Detection of Non-Helmet Riders and Extraction of License Plate Number using Yolo v2 and OCR Method

Prajwal M. J., Tejas K. B., Varshad V., Mahesh Madivalappa Murgod, Shashidhar R.

Abstract: *In current situation, we come across various problems in traffic regulations in India which can be solved with different ideas. Riding motorcycle/mopeds without wearing helmet is a traffic violation which has resulted in increase in number of accidents and deaths in India. Existing system monitors the traffic violations primarily through CCTV recordings, where the traffic police have to look into the frame where the traffic violation is happening, zoom into the license plate in case rider is not wearing helmet. But this requires lot of manpower and time as the traffic violations frequently and the number of people using motorcycles is increasing day-by-day. What if there is a system, which would automatically look for traffic violation of not wearing helmet while riding motorcycle/moped and if so, would automatically extract the vehicles' license plate number. Recent research have successfully done this work based on CNN, R-CNN, LBP, HoG, HaaR features,etc. But these works are limited with respect to efficiency, accuracy or the speed with which object detection and classification is done. In this research work, a Non-Helmet Rider detection system is built which attempts to satisfy the automation of detecting the traffic violation of not wearing helmet and extracting the vehicles' license plate number. The main principle involved is Object Detection using Deep Learning at three levels. The objects detected are person, motorcycle/moped at first level using YOLOv2, helmet at second level using YOLOv3, License plate at the last level using YOLOv2. Then the license plate registration number is extracted using OCR (Optical Character Recognition). All these techniques are subjected to predefined conditions and constraints, especially the license plate number extraction part. Since, this work takes video as its input, the speed of execution is crucial. We have used above said methodologies to build a holistic system for both helmet detection and license plate number extraction.*

Keywords: OCR, SVM, HOG, LBP, CNN.

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I. INTRODUCTION

All over the world around 1.35 million lives are lost each year, 50 million people are getting injured due to road accidents, according to a report titled "The Global status report on road safety 2018" released by world health organization. It is very hard to imagine that this burden is unevenly borne by motorcyclists, cyclists and pedestrians. This report noted that a comprehensive action plan has to be set up in order to save lives. Worrying fact is that India ranks number one as far as road crash deaths are considered. Rapid urbanization, avoiding helmets, seat belts and other safety measures while driving are some of the reasons behind this trend according to analysis done by experts. In 2015 India signed Brasilia Declaration on Road Safety, where India committed to reduce road crash deaths to 50 percent by 2020. Policy makers first have to acknowledge the problems that persist in India before halving road crash deaths. When a two-wheeler meets with an accident, due of sudden deceleration, the rider is thrown away from the vehicle. If head strikes any object, motion of the head becomes zero, but with its own mass brain continues to be in motion until the object hits inner part of the skull. Sometimes this type of head injury may be fatal in nature. In such times helmet acts as life savior. Helmet reduces the chances of skull getting decelerated, hence sets the motion of the head to almost zero. Cushion inside the helmet absorbs the impact of collision and as time passes head comes to a halt. It also spreads the impact to a larger area, thus safeguarding the head from severe injuries. More importantly it acts as a mechanical barrier between head and object to which the rider came into contact. Injuries can be minimized if a good quality full helmet is used. Traffic rules are there to bring a sense of discipline, so that the risk of deaths and injuries can be minimized significantly. However strict adherence to these laws is absent in reality. Hence efficient and feasible techniques have to be created to overcome these problems. Manual surveillance of traffic using CCTV is an existing methodology. But here so many iterations have to be performed to attain the objective and it demands a lot of human resource. Therefore, cites with millions of population having so many vehicles running on the roads cannot afford this inadequate manual method of helmet detection. So here we propose a methodology for full helmet detection and license plate extraction using YOLOv2, YOLOv3 and OCR.

Basically helmet detection system involves following steps such as collection of dataset, moving object detection, background subtraction, object classification using neural networks and extraction of licence plate number if the rider is not wearing helmet. Rattapoom Waranusast et al. [2] used KNN classifier for moving object extraction and classification.

