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Real-Time Helmet Detection of Bike Riders

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Abstract: Due to the affordability and ease in availability the motorcycle has seen a huge increase in its popularity. However, the rapid growth of motorcycle accidents is very alarming. According to the statistics given by the Ministry of Road Transport and Highway, amongst the road user categories, two-wheelers with a share of 37% constitute the largest number of road accident deaths (56,136) in 2019. To reduce the rate of accidents, the helmet is made compulsory for all riders. However, many riders ignore this rule. This paper aims to design a system for real-time detection of motorcyclists without helmets using the object detection-algorithms YOLO (You Only Look Once) to help solve the issue.
Keywords: YOLO, Object-Detection, Helmet detection, SSD, Feature selection, Vehicle classification, Machine Learning

I. INTRODUCTION

In the last decade, there was an increase in the number of motorcycle accidents. According to the statistics given by the Ministry of Road Transport and Highway, amongst the road user categories, two-wheelers with a share of 37% constitute the largest number of road accident deaths (56,136) in 2019. The main safety equipment of motorcyclists is the helmet. Although helmet use is mandatory in many countries, many motorcyclists do not use it or use it incorrectly. Non-wearing of helmets by two-wheeler riders caused 44,666 deaths and accounted for 29.82 percent of total road accident deaths in the country during 2019. The number of drivers killed were 30,148 and the passengers killed were 14,518. As the number of two-wheelers on the road are increasing, road mishaps are also increasing day by day. In the event of an accident, lack of timely medical attention to the injured person may lead to death. Thus, there is a need for a system which ensures safety of riders by enforcing riders to wear helmets as per government guidelines and assists in providing the rider for medical assistance in the event of an accident.

The main objective of this paper is to develop a real-time application for detection of non-helmeted motorcyclists using the single convolutional neural networks. Automatic detection of non-helmeted motorcyclists will help to reduce the burden faced by the traffic police, and it also needs fewer human resources. As a result, the number of motorcyclists not wearing a helmet will get reduced.

II. LITERATURE REVIEW

This paper discusses the real-time detection of license plate for non-helmeted motorcyclist with the use of the real-time object detector YOLO (You Only Look Once). In the proposed approach, a single convolutional neural network was deployed to automatically detect the license plate of a non-helmeted motorcyclist from the video stream. The centroid tracking method with a horizontal reference line was used to eliminate the fake positive generated via way of means of the helmeted motorcyclist as they leave the video frames. (Jamtsho et al, 2021)

This paper objectives to explain and illustrate an automated approach for bikes detection and classification on public roads and a system for automated detection of motorcyclists without helmet. For this, a hybrid descriptor for features extraction is proposed primarily based totally in Local Binary Pattern, Histograms of Oriented Gradients and the Hough Transform descriptors. (Silva et al., 2013)

This paper proposes a helmet detection model using tiny YOLO. Based on the detected categories 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 that recognizes the text and provides the registration {number plate/vehicle plate/registration code} number as output within the kind of Machine encoded text. And it may alsobe enforced in real time employing a Webcam. (Allamki et al., 2019)

In this paper, an SSD model is applied to the helmet detection problem. This model is in a position to use just one single CNN network to detect the bounding box area of bike and rider. Once the area is selected, we classify whether or not the biker is wearing a helmet. Convolutional Neural Network is used to pick motorcyclists among the moving objects and recognition of motorcyclists without a helmet. Further the License Plates of motorcyclists without helmets is detected using the YOLO model. Therefore, we've used 3 models in total the custom CNN Model, SSD Model and the YOLO model. (Santhosh, 2020)

Convolution Neural Network (CNN) model is intended for urban vehicle dataset for single object detection and YOLOv3 for multiple object detection on KITTI and COCO dataset. Model performance is analysed, evaluated, and tabulated using performance metrics like True Positive (TP), True Negative (TN), False Positive (FP), False Negative (FN), Accuracy, Precision, confusion matrix and mean Average Precession (mAP). Objects are tracked across the frames using YOLOv3 and Simple online Real Time tracking (SORT) on traffic surveillance video. This paper upholds the distinctiveness of the state of the art networks like DarkNet. The efficient

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detection and tracking on urban vehicle dataset is witnessed. The algorithms give real-time, accurate, precise identifications appropriate for real- time traffic applications. (Ravish, 2019)

