Helmet Detection using Machine Learning and Automatic License Plate Recognition

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Abstract - *Motorcycle accidents have been rapidly growing through the years in many countries. In India more than 37 million people use two wheelers. Therefore, it is necessary to develop a system for automatic detection of helmet wearing for road safety. Therefore, a custom object detection model is created using a Machine learning based algorithm which can detect Motorcycle riders. On the detection of a Helmetless rider, the License Plate is extracted and the Licence Plate number is recognized using an Optical Character Recognizer. This Application can be implemented in real-time using a Webcam or a CCTV as input.*

Key Words: **Automatic License Plate Recognition (ALPR), Deep Neural Network (DNN), Helmet Detection, Machine Learning, Mean Average Precision (mAP), Optical Character Recognition (OCR), You Only Look Once (YOLO).**

1. INTRODUCTION

The main safety equipment of motorcyclist is the helmet. The helmet protects the motorcyclist against accidents. Although the helmet use is mandatory in many countries, there are motorcyclists that do not use it or use it incorrectly. Over the past years many works have been carried out in traffic analysis, including vehicle detection and classification, and helmet detection. Intelligent traffic systems were implemented using computer vision algorithms, such as: background and foreground image detection to segment the moving objects in scene and image descriptors to extract features. Computational intelligence algorithms are used too, like machine learning algorithms to classify the objects.

Machine learning (ML) is the field of Artificial Intelligence in which a trained model works on its own using the inputs given during training period. Machine learning algorithms build a mathematical model of sample data, known as "training data", in order to make predictions or decisions and are also used in the applications of object detection. Therefore, by training with a specific dataset, a Helmet detection model can be implemented. Using this helmet detection model helmet-less riders can be easily detected. Based one the detected classes the license plate of the rider is cropped out and saved as an image. This image is given to an Optical Character Recognition (OCR) model which recognizes the text and gives the License Plate number as output in the form of Machine encoded text. And it can also be implemented in real time using a Webcam.

The objective of this paper is to develop a system to enforce helmet wearing with the help of CCTV cameras. The developed system aims in changing unsafe behaviors and consequently reducing the number of accidents and its severity.

2. RELATED WORK

Over the past years, multiple approaches have been proposed to solve the problem of helmet detection. The authors in [7] use a background subtraction method to detect and differentiate between moving vehicles. And they used Support Vector Machines (SVM) to classify helmets and human heads without helmets. *Silva et al.* in [9] proposed a hybrid descriptor model based on geometric shape and texture features to detect motorcyclists without helmet automatically. They used Hough transform with SVM to detect the head of the motorcyclist. Additionally, they extend their work in [10] by multi-layer perception model for classification of various objects.

Wen et al. [10b] uses a circle arc detection method based upon the Hough transform. They applied it to detect helmet on the surveillance system. The drawback of this work is that they only use geometric features to verify if any safety helmet exists in the set. Geometric features are not enough to find helmets. In [11b] it proposes a computer vision system aiming to detect and segment motorcycles partly. A helmet detection system is used, and the helmet presence verifies that there is a motorcycle. In order to detect the helmet presence, the edges are computed on the possible helmet region. The Canny edge detector [12b] is used.

Waranusat et al. [11] proposed a system to detect moving objects using a k-NN classifier over the motorcyclist's head to classify helmet. These models were proposed based on statistical information of images and had a limitation to the level of accuracy that could be achieved.

With the evolution of neural networks and deep learning models there was further improvement in the accuracy of classification. *Alex et al.* [13] introduced a convolutional neural network (CNN) based method for object classification and detection. *A. Hirota et al.* [12] use a CNN for classification of helmeted and non-helmeted riders. Although they use CNN, their helmet detection accuracy is poor with limitations to helmet color and multiple riders on a single motorcyclist.

