firstly they use background subtraction on frames of video to obtain objects in motion. Afterwards, Convolutional Neural Network (CNN) is used for recognize the motorcyclist from roaming objects. Again CNN algorithm is applied on upper 1/4th part for further findings of motorcyclist not wearing helmet. The execution of their approach is evaluated on two datasets, IIT_H Helmet_1 contains sparse traffic and IIT_H_Helmet_2 contains dense traffic. This experiments on real time windows has successful detection ratio of 92.87% violators with low false alarm ratio of 0.5% on an average.

Detecting motorcycle helmet use with deep learning. [4]

In continuous increase in motorization of traffic that leads to increase in number of road related fatalities and injuries. In accountancy with this, governments is concentrating on safety and law-abiding behavior in traffic. In developed countries motorcycle is a preferable vehicle taken into use but there is lack in helmet usage. Hence, Felix Wilhelm Siebert and Hange Lin developed an algorithm for automated registration of motorcycle helmet utilization from the video data, using Deep Learning approach. In Accordance with 91,000 frames of video data, they trained their algorithm to detect the moving motorcycles, detects number of riders and their position as well as it detect the helmet usage. The accuracy from the tested dataset in comparison for the human which have register motorcycle with helmet shows high accuracy. The accuracy of motorcyclist helmet usage rates by their approach is about −4.4% and +2.1% in comparison with manual detection. Their approach can be implemented with real time traffic infrastructure and also existing data.

Motorcyclist's Helmet Wearing Detection Using Image Processing. [5]

Ratio of Motorcycle accidents have been increasing in many countries. Because of several social and economic factors, vehicle is becoming popular. As a preventive measure helmet is main safety equipment for motorcyclist but most of them do not prefer to use it. If the motorcyclist do not wear helmet the accident may turn to deadliest one. So according to Pinit Kumhom, he presented an automated method for detecting vehicle, motorcycle classification on roads and the system will also detect the motorcyclist without helmet automatically. Procedure for it is mentioned below. Firstly, they detect the moving vehicles in real-time by taking out back ground out from front ground with the help of subtraction then intensifying it using threshold and mathematical morphology method. Secondly, they differentiate between motorcycle and other vehicles. Area is used for feature extraction and neural network methodology is used for classification purpose. In the last and final step, Hough transform methodology is used for helmet detection. From the results of experiments, the accuracy ratio of motorcycle classification was 98.22% and detection of helmet was 77%.

3. TRAINING

We have trained the dataset using YOLOv3 algorithm due to its efficiency and execution speed. We have prepared our own dataset of more than 2000 images and also requested IIT Hyderabad to provide their dataset to prepare our model. After collecting the dataset we labelled the dataset for the items that we have to detect. We have taken 4 classes for detection i.e. 1). Helmet, 2). Non-Helmet, 3). Two-wheeler and 4). Number Plate.

We have trained our model on Google Colab as they provide high GPU for training the model, so the training speed can be improved. The model was trained on Tesla K80 GPU and the time taken for detection was around 10-11

hours. To train every class on YOLOv3 we have to make 2000 iteration for it, as we had 4 class we trained the model for 8000 iteration. We have trained the model with different image size for better detection and the total filters in our model was 27 as it depends on number of classes, filter = (No. of classes + 5)*3 [6].

The dataset are trained along with the labelled data and the final weight after 8000 iteration is used for the detection purpose. The average loss during the training was about 0.213% as shown in Fig-1.

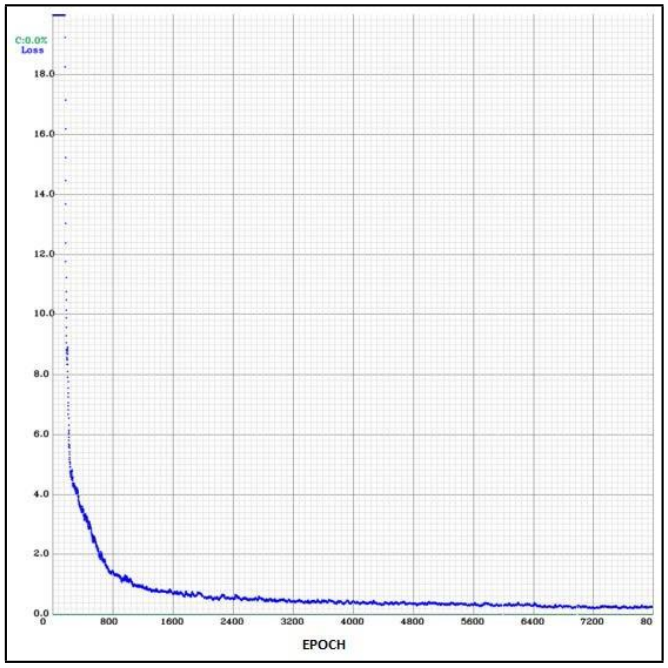

Fig -1: Average Loss during Training the Model

4. METHODOLOGY

The system is designed in such a way that the input can be pre-recorded video, image or can also detect live feed from the camera through IP address. This can be beneficial for Traffic police Department as they can do surveillance 24x7 without any requirement of humans. There are various modules for detection like motorcycle and person detection, helmet and non-helmet detection, number plate detection and number plate text extraction.