Here the head is classified as wearing helmet or not based on various features obtained from the segmented head region. Moving objects can be detected using adaptive background subtraction [13]. ViBe background modelling algorithm can also be applied to detect motion objects [15] [19]. Canny edge detection algorithm is used to get segmented moving objects [21]. Romuere Silva et al. [3], [17] proposed a methodology for feature extraction using LBP based hybrid descriptor, HOG and Hough transform descriptors. Whereas Xinhua Jiang et al. [8] incorporated grey level co-occurrence matrix along with LBP for feature extraction. YOLOv2 and COCO dataset can be employed to detect different types of objects and classify them accordingly [16] [20]. The intended objects are motorcycle, motorcyclists, pedestrians and workers. Helmet and tyre colour exhibits different characteristics, this can be exploited to detect motorbikes [6]. Kunal Dahiya et al. [9] used background subtraction and object segmentation in order to detect the bike rider. Others used CNN to select motorcyclists only [13][24]. Wearing helmet in construction sites is an important safety measure. For that HOG can be used [7]. In case of accidents fall detection is a pre-emptive procedure, background subtraction and OCR can be incorporated for the same [10]. Shoeb Ahmed Shabbeer et al. [12] proposed a method to identify two wheeler accidents using a microcontroller and accelerometer. Most of the time pedestrians are the real victims for road accidents, their safety is essential. Jie Li et al. [15] proposed a method to classify pedestrians using SVM based on histogram of oriented gradient features (HOG). The last step involves helmet detection. Colour based and circle Hough transform is used to detect helmet [7], [5], [10] and HOG descriptors can also be used for helmet detection [22]. Colour feature recognition is another option [15]. Kang Li et al. [19] deployed colour space transformation and colour feature discrimination for detecting the helmet. GLCM statistical features and Back-Propagation artificial neural network is used to detect helmet more effectively [8]. Romuere Silva et al. [4], used multi-layer perception classifier for detecting motorcyclists without helmet. Pathasu Doungmala et al. [11] utilised Haar like features for detection between full helmet and without helmet and circular hough transform for detection between half helmet and without helmet. For accuracy improvement of helmet detection PCA technique is used [14]. For detecting license plate and extracting the characters several methods have been used such as OCR, MobileNets and Inception-v3, Open ALPR[20], [18], [16].

II. METHODOLOGY

In this section we explain different processing steps.

At initial phase, frames are collected at regular intervals from video file as shown in Fig. 1(a) and Fig. 1(b). The collected frames are stored in a folder. They are named such that they include the frame number in their name, for example frame_7_50, frame_7_100 etc... Where indicates that it is 7th video file input and 50, 100 etc.… indicates the frame number. From the figures, it is clear that many frames are redundant. So, based on movement of vehicle movement with respect to camera, last frame or last second frame is chosen for further processing.

The entire work can be divided into following 5 phases for two cases:

Case 1: When the motorcycle/moped rider is wearing helmet

Case 2: When the motorcycle/moped rider is not wearing helmet Frame Collection

Frame Collection

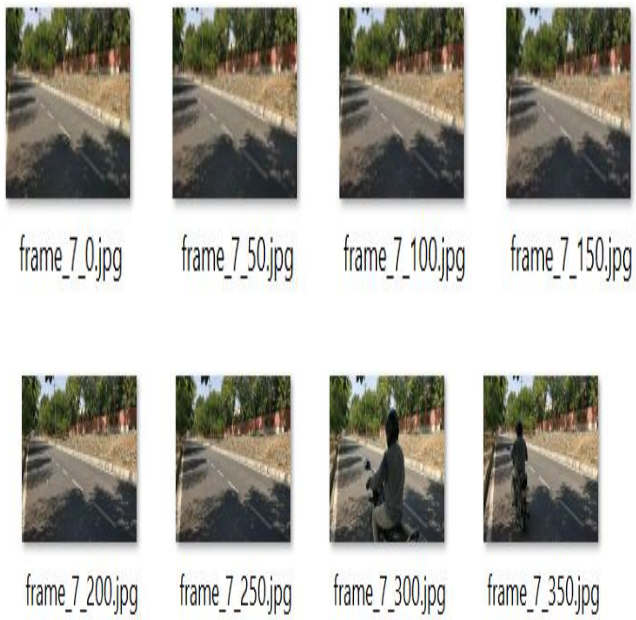

Fig. 1 (a): Frames collected at regular intervals (Case 1)