III. HISTORY OF YOLO (YOU ONLY LOOK ONCE)

YOLO is the latest state-of-the-art real-time object detection algorithm. It is a single convolutional neural network that concurrently predicts more than one bounding boxes and classes of the whole image in the single scan. The framework was evolved by (Redmon et al., 2016). The network structure was inspired by the GoogLeNet version for image classification (Szegedy et al., 2015). The network has 24 convolutional layers followed by fully connected layers. In YOLO, 1 × 1 reduction layers have been used followed through three × three convolutional layers. Currently, there are 4 versions of YOLO (v1, v2,v3 and v4). The original YOLO network is also termed as YOLOv1.In YOLO v2, it is an improved model of YOLO v1 which continues the gain on the speed with the introduction of batch normalization, anchor boxes and high-resolution classifier. In YOLO v3, a better characteristic extractor was introduced with the introduction of fifty-three convolutional layers trained on ImageNet. The accuracy of the YOLO v3 is better than YOLO v2 however it is slower than YOLO v2 because of extra layers. (Jamtsho et al., 2021). In YOLOv4, it is assumed that some features, such as batch-normalization and residual-connections, are applicable to the majority of models, tasks, and datasets such universal features include Weighted-Residual-Connections (WRC), Cross-Stage-Partial-connections (CSP), Cross mini-Batch Normalization (CmBN), Self-adversarial-training (SAT) and Mish-activation. New features such as: WRC, CSP, CmBN, SAT, Mish activation, Mosaic data augmentation, CmBN, DropBlock regularization, and CIoU loss are used , and combined to achieve state-of-the-art results. (Bochkovskiy et al., 2020)

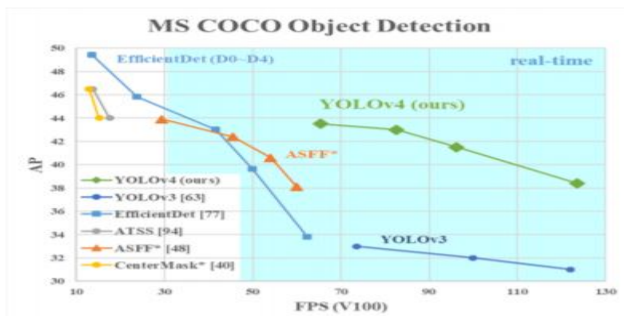

Fig -1: Comparison of YOLOv4 Models with the other state-of-the-art-detectors

IV. METHODOLOGY

A. YOLOv4 Algorithm

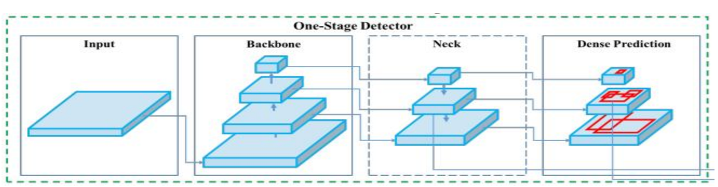

Fig -2: YOLOv4 Architecture

In our approach, we have used YOLO version 4 which YOLOv4 consists of:
Backbone: CSPDarknet53
Neck: SPP, PAN
Head: YOLOv3
YOLO v4 uses:

- Bag of Freebies (BoF) for backbone: CutMix and Mosaic data augmentation, DropBlock regularization, Class label smoothing
- Bag of Specials (BoS) for backbone: Mish activation, Cross-stage partial connections (CSP), Multiinput weighted residual connections (MiWRC)
- Bag of Freebies (BoF) for detector: CIoU-loss, CmBN, DropBlock regularization, Mosaic data augmentation, Self-Adversarial Training, Eliminate grid sensitivity, Using multiple anchors for a single ground truth, Cosine annealing scheduler, Optimal hyperparameters, Random training shapes
- Bag of Specials (BoS) for detector: Mish activation, SPP-block, SAM-block, PAN path-aggregation block, DIoU-NMS (Bochkovskiy et al., 2020)

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The input image is divided into SxS grid cells. The grid cell, which contains the center of the object is responsible for predicting the 5-bounding box (BB) coordinates (bx , by , bw, bh, c). The coordinates (bx , by) represent the center of the object relative to the grid cell location and (bw, bh) represents the width and height of the object relative to image dimensions. The presence of object in a grid cell is given by confidence score c. (Jamtsho et al, 2021)

1) *Data Annotation:* Before training the model, the training datasets need to be manually annotated with the BB information for- Hemet and No Helmet. The data annotation was done using LabelImg software (Tzutalin et al, 2015) since YOLO needs a ground truth. The software generates starting coordinates (x_0, y_0) and ending coordinates (x_1, y_1).