The proposed architecture of the system is as follows:

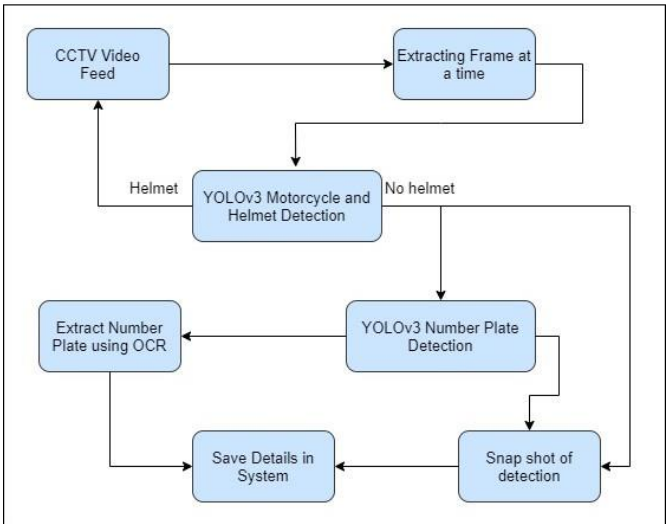

Fig -2: Block Diagram

In the proposed method we take the video input from the CCTV camera and extract frames one after the other. This frames are passed to YOLOv3 model for motorcycle and helmet detection and after that two Cases can be possible:

Case 1: Motorcycle with person and with Helmet

Case 2: Motorcycle with person and without Helmet

4.1 MOTORCYCLE AND HELMET DETECTION

The frame from the CCTV passes simultaneously to the Motorcycle and Helmet detection model where it detect the classes "Two-Wheeler", person with "Helmet" and "Non-Helmet". After passing through the model the output of the frame will be shown with the detected objects marked by bounding box along with the confidence score of the detection as shown in the Fig-3 and Fig-4.

Fig -3: Frame before detection and after detection (Case 1)

Here as shown in Fig-3, two classes "Helmet" and "Two-Wheeler" are detected. If only motorcycle is found then the detection will eliminate it, similarly with person not found with motorcycle it will eliminate them. As, shown in Fig-3, the person is wearing the helmet, as he is not violating the law the process will not pass further for number plate detection but will take another frame and continue the motorcycle and helmet detection. So, if the person is not found violating the traffic rule, the system will not detect the number plate and move to next frame. This, reduces the load the system and can reduces the time as it ignores the useless detections.

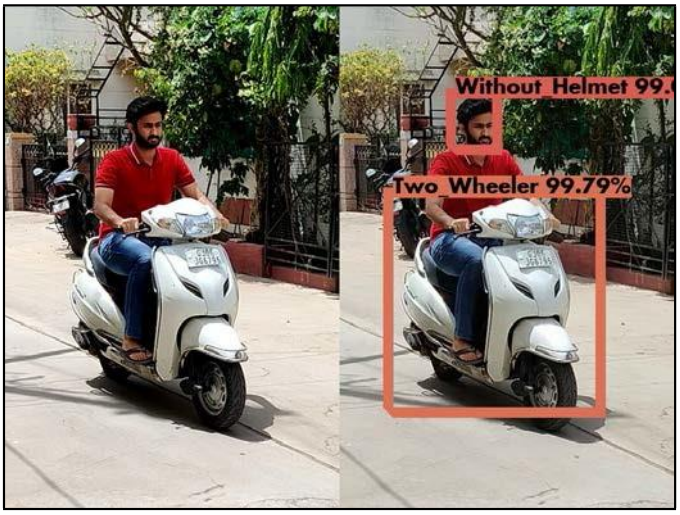

Fig -4: Frame before detection and after detection (Case 2)

Here, as shown in Fig-4, classes "Without-Helmet" and "Two-Wheeler" are detected by the model. But here the person is found to violate the law as he is not wearing the helmet, so the system will move forward for number plate detection to extract the number plate details and identify the violators. At the same time the system will snapshot the given frame for further processing and it can act as a proof when generating the Challan. All this snapshots are stored in the system so they can be easily accessible.

4.2 NUMBER PLATE DETECTION

If the frame is identified as Case 2 then it will pass to the number plate detection model where the number plate is detected and the output will be generated by bounding box along with confidence score. Here the snap shot of the motorcycle is used to find the number plate.