Fig. 1 (b): Frames collected at regular intervals (Case 2)

III. MOTORBIKE AND PERSON DETECTION

The frame chosen is given as input to YOLOv2 object detection model, where the classes to be detected are ‘Motorbike’, ‘Person’. At the output, image with required class detection along with confidence of detection through bounding box and probability value is obtained as shown in the Fig. 2 (a) and Fig. 2 (b).

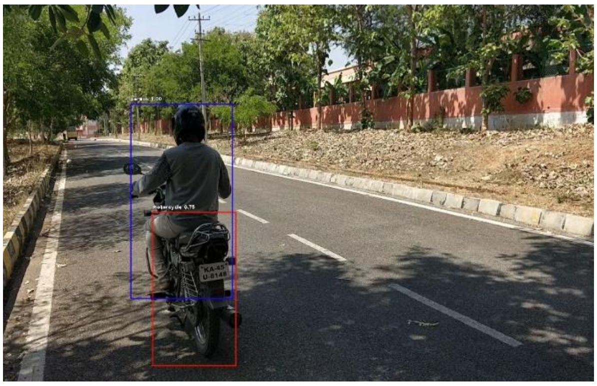

Fig. 2 (a): Frame with ‘person’ and ‘motorcycle’ classes detected (Case 1)

Fig. 2 (b): Frame with ‘person’ and ‘motorcycle’ classes detected (Case 2)

Fig. 3 (a): Extracted motorcycle and person images (Case 1)

Fig. 3 (b): Extracted motorcycle and person images (Case 2)

With the help of functions given by Image AI library, only the detected objects are extracted as shown in Fig. 3 (a) and Fig. 3 (b) and stored as separate images and named with class name and image number in order. For example, it will be saved as motorcycle-1, motorcycle-2, etc.… if extracted object is motorcycle or person-1, person-2, etc.… if extracted image is of person. The details of these extracted images which is stored in a dictionary which can be later used for further processing.

IV. HELMET DETECTION

Fig. 4: Cropped images (Case 1 and Case 2)

Once the person-motorcycle pair is obtained, the person images is given as input to helmet detection model. While testing the helmet detection model, some false detections were observed. So, the person image was cropped to get only top one-fourth portion of image, as shown in Fig. 4. This ensures that false detection cases are eliminated as well as avoid cases leading to wrong results when the rider is holding helmet in hand while riding or keeping it on motorcycle while riding instead of wearing.

Fig. 5: Helmet detection

After applying cropped image to helmet detection model, output is as shown in Fig. 5. The bounding box around helmet along with the detection probability is displayed as shown in Fig. 5. As the rider wearing helmet in Case 1, no further processing is necessary. Since in Case 2, rider is not wearing helmet, no bounding box is created.

V. LICENCE PLATE DETECTION

If the helmet is found, there is no need for this step. However, if the helmet is not found, then the motorcycle image is given as input to license plate detection model. For training purpose, 832 images were collected as dataset which were images of bike, mopeds with their license plate. Then using labeling tool, the license plate in those images were annotated, i.e., a bounding box is created around license plate in those images so that the model could learn. The information regarding the bounding box is stored in .xml file with the name being same as image name. Then the annotated images are used to build the trained model for detecting license plates.