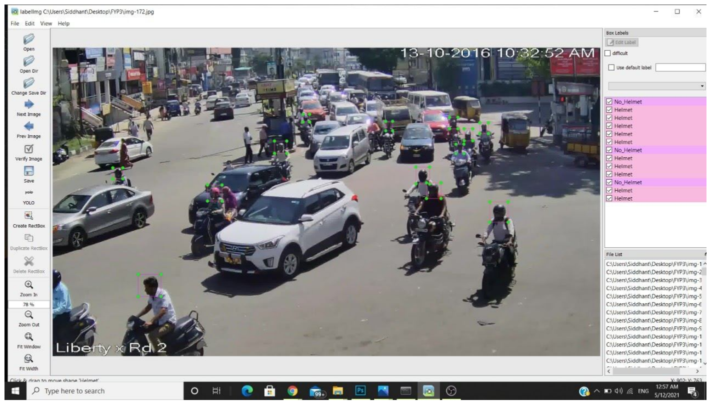

Fig -3: Annotated Image using Labeling

2) *Overview of the System:*

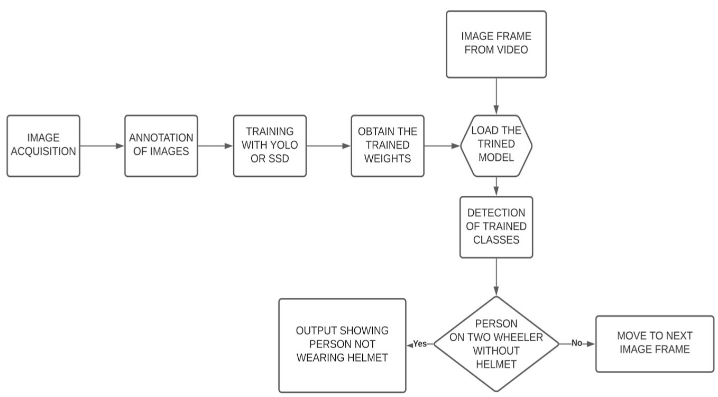

Fig -4: Process Flow Diagram

Fig.4 shows the process flow diagram of our implemented system. The real- time video is considered as the input and the expected output is the identification of helmet and non-helmet wearers.

V. EXPERIMENTAL RESULTS

The datasets for this study were collected from Indian Institute of Technology Hyderabad, Kandi and traffic cameras in Mumbai. The datasets were separated into 80%–20%, where 80% was treated as the train set and 20% as the test set. The CSPDarknet53 framework (Jamtsho et al, 2021), which defines the YOLOv4 network, was used to train the model in the Google Collaboratory. Google Collaboratory is an online GPU which provides Tesla K80 GPU with 12 GB RAM. The programs used in automatic detection of non-helmeted motorcyclist were written in Python 3.8.2 with OpenCV library. For training of YOLO model, datasets were annotated with the bounding box information including the class labels for two classes. The YOLOv4 model includes 52 fully convolution layers, in which 46 layers are divided into 23 residual units with 5 different sizes. The model was trained for 6,000 iterations with the input image dimensions of 416 × 416 pixels. Table 1 shows the average IOU and the average precision (AP) generated by each iteration for three classes.

Fig -4: Output

Table 1: Tabulation of AP with average IOU of each class.

Epochs	Helmet	No Helmet	Avg IOU	Map
1000	90.19	76.55	51.04	83.37
2000	91.49	77.88	60.17	84.68
3000	92.17	88.78	61.82	90.48
4000	90.81	73.09	61.14	81.95
5000	94.08	85.11	64.07	89.6
6000	96.13	89.75	64.37	92.94

Table 2 : The Confusion matrix obtained from the experiments.

	Helmet	No Helmet
Helmet	56	2
No Helmet	10	30

From Table 1, we can select the epoch having higher average IOU since it has the highest area of overlap between the ground truth and the predicted bounding box. The overall mean precision (mAP) for two classes is 92.94% with the average training loss of 0.0829.

