Helmet and License Plate Detection using Machine Learning

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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. It is necessary to develop a system for automatic detectionof helmet wearing for road safety. This project aims to solve this problem by automating the processof detecting the riders who are riding without helmets. The system takes a video of traffic on an openstreet as an information and recognizes the moving items inside the scene. Therefore, a custom object detection model is created using a Machine learning based algorithm which can detect Motorcycle riders wearing Helmet or not . We propose a framework for the detection of traffic rule violators who ride bikes without using a helmet.**

Keywords--YOLO v4, Object Detection, Convolutional Neural Network, Helmet Detection.

I. INTRODUCTION

Two-wheeler vehicles are the most popular type of vehicles in India because of their availability and convenience. They are owned by a major part of the population in the country according to the statisticsprovided by the Department of Statistics and Implementation Systems (MSPI), the Government of India. According to a report released by the Department of Transport and Highways, more than 37% of people die in road accidents (56,136) or six every hour on an average - including two wheelers. It ishighly recommended for two-wheeler riders to use a safety helmet to reduce the risk of injury. It is a criminal offense to ride a two-wheeler without a helmet. So, the automation of this process in real timeis a need of the hour and will help to accurately monitor passengers who break the rules, and greatly reduce the number of human interventions. In the existing system, the police officer has to manually capture the image of the number plate of the bike rider who is not wearing the helmet. A very big disadvantage of this method is that often such rule-violators speed up and run off andare not penalized for their actions. This method of monitoring motorcyclists is inefficient due to insufficient police force and limitations of human senses. Also, all major cities use CCTV surveillance based methods. But, those require human assistance and are not automated.

To overcome the disadvantages of the existing system, we have proposed an automated system which is more accurate and requires minimum human efforts. Here we are utilizing a profound learning method called YOLOv4. The system will divide the traffic video into various images(frames) and from those images the system is able to detect bike riders from an image consisting of both two wheelers and other vehicles using YOLOv4. Once the bike riders are detected,the system is able to detect if the motorcyclist is wearing a helmet or not. When compared with different forms of YOLO, YOLOv4 utilizes a variation of Darknet and posses high accuracy so it would be progressively ideal for our project.

In machine learning (ML), 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 on the detected classes.

II. RELATED WORK

In the early stages, researchers used machine learning approaches such as HOG, SURF, SIFT for computer vision to automatic detection of helmet wear or not for motorcyclists .RRV e Silva et al. [1] applied the HOG (Histogram of Oriented Gradients) descriptor for extracting the image attributes and then they used a multiplayer perception classifier for helmet detection. They collect data from traffic images having 255 images of which 151 images with a helmet and 104 without a helmet. And they get 91.37% accuracy rate of helmet detection.

K Dahiya et al. [2] proposed an approach for detecting motorcyclists from surveillance videos. They have used object segmentation and background subtraction than by using SVM they detect helmet to wear or not. They collect their dataset. Their accuracy 93.80% on real-world surveillance data.A few years ago, the field of computer vision is moving from machine learning to deep learning neural network techniques [3] [4]. There are as yet many challenging issues to illuminate in computer vision. In any case, deep learning techniques such as YOLO V1, YOLO V2, YOLO V3, VGG16, VGG19, CNN, Fast R-CNN, Faster R-CNN etc. are accomplishing state-of-the-art results on some particular issues. It isn't only the exhibition of deep learning models on benchmark issues that is most fascinating; the reality is that deep learning model can perform vision takes after learning from images, forestalling the requirement for a pipeline of particular and hand-created techniques. In computer vision, many problems, such as classification of images, detection of objects, object segmentation, image colourization etc. can be solved by using deep learning techniques. This research work is a part of the object detection problem in computer vision. In object detection, we detect motorcyclists with a helmet or not with a helmet.C.

Vishnu et al. [5] proposed a method to detect motorcyclists without a helmet in traffic videos using CNN (Convolutional Neural Network). First author used the adaptive background subtraction method on videos for getting objects. Second, they apply CNN for the detection of motorcycle and finally, they again apply CNN on the upper one-fourth part for helmet detection. They used IITH Helmet 1 and IITH Helmet 2 dataset. They achieved 92.87% accuracy on their experiments.

