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Detection of Helmet and License Plate Using Machine Learning

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Abstract: Individuals frequently disregard how important it is to wear helmets, which causes tragic accidents. A helmet reduces your risk of getting a serious brain injury and dying by deflecting most of the impact energy that would otherwise hit your head and brain during a tumble or collisions. In India, it is against the law to operate a motorbike or scooter without a helmet, which has increased fatalities as well as crashes. The existing system mostly relies on surveillance footage for keeping up with traffic violations, necessitating a close-up of the license plate by traffic police in the case that the motorcyclist lacks a helmet. Yet, this necessitates a substantial amount of personnel and time considering the high frequency of traffic violations and the rising everyday use of motorcycles. Imagine if there was an algorithm that monitored traffic infractions, such driving a motorbike with no a helmet, and, if any were identified, generate the license plate of the vehicle that committed the violation. Helmet and license plate is detected using a neural network is proposed in this paper. There will be two phases. Initially, we check to see if the riders are wearing helmets. If not, a second step is used to find their license plate. To identify unauthorized vehicles, we also look for license plates on passing vehicles.

Keywords: *Convolutional Neural Network, Helmet Detection, Machine Learning, Yolov8*

1. Introduction

The vast majority of people commute daily on bikes in impoverished nations. By definition, motorbikes are less crashworthy than closed vehicles. They are also less sturdy than four-wheel vehicles and less noticeable to other vehicles and pedestrians. Compared to drivers of enclosed cars, motorbike riders and passengers are more susceptible to weather and road conditions. The rider of a two-wheeler gets threw from the vehicle if there were a mishap because of a quick braking. The velocity of the head stops when it strikes with an object, but the gesticulation of the brain is preserved by the mass of the brain until the object strikes the internal region of the head. This kind of brain damage may sporadically prove mortal. In these conditions, a helmet can save your life. Helmets reduce the chance that the head will deliberate down, which virtually eliminates head motion. After the accident's effect has been captivated by the helmet's cushion over time, the head finally comes to rest. Moreover, the power of the hit is detached transversely a broader area, guarding the skull from severe injuries. Most of all, the helmet acts as a machine-driven guard to protect the rider's head from anything they come into contact with. If a full helmet of decent feature is worn, injuries can be reduced. The goal of traffic laws is to promote self-control so that the danger of mortalities and severe wounds can be significantly decreased. Unfortunately, in practice, these regulations are not adhered to strictly. It is necessary to provide practical and efficient solutions to these problems. To manually monitor traffic, current procedures include using Surveillance video. Yet in this instance, it takes a lot of labor to carry out the numerous iterations required to accomplish the objective. Thus, cities with millions of residents and several moving automobiles, this inadequate manual method of helmet identification cannot be used. Many studies in traffic analysis have been conducted in recent years, including those on vehicle recognition and categorization and helmet recognition. Computer vision technologies, such as contextual and forefront image detection to section the moving objects in a scene and image descriptors to extract features, were used to build intellectual traffic systems. To categorize the objects, computational intelligence technologies such as machine learning algorithms are also used. The realm of artificial intelligence known as machine learning (ML) involves a model that has undergone training utilizing input data, which it can then use to function independently. To make predictions or decisions, machine learning algorithms construct a mathematical representation using a set of example data known as "training data". Hence, a Helmet detection model can be put into use by training with a certain dataset. Our helmet detection model makes it simple to identify riders without helmets. The rider's license plate can also be identified based on the classes that have been detected.

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2. Literature Survey

For the automatic recognition of bike helmet use in recorded video information, many different methods have been recommended.

A deep learning-based system put up by HANHE LIN automatically satisfies three requirements for human observers registering motorcycle helmet use: active motorcycle detection and tracking, rider number identification per bike, rider location. The component of helmet usage class detection, which records rider number, location, and rider exact helmet use on a level dependent on frames, achieves an accuracy of roughly 86.6 percent [1]. not be selected.

