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Motorcycle Traffic Rule Violation Detection and Licence Plate Recognition using YOLO

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Abstract: Motorcycles are one of the most popular means for transportation. As the popularity and usage of two-wheelers increase, the number of accidents also inevitably increases. Road accidents are one of the primary causes for non-natural deaths. In order to solve this problem, numerous countries have proposed vehicle laws, making helmets compulsory for both the rider and the passengers. Also, the number of people riding on motorcycles is limited to 2. In India, any person above the age of 4 must compulsorily wear a helmet. Even though wearing a helmet is essential and compulsory, not everybody follows this rule, as there are multiple instances of people not wearing a helmet while driving a two-wheeler. There are also several instances where people do triple riding or riding with more than the allowed number of passengers. To mandate this, we have created a model using OpenCV, TensorFlow and YOLO to identify rule violations. The model takes the front view image and side view image of the vehicle and using object detection techniques, it identifies riders with and without helmet. The model also checks for multiple rider rule violations. If any rule is violated, the licence plates of such riders are automatically extracted and stored

Keywords: Automatic Number Plate Recognition (ANPR), You only look once (YOLO), Helmet Detection, Person detection, Machine Learning (ML), Optical Character Recognition (OCR), Common Objects in Context (COCO)

I. INTRODUCTION

As motorcycles become more and more popular, the number of accidents also increases. Motorcycles are a great mobility solution for 1 or 2 people. It requires the least parking space. It requires less capital to buy and has less running cost. Also with two-wheelers, one can easily maneuver through the traffic. With all the advantages it has, there are serious dangers involved in riding without a helmet. The primary purpose of the helmet is to reduce the risk of serious head and brain damages and injuries in the event of traffic accidents. The causes of road accidents can be (i) human error (ii) road conditions (iii) vehicle conditions et cetera. More crashes and deaths are resulting from defective licensing laws, no training provided for the riders, poor road conditions and unsafe helmets. In 2017, more than 48,746 two-wheeler users died in road accidents and 75% of them did not wear a helmet [11]. About 30% of deaths in the year 2018 can be attributed to non use of helmets. About 12% of the deaths occured because of overloaded two-wheelers [10]. Although the mortality toll among two-wheeler riders is alarming, other injuries must also be taken into account. In 91% of the cases of two-wheeler accidents, the person not wearing a helmet was hurt [11]. That is, they either died or were grievously injured or sustained minor injuries.

The helmet is one of the essential safety equipment for motorcyclists. It is important for motorcyclists to understand the risks of riding without a helmet. Motorcyclists must be aware of the dangers of not wearing a helmet when riding. Despite the fact that wearing a helmet while riding a motorcycle has been made compulsory in many countries, many riders fail to do so or do it incorrectly.

Machine learning is a field of computer science where computers are enabled to learn automatically from the past data. In machine learning algorithms, a mathematical model is built based on sample data or also termed as training data. Based on this, it makes predictions and decisions without explicitly being programmed to do so. It has various applications including image recognition, speech recognition, recommender systems, object detection to include some. YOLO makes predictions based on single network evaluations as compared to systems like R-CNN which uses thousands of layers for a single image. This makes it faster than traditional neural networks.

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By using a specific dataset, object detection models can be built to detect helmets, motorcycles et cetera. Using this model, non-helmet wearing riders can be identified. From the front view image, the number plate can be recognized, cropped and stored. This image can be passed to an Optical Character Recognition (OCR) model, which identifies the text and gives the number plate as output. This model can also be deployed as raspberry pi and integrated with CCTV surveillance cameras.

II. RELATED WORK

The authors of [1] present a system for detecting helmet, single or multiple riders on a motorcycle. System has two stages, one for motorcycle detection and other for helmet detection. Motorcycle detection is achieved using the YOLO v3 model and helmet detection using a custom CNN model.
Similarly the authors of [2] have made use of image processing and deep CNNs for finding riders who are not wearing helmets. This system has three modules: motorcycle detection, helmet detection and licence plate recognition. In [7] they have made use of CNN and other pre-trained models to detect helmets. It gives a method to classify motorcyclists wearing a helmet and not. They have made use of GoogleNet and MobileNet pretrained models to classify images.