Narong Boonsirisumpun et al. [6] proposed a method for the detection of helmet for motorcyclists using deep learning algorithms. They used VGG16, VGG19, GoogleNet and MobileNet Models for experimental purpose and compare their results. Dataset used by Narong Boonsirisumpun at el. having a total of 493 images in which 335 images have “Bike_with_helmet” and 157 images have “Bike_with_no_helmet”. They get maximum accuracy 85.19% on MobileNet model.

B. Yogameena et al. [7] proposed a system for solving the automatic detection of wear helmet by using the deep-learning-based method (R-CNN), a system that performs foreground segmentation on video frames using Gaussion Mixture Model (GMM) and blobs are labelled, then they use Faster R-CNN for detection of motorcycle from foreground regions. Then they detect helmet for the motorcyclists using the Faster R-CNN. Finally, they detect the number plate of non-helmet motorcyclists using the CNN (Character Sequences Encoding) model and ST (Spatial Transformation). They use low resolution, blur, occlusion, bald head and person with different colour of hair. They used TCE1 (2014), TCE2 (2017), Bangalore1, Bangalore2 datasets to train and evaluate the Faster R-CNN model and get maximum mAP (%) on TCE2 dataset with 79.5 on motorcyclists without helmet and 77.5 on motorcyclists with a helmet.

From the literature survey despite the fact that video analytics exits for motorcyclists with helmet or not with helmet detection still needs a lot of enhancement in real-world scenario. Especially for the Pakistan scenario, the advancement required for motorcyclist with helmet or not with helmet detection. Especially in different variation of an object, low-resolution video, illumination, profile and frontal view, occlusion and scale variations. The key contribution in this paper is that we make own dataset from Pakistan scenarios videos, this dataset comprises the real-world challenges of helmet detection such as blur images, cap wear images, low resolution, frontal view images, profile view images, back view images, occlusion, helmet carry in hand. This dataset and experimentation using Faster R-CNN is the main contribution of the proposed work..

III. PROPOSED METHODOLOGY

This segment presents the proposed approach for continuous recognition of no. of bike-riders and bike riders without helmets utilizing YOLO.

The system architecture in the Fig 1 is the model that defines the entire framework of the system’s behaviour and structure. Here the input video from the user is split into frames then each frame is filtered one by one to remove noise. After that, each frame is passed to a trained neural network model for detecting the activity, if any objectionable action is recognized then the corresponding disclaimer is added to the video. This is repeated for the entire video frames. At last entire video is saved as an output file. The video is pre-processed and send to activity recognition, where the object detection is done .