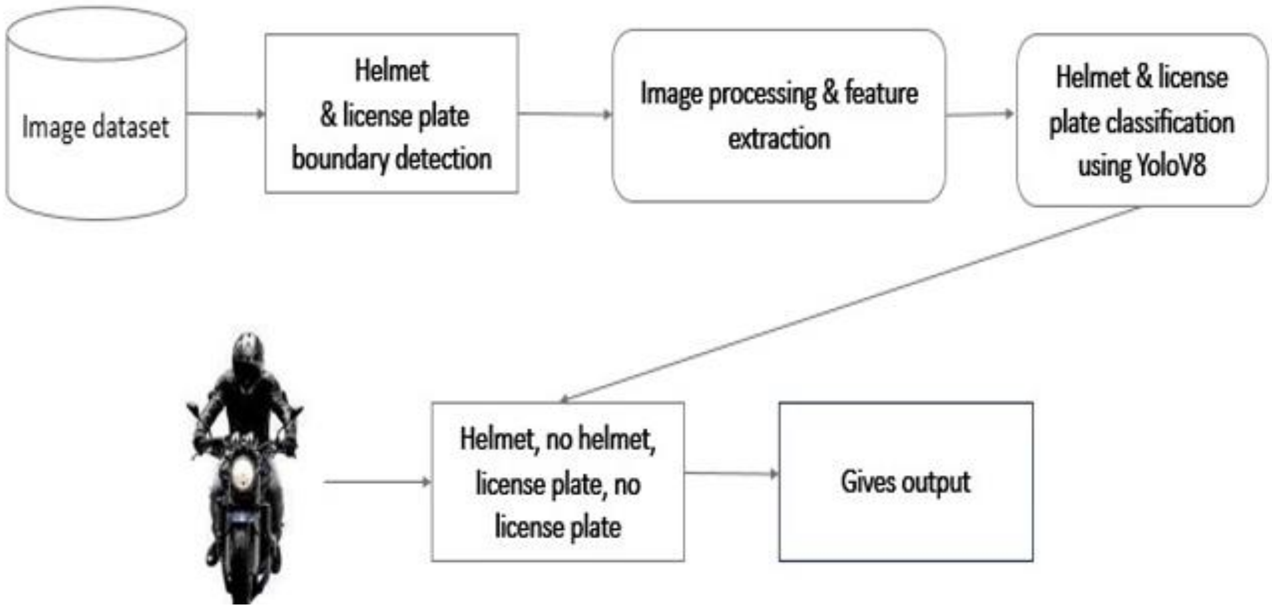

Fig. 1. System Architecture

By means of first and second order derivative edge recognition, Sneha A. Ghonge proposed a real- time vision-based motorbike monitoring system to identify and track motorcycles in a series of photos [2]. Algorithm with neural network for determining whether a helmet is present or absent, and (OCR) Optical Character Recognition with Neural Network for determining the location of a license plate. The suggested method is intended to identify drivers who disobey traffic laws by deteriorating to wear a helmet, to record the violators' authorization plate information, and to automatically create a challan [3].

A study by Prajwal M. J. used a video file as the input for a system being developed to locate riders without wearing helmets. If the rider in the video clip is riding a bike without a helmet, then the bike's number plate number is retrieved and displayed. The item detection principle of the YOLO architecture is used to detect bikes, persons, helmets, and license plates. In cases OCR is used to extract the digit plate in cases where the rider miscarries to put on a helmet [4].

The model developed by Lokesh Allamki1 conducted 50,000training iterations utilizing 11,000 images from 5 classes of tiny YOLOv3 data. High levels of precision were achieved in the detection of all object kinds, and the mean average precision (mAP) continually got a maximum of 75%. The encryption excerpts the authorization plate from the object detector's output. The bikes from which the authorization plate extraction code discards the authorization plates of bikes whose riders are wearing helmets and excerpts the registration of the rider who is not tiring a helmet. With an accuracy of up to 85%, the OCR model can find and identify the license plates that are visible in a picture [5].

A new framework for helmet detection in UAV aerial imagery was unveiled by Xiaohan Wang. They began by extracting and fusing the features of the input information using a backbone network of the ladder type [6]. Second, in addition to adaptive layer-by-layer spatial information selection, the recommended RCTAM and 3DsAM indirectly provide universal extended-variety modelling. Third, the target box is reconstructed using ESRGAN, which recovers the target image's sharper edges and more finely defined textures. The classifier is then utilized to provide results [7].

3. Materials and Methods

3.1. Existing Idea

In that study, a novel method that makes use of deep learning for the identification and monitoring of certain motorcycles as well as the tracking of helmet use has been proposed. That technique overcomes the drawbacks of earlier detection techniques, for example, their incapability to follow exact bikes through several structures and differentiate between riders and passengers [8]. The paper also presents the dataset of images, that includes 91,000 labelled structures of 10,066 distinct bikes from 12 areas in Myanmar. The dataset includes an assessment criterion for helmet wear and rider recognition exactness that can be used as a guide for upcoming recognition techniques [9]. That method beats earlier research in terms of effectiveness, accurately recognizing the number of riders and helmet use of monitored bikes while attaining a treating speed of more than 8 structures per second on standard hardware, with a weighted average F-measure of 67.3%. The study emphasizes how deep learning may be used to collect vital data on road safety while using few resources [10].