In [4] they have made use of YOLO - Darknet framework, which extracts object classes based on features extracted. It is trained using the COCO dataset. It has three classes: helmet, motorcycle and licence plate. Similarly [8] uses the video feed from a traffic camera to capture frames with a motorcycle. This frame is passed through a machine model to classify if the rider is wearing a helmet or not. They have used YOLO v3 for object detection and trained using COCO dataset. Authors of [9] have made use of YOLO v3 to detect motorcycles, if detected then that particular frame is passed to the next model. Next model detects if the rider is wearing a helmet. If a rider is violating the helmet rule then his licence plate is stored in the database. Some papers have made use of pattern recognition and feature extraction using a deep learning model. It uses a type of deep learning model known as Single Shot MultiBox Detector (SSD) for detecting if a rider is wearing a helmet or not. This model detects motorcycles which are then sent to detect helmets. All this is done using a single CNN model.

Authors of [5] have provided various efficient approaches that can be used for automatic licence plate recognition. The system first extracts the number plate. Then Number Plate Character Segmentation is performed and lastly using Optical Character Recognition the characters of the number plate are identified. Authors of [6] have presented an automatic detection of a motorcycle and classification based on whether the rider is wearing a helmet. They have used hybrid descriptors for feature extraction using Local Binary Pattern, Hough Transform Pattern and Histograms of Oriented Gradients.

III. IMPLEMENTATION

The system uses YOLOv3 for object detection and tesseract for optical character recognition in licence plates. System is divided into four main components: i) YOLOv3 is used to identify the motorcycle ii) All the riders in the particular motorcycle is detected using YOLOv3 iii) Another YOLO v3 model is used for detecting helmet and iv) Finally number plate is detected using another YOLOv3 model and characters in number plate is recognised using Google's tesseract OCR. System uses two images to work completely, that is front view and side view images. Side view image is used for detecting the number of riders and for helmet detection. For number plate extraction, front view images can be considered. Architecture diagram of the system is shown in figure 1 Flow chart of the proposed system is shown in figure 2.

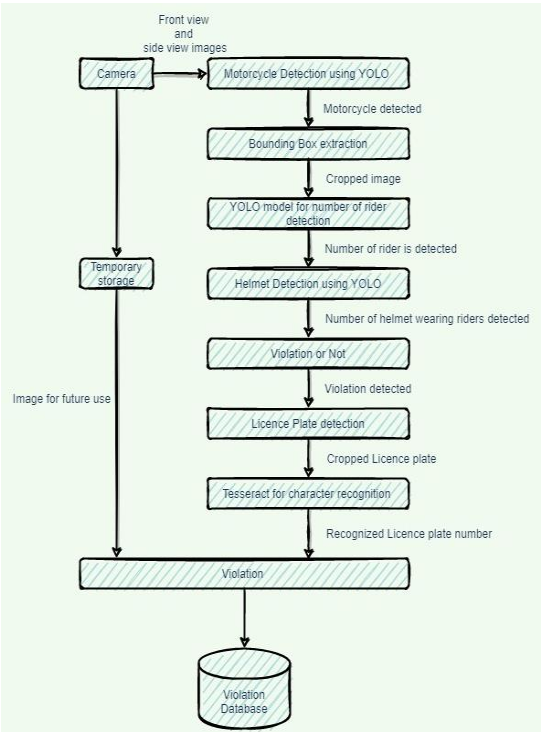

Figure 1. Architecture Diagram

3.1 Motorcycle and rider detection using YOLOv3

In this system a pretrained Yolo v3 model is used for detecting motorcycles with riders.. To get better results the model is trained again using a dataset containing 835 images. Bounding boxes are drawn to localize the area of interest which here is the motorcycle with the riders.