Fig -5: Number plate detection

Here, the detected number plate in bounding box is snapshotted and then it is send to the OCR module for number plate detection and extracting its characters [7].

Fig -6: Snapshot of number plate detected

The training of number plate was done on Indian number plate to get optimum result, as it has unique font then others. The training was done on more than 800 images of number plate. The flow of OCR number plate detection and extraction is as follows.

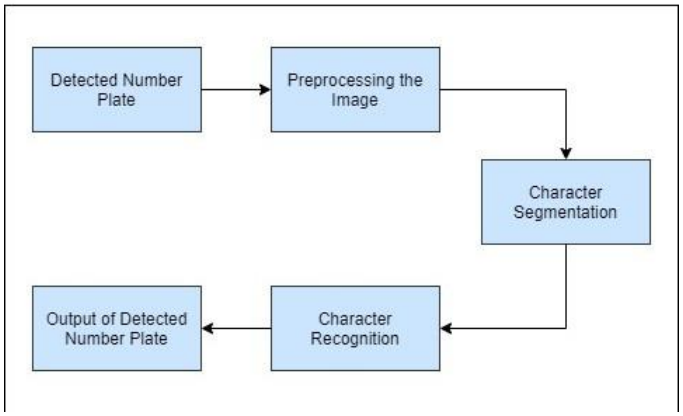

Fig -7: Block Diagram of Number Plate Detection

Before the detected number plate is passed to the OCR we need to do some preprocessing so we can get better output. Firstly, the image is rotated according to the requirement as the position of camera installed on road is same but the angel of image taken for various vehicles would be different. So, to

eliminate this issues we need to rotate the detected image according to the requirement. Secondly, we need to eliminate the noise in the image and make it smooth so that the detection is clean. Here, Gaussian Blur preprocessing method is used to make the image smooth [8].

After that it is passed to the OCR where Character Segmentation is performed to recognize each and every character in the number [9]. Here, the image is broken into smaller parts so each character can be processed furthered. At the end Character recognition is performed where each and every character are recognized by matching it character predefined result. Finally, the number plate details are converted into the text format and can be used to fetch details of violators from database and generate Challan. Thus the final set of whole number plate is created as shown in Fig-8.

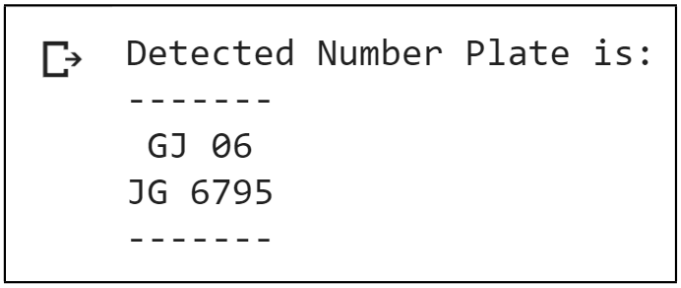

Fig -8: Output after applying OCR

5. RESULTS

The accuracy of the model depends on the number of factors. Firstly, it depends on the dataset, higher the number of dataset use for the training higher will be the accuracy, Secondly, various images of wide scenario for e.g. images of different size, images taken at various angles so the overall accuracy increases. Thirdly, it depends on the number of iteration the model is trained, higher the number more will be the accuracy. The threshold value of 0.5 was taken for Motorcycle with Helmet (Case 1) and Motorcycle without Helmet (Case 2) and for number plate the threshold value of 0.25. The details are shown in the table below:

Table -1: Details of Model, Threshold Value and Accuracy

Sr. No	Detection Model	Threshold Value	Accuracy
1.	Motorcycle with Helmet	0.5	98.7%
2.	Motorcycle without helmet	0.5	99.1%
3.	Number Plate	0.25	97.4%

6. CONCLUSION

The proposed system is developed for the sole purpose of detecting the violators not following the traffic law by catching the non-helmet motorcyclist by automatic detection using YOLOv3 algorithm and extracting the details of motorcyclist by detecting its number plate using OCR which can used by Traffic Police to fetch the details form their database and generate Challan. The whole system is designed in such a way that the detection is done automatic with minimum human interaction. This in turn can not only benefit Traffic Police department but also save a large sum of money on Human resources. This money can be used for betterment of people or installing more camera on the road for better surveillance. If the present manual detecting system is replaced by automatic detection more violators can be fined and due to the fear of fine people would definitely start to follow the traffic rules and to wear the helmet. Object detection principle using YOLO is used to detect the helmet and motorcycle due to its better performance and detecting multiple objects at a time.
Also, the YOLO model is extremely fast compared to other object detection model. All the detection are accurate with motorcycle detection at 96.3%, helmet detection at 94.1%, non-helmet at 97.2% and number plate detection at 92.7%. The accuracy of each class can be improved by taking more dataset and training for more number of iterations. Also, for optimum result the detection must take place at daylight.

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