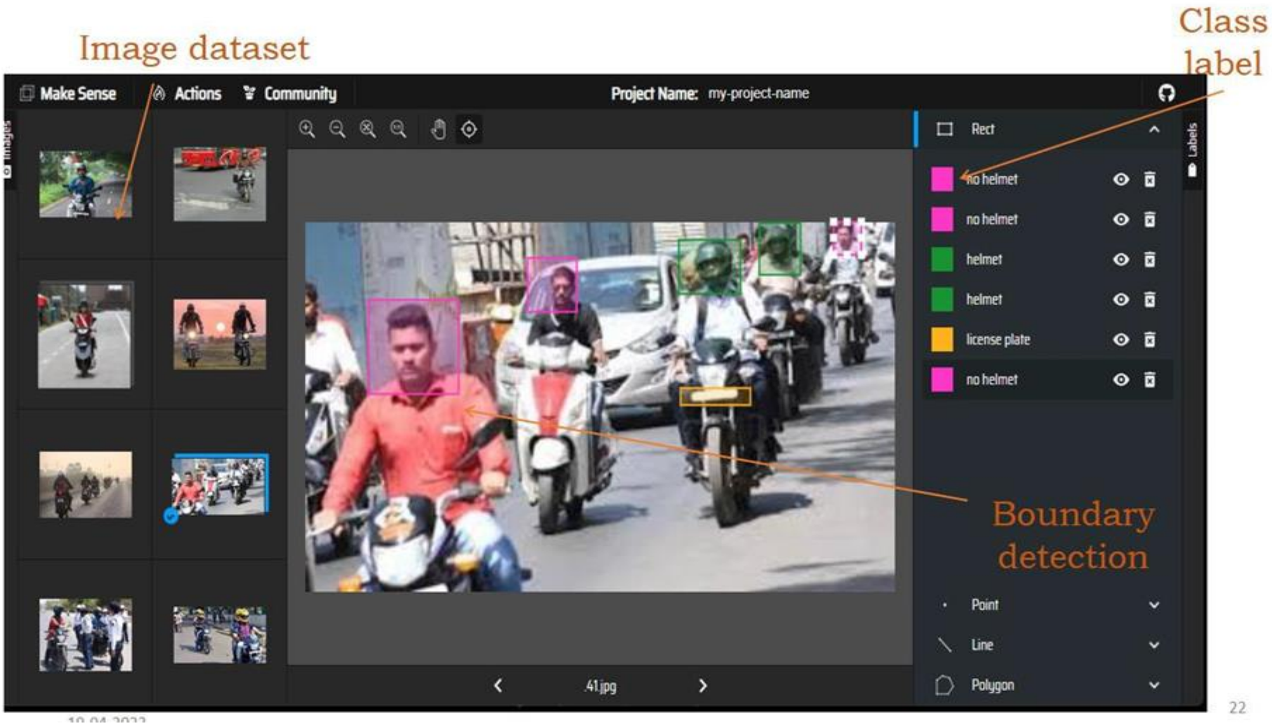

Fig. 2. Image Dataset

Fig. 3. Boundary detection

3.2 Proposed Work

Agility and precision are necessary for real- time helmet detection. We therefore went with the You Only Look Once (YOLO) concept. Figure 1 shows the system architecture. The latest and pioneering YOLO model, YOLOv8, can be employed for applications including entity identification, image classification, and illustration segmentation. Ultralytics, who also created the significant and YOLOv5 model that defined the industry, developed YOLOv8. Compared to YOLOv5, YOLOv8 has a number of architectural modernizes and improvements [11]. According to COCO and Roboflow 100 measurements, YOLOv8 has a high accuracy rate. A range of developer- approachable structures, including an instinctive CLI and a well-made Python package, are encompassed in YOLOv8. There are many specialists in computer vision area who may be able to support you when you need guidance because there is a substantial community around YOLO and an emerging community around the YOLOv8 model [12]. The YOLOv8 developer-friendly features are vital. YOLOv8 has a CLI that allows training a model relaxed, in contrast to other models where tasks are spread across several executable Python files. Moreover, there is a Python bundle that suggestions a flatter progress involvement than previous models. A backbone network, a neck network, and ahead network are all parts of the YOLOv8 design. The neck network combines the elements that the backbone network has combined to provide high-level representations from the input image. Based on these representations, the head network predicts where various things will be in the image. The YOLOv8 algorithm employs a single-stage methodology, predicting object locations straight from the input image [13].