VI. CONCLUSIONS

The main objective of this paper was to develop a system for real-time detection of motorcyclists without helmets using the object detection-algorithms YOLO (You Only Look Once). The system can successfully differentiate between a person wearing a helmet and a person not wearing a helmet.

VII. ACKNOWLEDGEMENT

Special thanks to C. Vishnu, Dinesh Singh, C. Krishna Mohan and Sobhan Babu from Indian Institute of Technology Hyderabad, Kandi for providing us with traffic camera footage.

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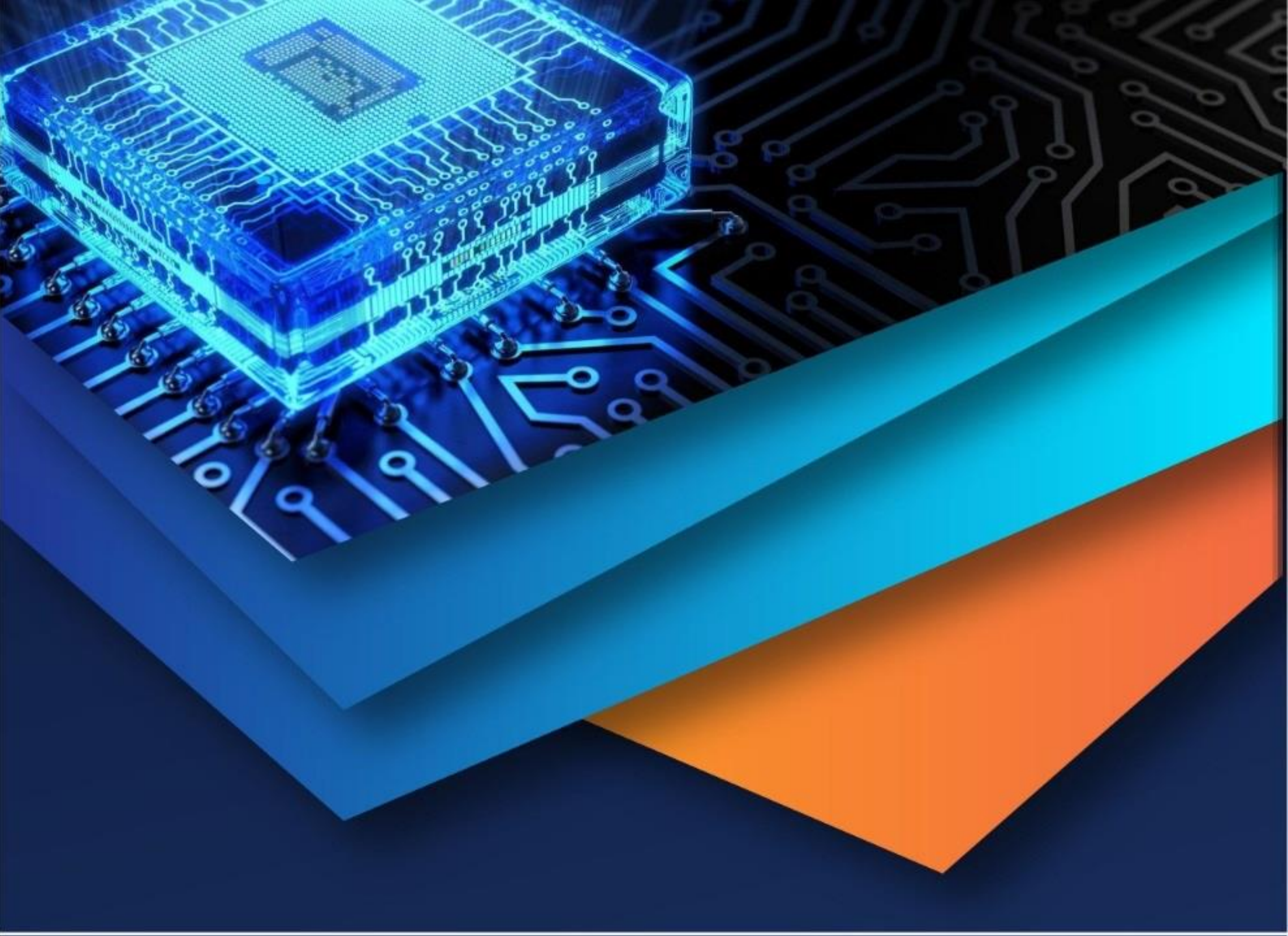

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