3.2 Number of riders detection using YOLOv3

Basic YOLO v3 weights are pre trained using coco datasets for 80 classes of objects like umbrella, bus, boat et cetera. Among these 80 classes, person is also one of the pre-trained classes. So we have

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made use of this class to find the number of persons riding in the motorcycle. The bounding box of the motorcycle detected in the previous model is cropped and that image is passed as input to this present model to detect the number of riders. This model returns the number of riders detected.

3.3 Helmet detection using YOLOv3

Helmet detection is again implemented using YOLO v3. Similar to the first model here, pretrained model weights are trained again to get better results. Here open dataset v6 is used. It has 5000 images of motorcyclists and out of which 1000 are wearing helmets. Here 900 images are used for training, and 100 for testing. A bounding box is drawn across the helmet detected. This model gives the number of helmets detected.

3.4 Licence plate detection using YOLOv3

To get the licence plate number, firsty the licence plate must be detected. Here it is done using another pre-trained YOLOv3 model. This model has 8 classes for different licence plates like truck, car et cetera. Out of eight classes motorcycle licence plates are also one. Since most of the image contains multiple motorcycles to get one particular motorcycle, the first model is used and the motorcycle is cropped according to the bounding box. This is passed through the licence plate model. Once the licence plate is detected it is cropped again and passed through a series of pre-processing steps. Preprocessed image is passed through pytesseract to get the licence plate number. The detected licence plate number is stored in a violation database.

IV. RESULTS

The model was tested on 75 images from the test dataset. The accuracy of each individual object detection class was identified based on the classification results for each image. Then the overall model accuracy was calculated

Let r = number of riders on the motorcycle
h = number of helmets detected.

Table 1. Results of different classes

Model	Accurate classification	Inaccurate classification	Accuracy
Helmet Detection	63	12	84.0%
Person Detection	65	10	86.6%
Person_bike Detection	57	18	76.0%
Number_plate detection and character recognition	29	8	78.37%
Overall	62	13	82.66%

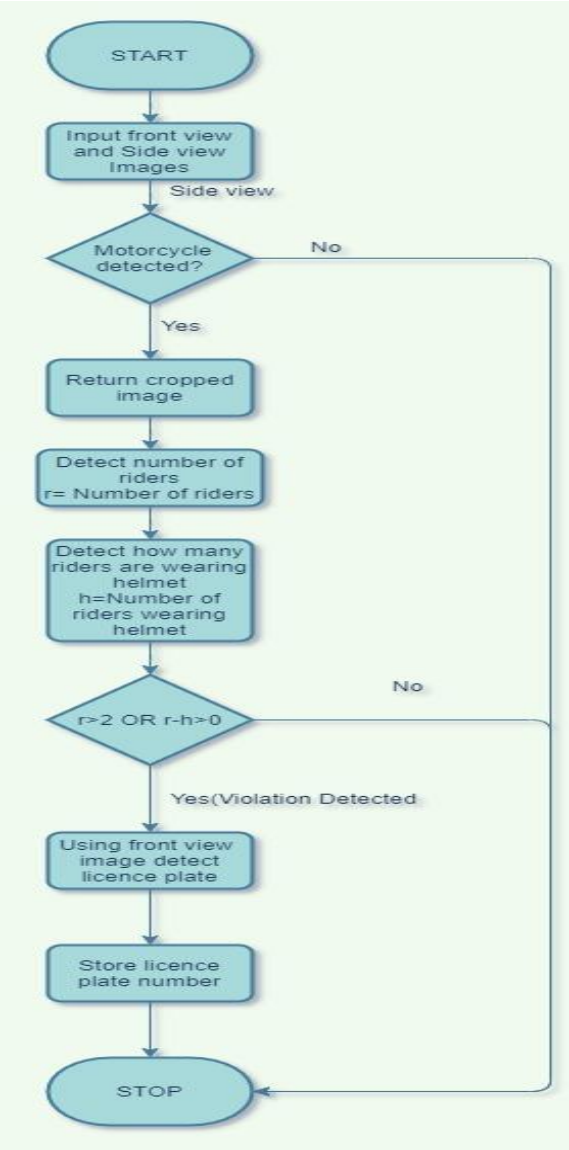

Figure 2. Flow chart

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Table 2. Overall result

Classification	Correct recognition	Incorrect recognition
No of images	62	13
Accuracy		82.66%