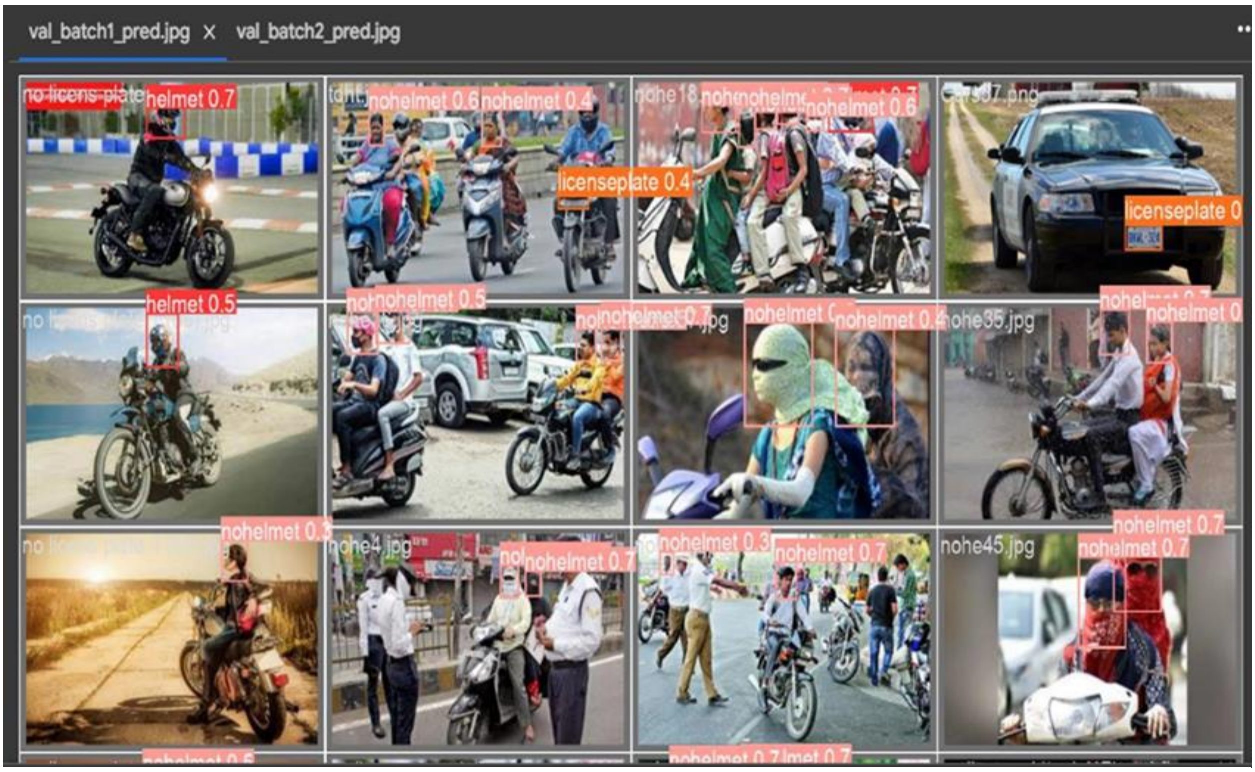

Fig. 4. Training outcome

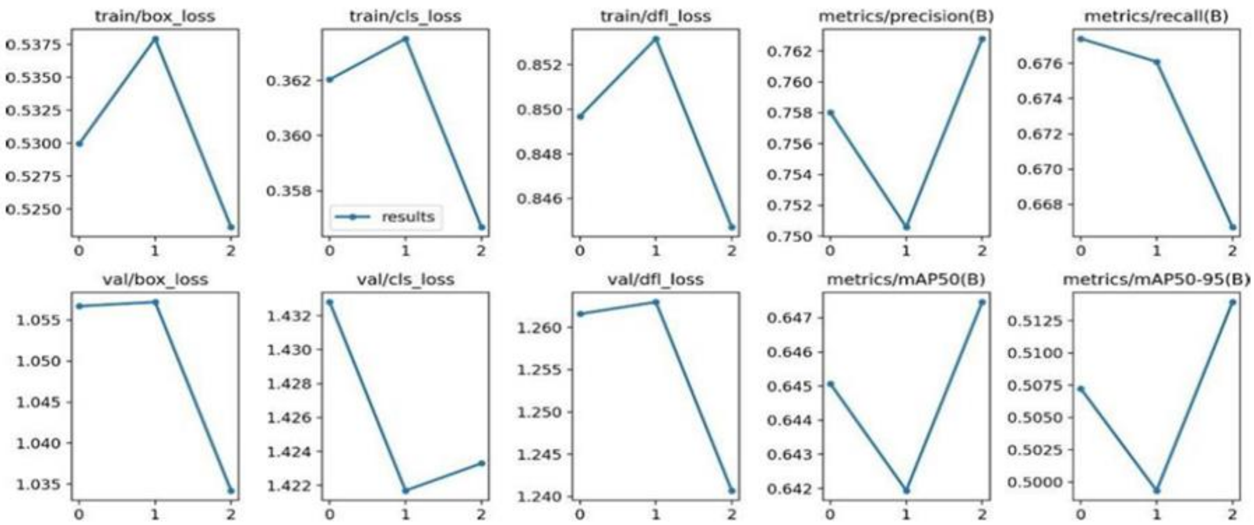

Fig. 5. Resulting Matrix Graph

Figure 2 shows the image dataset. We have gathered a sizable dataset of pictures of motorbikes, scooters, or other pertinent vehicles with both license plates and helmets on them. The pictures must to have different backgrounds, angles, and lighting setups [14]. the location of the helmet and authorization plate in each photograph has then been labelled. Then the photos were resized and normalized to a consistent size as part of the data collection's pre-processing. Figure 3 shows the boundary detection. To expand the dataset, employ data augmentation techniques including rotation, flipping, and scaling. Construct training, validation, and test datasets [15].

To locate helmets and license plates in the images, use the YOLOv8 algorithm. Adjust the YOLOv8 algorithm's hyper parameters, for example the learning rate, group size, and amount of layers, to make it more precise. Figure 4 shows the training outcome. Utilize strategies like weight decay and dropout to avoid overfitting. Utilize the validation set to track the model's effectiveness and modify the hyper parameters as necessary [16]. Analyze the model's performance on the test set. To gauge the prototype's enactment, use assessment metrics of accuracy and precision. The model can be used in real- world applications after being trained and tested. Figure 5 shows the resulting matrix graph.

3.3 Algorithm

Step 1: Gather a dataset of images and labeling dataset
Step 2: Export dataset to YOLOv8

Step 3: Train YOLOv8 to recognize the objects in dataset
Step 4: Evaluate YOLOv8 model performance
Step 5: Run test inference to view model at work