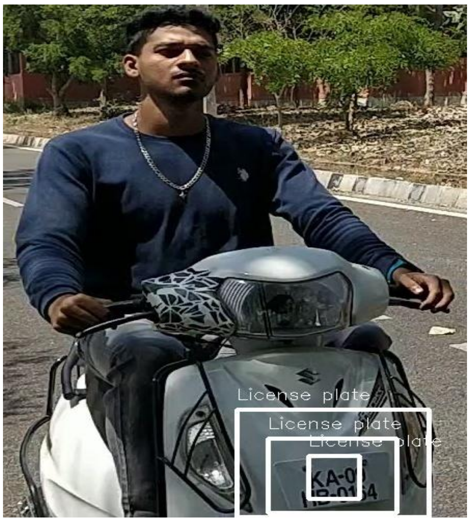

Fig. 6: License plate detection

Using the trained model, the bounding box is created across license plate in given input image. The corresponding information includes top-left, bottom right co-ordinates of bounding box, class name, confidence of detection in a .json file. Then to extract the license plate image only, the bounding-box co-ordinates stored in .json file are used and extracted images are stored. Sometimes, as shown in Fig. 6, for a single motorcycle image, more than one bounding box were detected. In that case, a threshold of 0.5 is set for confidence of detection. While reading details of bounding box in the .json file, the one with confidence greater than the threshold is chosen.

Fig. 7: License plate extraction and rotation

Fig. 8: License plate image after increasing brightness and rescaling

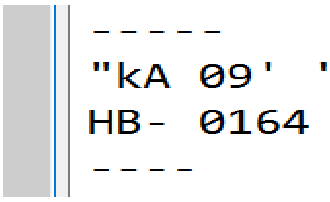

Fig. 9: Output after applying OCR

Before applying OCR directly to extracted license plate image, pre-processing as to be done to get output of better accuracy. Hence the image was rotated. Fig. 7 shows how the license plate image will be once it is extracted and rotated. Since the camera will be fixed position with respect to motorcycle, the angle to which the extracted license plate image has to be rotated, has to be found once by trial and error method and that value remains same for all the other cases. In this case, it was found to be 6 degrees.

The rotated image was rescaled so that OCR can detect the strings with good accuracy. The rescaled image size was determined by choosing a scaling ratio, i.e. ratio of size of rescaled image to the size of original image, width wise and height wise. Let w, h be the width and height of original image, w`, h` be the width and height of rescaled image. r be the ratio.

Then the rescaled image size is obtained by:

$$w` = w * r \ldots\ldots\ldots\ldots \quad (1)$$

$$h` = h * r \ldots\ldots\ldots\ldots \quad (2)$$

where r, the ratio is a variable and depends on the frame chosen during frame extraction. For this case, it was found to be lying between 1.4 to 1.47.Then the brightness of the image is increased, to ensure that black plate numbers against white background is clearer. The h,s,v (Hue, Saturation, Value) values of the image was obtained. As it is known, v(Value) describes the brightness or intensity of the color. A limit was chosen, such that if the 'v' value is greater than that limit for a particular pixel, then 255 is assigned as 'v' for that case. If the 'v' value is lesser than the limit, then a constant value was added to the 'v' value of that pixel. In this case, the constant value chosen was 30, and the limit is 225 (255-30).

value = 30
limit = 255 – value
if v ≥ limit :
v = 255
else:
v = v + value

Fig. 1. Example of a figure caption. (*figure caption*)

VI. RESULT AND DISCUSSION

Table 1. Details of Threshold value with model

Sl. No	Detection model	Number Plate Detection	Threshold value
1	YOLO v2(Without Helmet)	Yes	0.5
2	YOLO v2(With Helmet)	No	0..87

Results obtained are discussed here for two cases. They are, Case 1: When the motorcycle/moped rider is wearing helmet as shown in fig.5.

Case 2: When the motorcycle/moped rider is not wearing helmet and License plate is detected as shown in fig 6.

VII. CONCULUTION

A Non-Helmet Rider Detection system is developed where a video file is taken as input. If the motorcycle rider in the video footage is not wearing helmet while riding the motorcycle, then the license plate number of that motorcycle is extracted and displayed. Object detection principle with YOLO architecture is used for motorcycle, person, helmet and license plate detection. OCR is used for license plate number extraction if rider is not wearing helmet. Not only the characters are extracted, but also the frame from which it is also extracted so that it can be used for other purposes. All the objectives of the project is achieved satisfactorily.

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