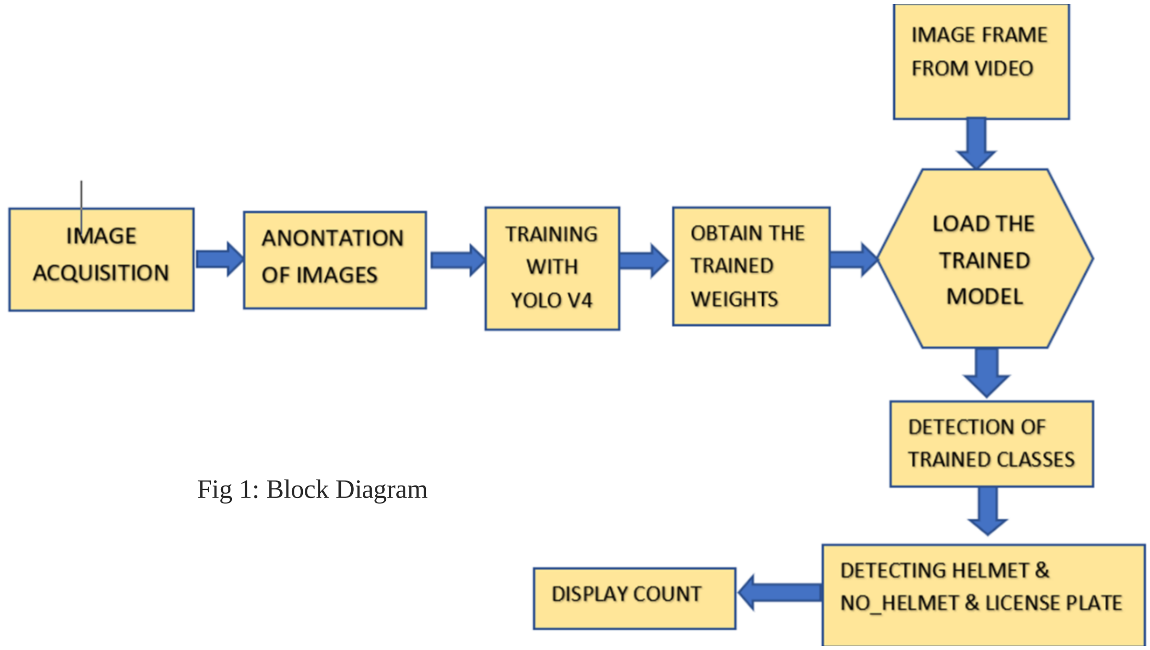


Fig 1: Block Diagram

Preparing systems are prepared with the guide of the Python TensorFlow library; at that point exactness is measured and picks two appropriate models for use in picture recognition. Further it is processed with Google Colab to train the data and weights are obtained.

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. YOLO recognizes objects more precisely and faster than other recognition systems.

It can predict up to 9000 classes and even unseen classes. The real-time recognition system will recognize multiple objects from an image and also make a boundary box around the object. YOLO sees the entire image during training and test time so it implicitly encodes contextual information about classes as well as their appearance.

YOLO trains on various full pictures and legitimately expands discovery execution. This particular model has loads of greater advantages over standard strategies for object popularity. In the first vicinity, YOLO is extremely brief. Since area is outlined as a relapse issue, the system need not hassle with a luxurious pipeline. The neural system is run on a substitution photograph at test time to foresee discoveries.

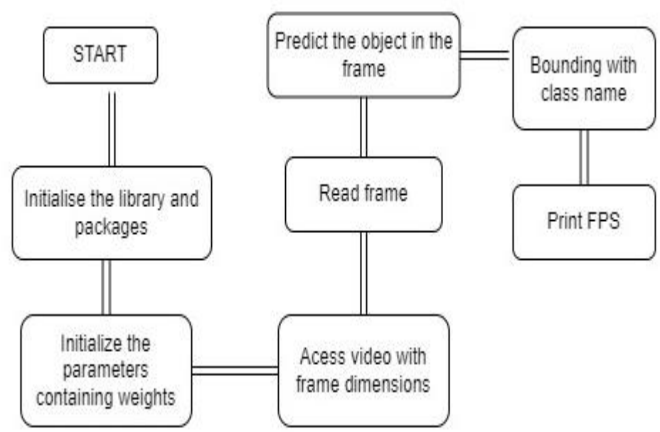


Fig 2: Workflow of YOLO scheme

A. Why choose YOLO V4?

YOLOv4's architecture is composed of CSPDarknet53 as a backbone, spatial pyramid pooling additional module, PANet path-aggregation neck and YOLOv3 head.YOLOv4 is twice as fast as EfficientDet (competitive recognition model) with comparable performance. In addition, AP (Average Precision) and FPS (Frames Per Second) increased by 10% and 12% compared to YOLOv3.

B. Machine Learning

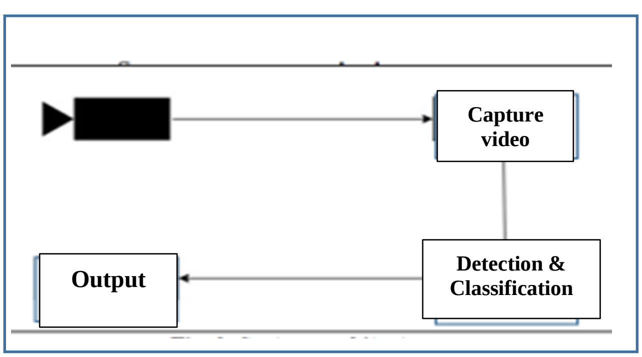
The simple system of device studying is to give schooling facts to a learning algorithm. The learning algorithm then generates a brand new set of rules, primarily based on inferences from the facts. This is in essence producing a new algorithm, officially referred to as the machine mastering model.
Instead of programming the computer each step of the manner, this approach offers the device commands that allow it to study from facts without new step-with the aid of-step commands via the programmer. Several troubles need to be considered while addressing AI, including, socioeconomic effects; troubles of transparency, bias, and accountability; new makes use of for information, considerations of protection and safety, ethical issues; and, how AI enables the advent of latest ecosystems.
At the same time, in this complicated field, there are specific demanding situations facing AI, which encompass: a loss of transparency and interpretability in selection making; problems of information satisfactory and capability bias; protection and safety implications; concerns regarding responsibility; and, its doubtlessly disruptive effects on social and monetary structures. Here Machine learning is used with YOLO for the detection specifically of heads, vehicles - two wheelers.