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3. PROPOSED METHODOLOGY

The training is done by feeding all the captured images with their annotations. The model extracts the features of each
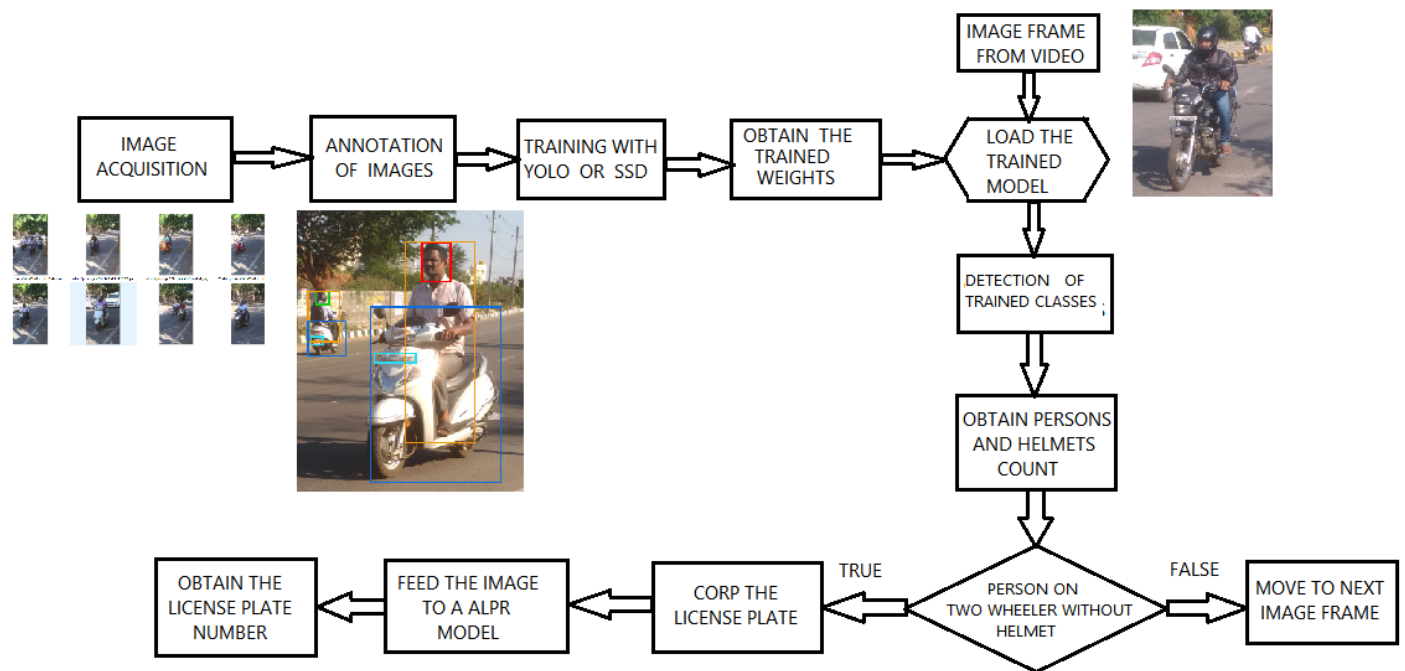
For real-time helmet detection, there is a need for accuracy and speed. Hence a DNN based model You Only Look Once (YOLO) was chosen. YOLO is a state-of-the-art, real-time object detection system.

YOLOv3 is extremely fast and accurate and is a huge improvement over the previous YOLO versions. It also makes predictions with a single network evaluation unlike systems like R-CNN which require thousands for a single image. This makes it extremely fast, more than 1000x faster than R-CNN and 100x faster than Fast R-CNN [4].

Object detection is the craft of detecting instances of a certain class, like animals, humans and many more in an image or video. The Pre-Existing Object Detection API makes it easy to detect objects by using pretrained object detection models. But these models detect several Objects which are of no use to us, therefore in order to detect the necessary classes a custom object detector becomes necessary.

In order to implement helmet detection and number plate recognition and extraction, 5 objects need to be detected. The objects are – Helmet, No Helmet, Motorbike, Person (sitting on the bike) and License Plate.

There is a need to create a custom object detection model that is capable of detecting these objects. A collection of images containing the objects of the classes to be detected are used as a Dataset. This dataset is then used to train the custom model. Once the model has been trained, it can be used to detect these custom objects.

class from every image with the help of ground truth of the required classes. For extracting the features and storing them to recognize those features from other images, we use a deep learning, classifier based on the convolutional neural networks. When an image is given to this trained model the detection of the pretrained class is necessary. A few images are taken as an example to show the detection capability of the custom trained model.