The system was tested on various images containing helmet, without helmet, with multiple riders et cetera. A bounding box was drawn after each stage of identification and the results obtained are as follows

4.1 Rider not wearing helmet

From figure 3, we can observe that the rider is not wearing a helmet which is against the norms. So, the motorcycle is first identified. Then the person is identified using the person class. Since the rider is not wearing a helmet, there is no helmet detected. Since there is a rule violation, the number plate is extracted and stored.

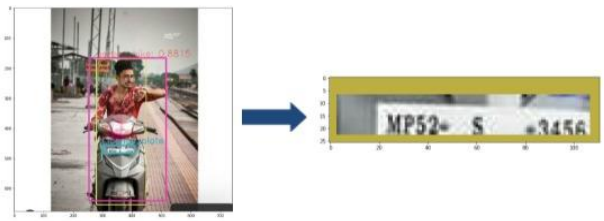

Figure 3. Rider not wearing helmet. Licence plate is detected accordingly.

4.2 Either of them not wearing helmet

The model is trained for multiple riders. In figure 4, the passenger is not wearing a helmet. If either of them are not wearing a helmet, there is a rule violation. In such cases, the model is able to detect the number of persons riding on the motorcycle and the number of helmets. If the result of (r-h)>0, then there is a helmet rule violation. Hence, the system tries to identify the licence plate. The licence plate if available is extracted and stored respectively.

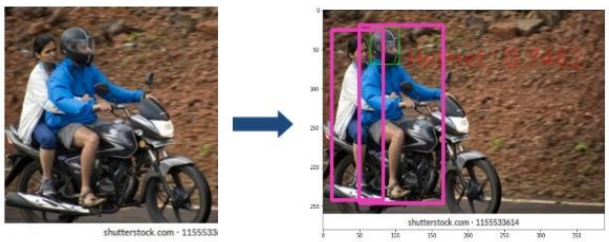

Figure 4. Passenger not wearing helmet.

4.3 Both rider and passenger not wearing helmet

Here, both the rider and the passenger are not wearing a helmet. A rule violation is detected. And the system tries to detect and store the licence plate.From figure 4, one can see that the licence plate is correctly recognised.

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Figure 5. Both rider and passenger are not wearing helmets. Licence plate is recognised accordingly.

4.4 Triple Riding

From figure 6, the system identifies the number of people riding on the vehicle, we check if it's more than two riders as it is the permissible limit set by the Indian government. If the number of people riding on the motorcycle (excluding children) surpasses two i.e. (r>2), a triple riding rule violation is detected. This can be done by using the side view image of the vehicle. With the front view image, the system can then identify and extract the number plate.

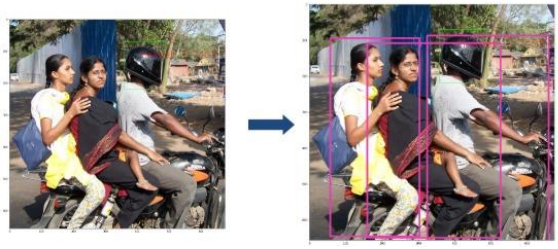

Figure 6. Triple riding.

V. CONCLUSION

In this paper, a system is proposed that can detect motorcycle related rule violations where people who are not wearing helmets are identified and triple or more riding are also identified. From the above results, it is evident that the YOLO v3 model performs well in terms of real time object detection and was able to differentiate and classify all the object classes. The following end-to-end model developed, can be deployed on CCTV surveillance cameras for automated monitoring. The rule violators are identified and their number plates are detected and stored. For number plate extraction, front view images can be considered. The model is able to recognise helmet rule violations, triple riding rule violations. The purpose of creating this model was non-efficient traffic management and no proper actions being taken against rule violators. By deploying this model, the identification of rule violations can be automated and hence reach a step further towards efficient traffic management.

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