C. Helmet and license plate detection

From the beginning YOLOv4 designing was used for two wheelers and individual revelation. YOLOv4 model is a continuous upgrading type of YOLO.

In order to implement helmet detection and license plate 5 objects need to be detected. The objects are – Helmet, No Helmet, Motorcycle , 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.

Fig 3: System Architecture



The OpenCV Libraries are used alongside the detection system which contains the predefined functions and data members used for processing images like background subtraction, morphological operations and classification.

Fig 4: Detection of helmet, no_helmet and motorcycle

The annotated images are given as input to YOLOv4 model to train for the custom classes. The weights generated after training are used to load the model. Once this is done, an image or video. The model in fig 5 detects all the five classes trained. From this we obtain the information regarding person riding motorbike wearing helmet or not wearing helmet along with detection of license plate.

Fig 5: Detection Classes

IV. REAL TIME IMPLEMENTATION

a)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 YOLOv4 model, it supports up to 220 fps processing speed.

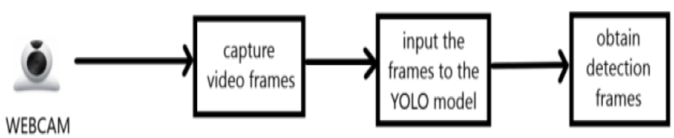


Fig 6: Implementation block diagram

V. RESULTS

The model was trained on tiny YOLOv4 for over 2000 images on 5 classes for 9,500 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 92.98 % hence the training was stopped at 9,500 iterations.

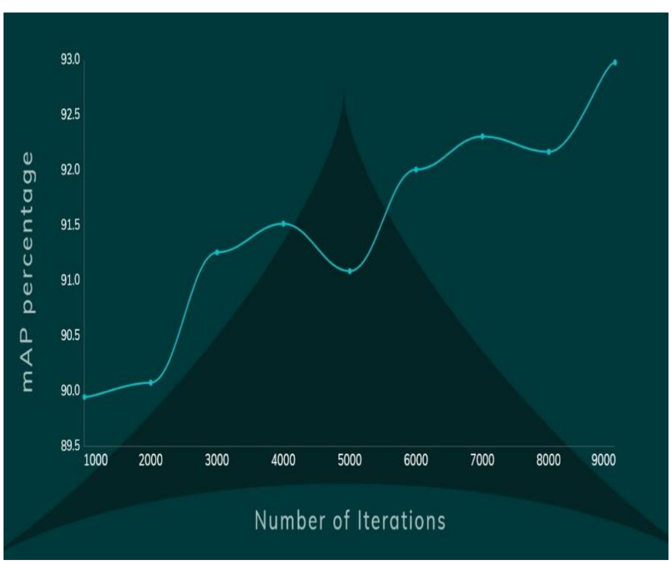


Fig 7: Accuracy Graph

A few examples of the input image and the output object detector are shown in the figure below:

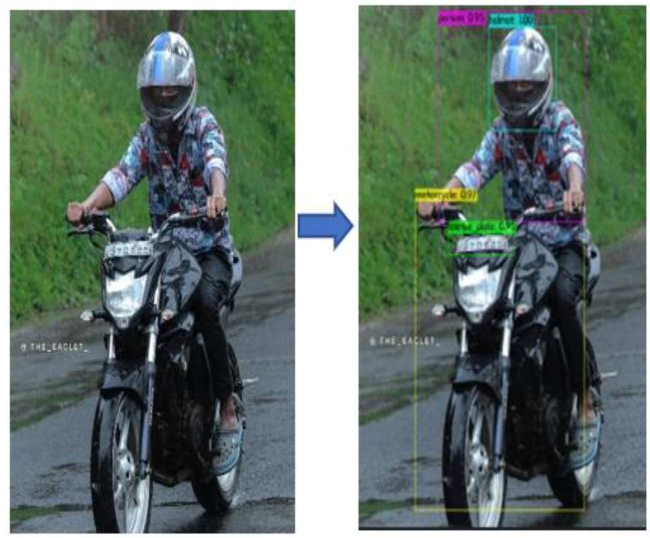


Fig 8: Example1:Detection of class labels

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data/img_(86).jpg: Predicted in 613.209000 milli-seconds.
motorcycle: 97%
person: 95%
license_plate: 95%
helmet: 100%
```

Fig 9: Prediction accuracy result of Example1:

Fig 10: Example2: Detection of class labels

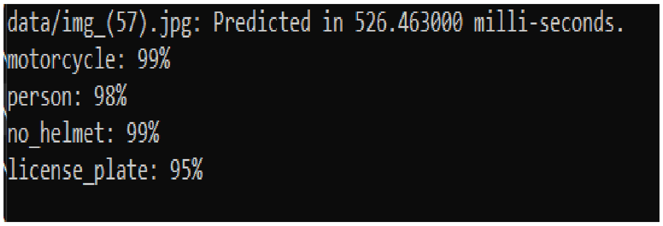

Fig 11: Prediction accuracy result of Example2:

Detection using Experimental Setup

Python code is used to run the desktop application named HD – Application.

The eel python library was used to integrate the backend and the frontend. Detection of 5 classes can be seen on-screen and the result detected video is saved into Project\Demo folder.

Screen of detection application is shown below:

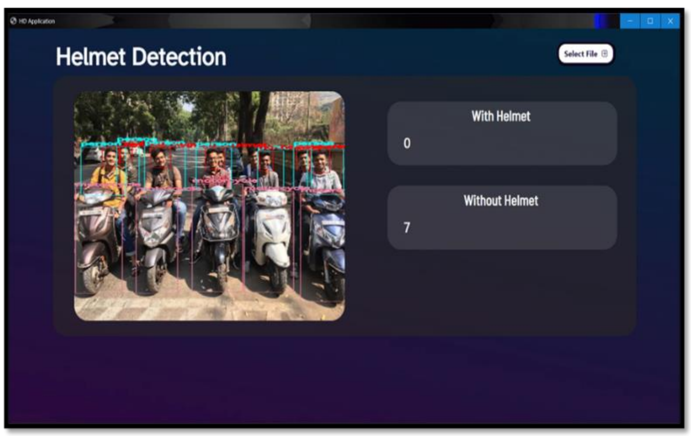

Fig 12: a) count-With helmet 0 and without helmet 7

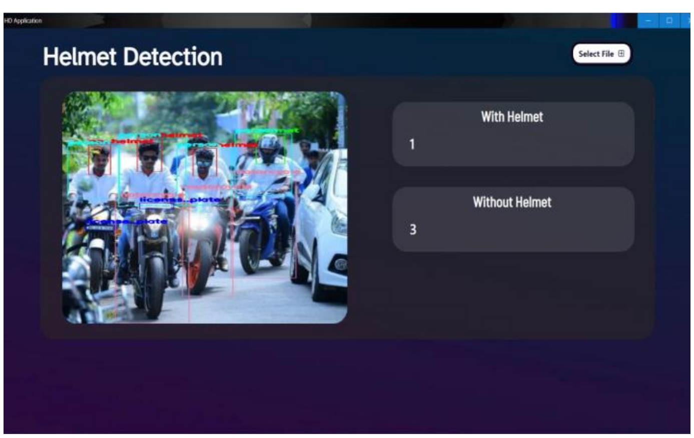

Fig 12: b) count-With helmet 1 and without helmet 3

VI. CONCLUSION

YOLO object detection is well suited for real-time processing and was able to accurately classify andlocalize 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.

This system has helped for ceaseless identification of traffic rule violators who ride motorbikes without using helmets and also defaulters, who triple ride on the vehicle. A PC vision framework that is isolated into modules like moving items division, moving articles arrangement and helmet use identification will help the traffic specialists to require activity contrary to managing violators. Proposed framework additionally will help the traffic police for such violators in odd ecological conditions like scorching sun, and so on.

All the libraries and software used in our project are open source and hence is very flexible and costefficient. 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.

VII. FUTURE SCOPE

Normally this is done manually by screening the entire video file and manually inserting the warning. OCR is used for license plate number extraction if the rider is not wearing a helmet. Not only the characters are extracted, but also the frame from which it is also extracted can be used for other purposes. Furthermore, we can further map this to the automatic license plate identification and obtain the information of the person owning the vehicle.

Also a software that generates challans for not wearing helmets can be added as a feature.

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