3.1 Helmet Detection

The annotated images are given as input to YOLOv3 model to train for the custom classes. The weights generated after training are used to load the model. Once this is done, an image is given as input. The model detects all the five classes trained. From this we obtain the information regarding person riding motorbike. If the person is not wearing a helmet, then we can easily extract the other class information of the rider. This can be used to extract the license plate.

3.2 License Plate Extraction

Once the helmetless rider is detected, the associated person class is detected. This is done by finding whether the co-ordinates of the no helmet class lie inside the person class or not. Similarly, the same steps are followed to detect the associated motorbike and license plate. Once the coordinates of the License plate are found, it is cropped and saved as a new image.
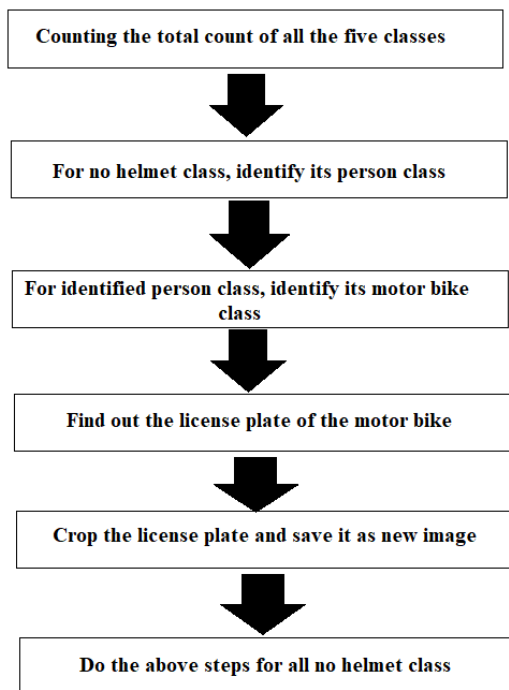
accurately. Then, the license plate recognized with highest confidence value is stored in a text file for further use.
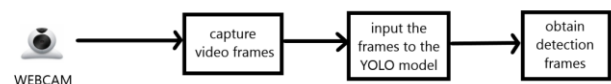

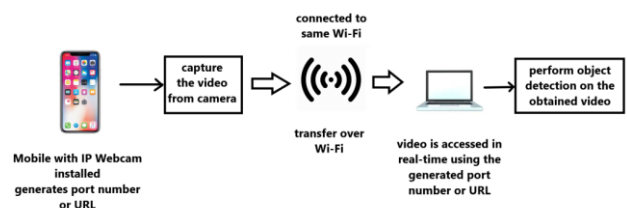## 4. REAL TIME IMPLEMENTATION

4.1 Using Webcam

The webcam can be used as the input device to receive the image frames for object detection in real-time. Since we are using YOLOv3-tiny model, it supports up to 220 fps processing speed.
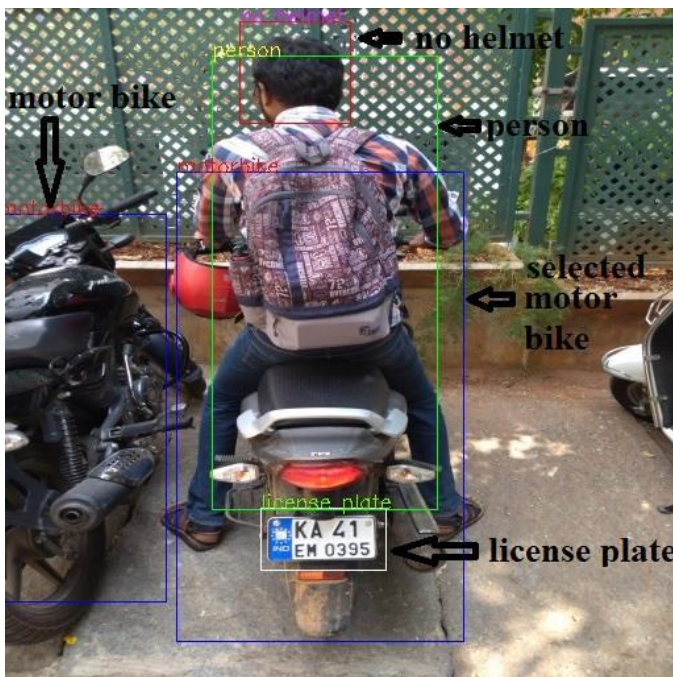