Fig. 6. Input Image

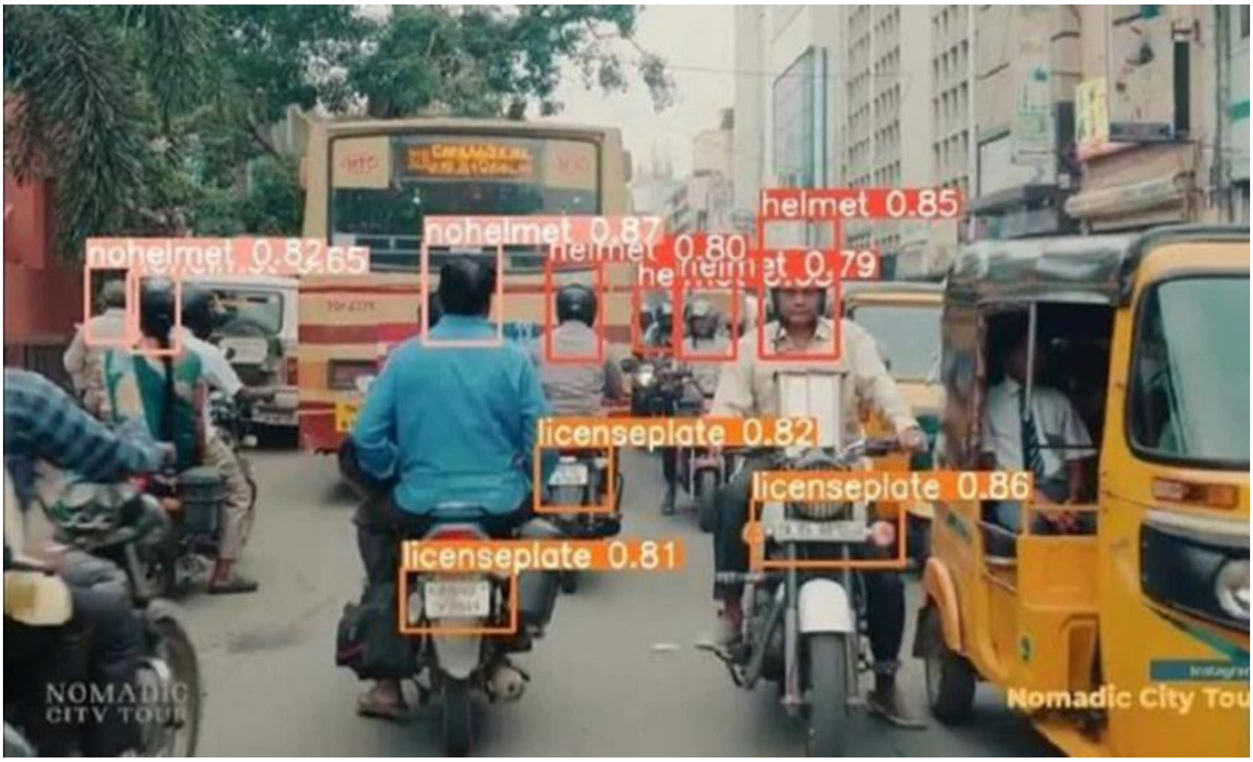

Fig. 7. Proposed model Result

Fig. 8. Input Image

Fig. 9. Proposed model Result

4. Results

The YOLOv8 algorithm can be applied independently or as part of a bigger system. The prototype was trained on YOLOv8 for 10,000+ images on four classes for 40,000 iterations. The recognitions of all the entities classes was obtained with high precision value and the mean average precision (mAP) got a constant max value of 85% hence the training was clogged at 40,000 iterations. The sample two input and their proposed model result was shown in figure 6,7,8 and 9 respectively.

5. Discussion

Table 1 shows the comparative discussion of proposed model with the previous method published.

Table 1. Comparative Discussion of Proposed Model

Previously published articles	Methodology	Inferences
[9]	Wear-Enhanced YOLOv3 Algorithm	For the purpose of detecting personnel and PSPE at substations, a novel detection model called wear-enhanced YOLOv3 has been proposed. Gamma correction usage raises the mAP by 2.28%.
[1]	CNN-Based Multi-Task Learning	The identification of rider numbers per motorcycle, rider location, and rider-specific helmet use are the three tasks that a deep learning-based system that registers the use of motorcycle helmets by human observers automatically does.
[5]	Tiny YOLOv4	Put forward the model that was trained using 11,000 images from 5 classes of small YOLOv3 data over the course of 50,000 iterations. Excellent levels of precision were achieved in the detection of all object kinds, and the mean average precision (mAP) regularly reached a maximum of 75%.
[2]	Neural Network	The presence or absence of a helmet is detected using a neural network and the first and second order derivative edge detection algorithms, which are proposed as a real-time vision-based motorbike monitoring system to identify and track motorcycles in a series of photos.
[3]	Modified template-matching technique	The proposed approach locates license plates by identifying their color and shape. The approach has undergone in-depth analysis, been fully put into practice, and shown to be useful.
[8]	YOLOv4	According to the testing results, our revised algorithm's mAP is 2.2 higher than the original SSD algorithm's mAP on the PASCAL VOC2007 dataset and 1.8 higher on our own helmet dataset when the input size is 300, and the detection speed is 51 frames per second.
Proposed model	YOLOv8	The prototype was trained on YOLOv8 for 10,000+ images on four classes for 40,000 iterations. The recognitions of all the entities classes was obtained with high precision value and the mean average precision (mAP) got a constant max value of 85%.

6. Conclusion

In the proposed system, we designed a model that detects license plates, and helmets that identifies whether they are following rules or not. And also checks whether the drivers have license plates on their four- wheelers. This can be identified by our model using real-time footage. The algorithm and various computer vision techniques aid in the detection of helmets and license plates with high accuracy. For further enhancement, an official inputs a license number, and using the developed system, it can search, extract and identify the desired vehicle.

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Conflicts of interest

The authors declare no conflicts of interest.

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