4.2 Using IP Webcam for Mobile

Mobile camera can be used as the input rather than using the webcam. This can open up a lot of possibilities as mobile can be carried and can cover different angles. Doing all this in real-time is an added advantage. So, from this not only CCTV footages but a handheld device can be used for obtaining the footage. Also, the footage from mobile being up-close can provide a clearer and more readable number plate for the OCR to give out an accurate number.

3.3 License Plate Recognition

The extracted license plate is given to an Optical Character Recognition (OCR) model. The OCR recognizes text in the given image and outputs the recognized strings in the machine-encoded text. The OCR module within will output a list of predicted license plate numbers along with a confidence value. The confidence value indicates how confident it is in recognizing the given license plate
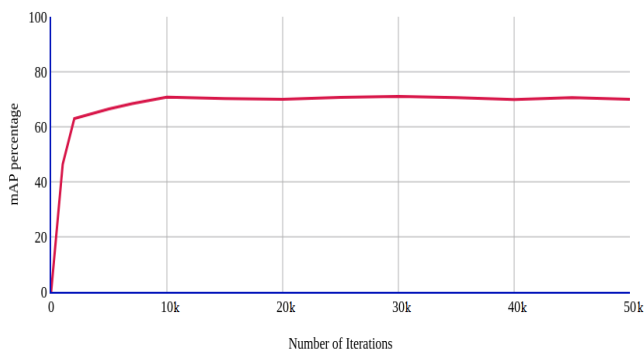
5. RESULTS

The model was trained on tiny YOLOv3 for 11,000 images on 5 classes for 50,000 iterations. The detections of all the objects classes was obtained with high precision value and the mean average precision (mAP) reached a constant max value of 75% hence the training was stopped at 50,000 iterations.

A few examples of the input image and the output object detector are shown in the figure below
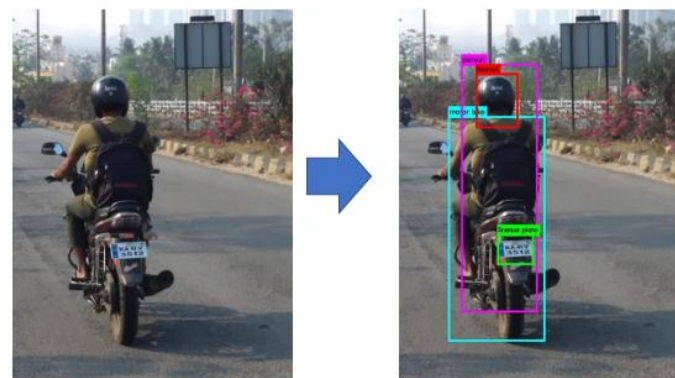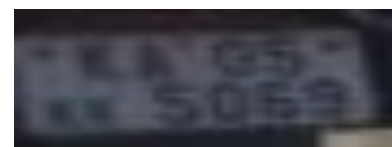
The code extracts the License plate from the Object detector output. The License plate extraction code extracts only from the motor bikes which has a rider who is not wearing helmet and discards the License plate of the motor bikes whose rider has helmet.

The OCR model is able to detect and recognize the License plates present in an image with an accuracy up to 85 percent. An example of the recognized license plate are shown in the following figure.

6. CONCLUSION

From the results shown above it is evident that the YOLO object detection is well suited for real-time processing and was able to accurately classify and localize all the object classes. The proposed end-to-end model was developed successfully and has all the capabilities to be automated and deployed for monitoring. For extracting the number plates some techniques are employed by considering different cases such as multiple riders without helmets and designed to handle most of the cases. All the libraries and software used in our project are open source and hence is very flexible and cost efficient. The project was mainly built to solve the problem of non-efficient traffic management. Hence at the end of it we can say that if deployed by any traffic management departments, it would make their job easier and more efficient.

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