Helmet & Number Plate Detection using Machine learning

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Abstract:
There are very few automobiles in developing countries because motorcycles have always been the predominant mode of transport. Motorcycle crashes have been on the rise in the last few years. A number of people who are involved in traffic collisions include motorcyclists who do not wear reflective helmets, since they do not believe they provide sufficient protection. Once the traffic police spot those driving motorcycls on a whole-or mMotorcycles in junctions-without helmets, they also use video from CCTV to take control of the drivers of those vehicles and penalise those who are riding without one. However, it can only be achieved through human action and commitment. Secondly, the classifies moving vehicles as motorcycle or nonmotorcycle. for example, when referring to the head component, in the case of a motorcyclists, it is graded as either full face or non-full face. An excellent image analysis of the motorcycle number is then used to extract the characters that were missed by the identification software and/ Finally, the character count of the motorcycle is found, and from the motorcycle is examined using OCR software.It is an Object Detection Algorithm used to identify faces in an image or a real time video. The algorithm uses edge or line detection features proposed by Viola and Jones in their research paper "Rapid Object Detection using a Boosted Cascade of Simple Features.A Convolutional Neural Network is a Deep Learning algorithm which can take in an input image, assign importance to various aspects/objects in the image and be able to differentiate one from the other. CNNs are used for image classification and recognition because of its high accuracy. The CNN follows a hierarchical model which works on building a network, like a funnel, and finally gives out a fully-connected layer where all the neurons are connected to each other and the output is processed.

1. Introduction

As we all know that two-wheelers are a very popular and efficient mode of transportation in almost every country. And especially in India, the number of accidents is increasing rapidly, and Deaths due to two-wheeler road accidents in India increased to 56,873 in 2020 from 56,136 registered in 2019. As many as 158,964 two-wheeler road accidents took place in India in 2020, which caused 56,873 deaths, 25 per cent of total accidents belong to two-wheelers only because of ignoring safety measures. The two-wheeler rider needs to use a helmet. As well as the government also have made it a punishable offence and challan for the same and they have adopted manual strategies to catch the violators. However, the existing video surveillance based methods are passive and also require human assistance and the efficiency decreases over a long duration. Automation for this is highly recommended for reliable and robust monitoring of these violations as well as it also significantly reduces the number of human resources/efforts needed.

The motivation of this work is to enhance the surveillance on the roads in almost all locations where the use of helmets is mandatory. These stats reveal the need for enhancement and enforcement of traffic laws, particularly for offences for which there are very less and low accuracy automatic detection methods. As a result, the increase in the number of two-wheeler riders using helmets causes a drastic decrease in the number of accidents with victims, which is high in those countries.

However, to adopt such automatic solutions certain challenges need to be addressed:

1. **Occlusion**: In real life, the dynamic objects usually occlude each other due to which the object of interest may only be partially visible Segmentation and classification become difficult for these partially visible objects
2. **The direction of Motion**: 3-D objects have various appearances from different angles. It is well known that the accuracy of classifiers depends on features used which in turn depends on an angle to some extent. A reasonable example is to consider the appearance of two-wheeler riders from the front view and side view
3. **Temporal Changes in conditions**: Over time, there are several changes in environmental conditions such as illumination, shadows, climate change, etc.

4. **Quality of Video Feed**: Generally, CCTV cameras capture low-resolution video. Also, conditions such as low light and bad weather complicate it further. Due to such limitations, tasks such as segmentation, classification and tracking become even more difficult.

Our study aimed to design and develop an automated vision methodology to detect two-wheeler riders without helmets. Further CCTV footage is used to detect whether a rider is wearing a helmet or not, using Deep Learning and Image Processing technology. The algorithm used here is CNN, because it increases the detection rate of motorcycles, compared to other deep networks such as Decision tree, SVN, and KNN. The violator's vehicle's registration number is recognized from the vehicle using open-CV and an alert is sent to the nearby police station.

Here we mainly categorized into four areas, are

- Motorcycle Detection
- Head Detection
- Helmet Detection
- Number plate detection

Fig.1 depicts the approach mentioned in the paper.

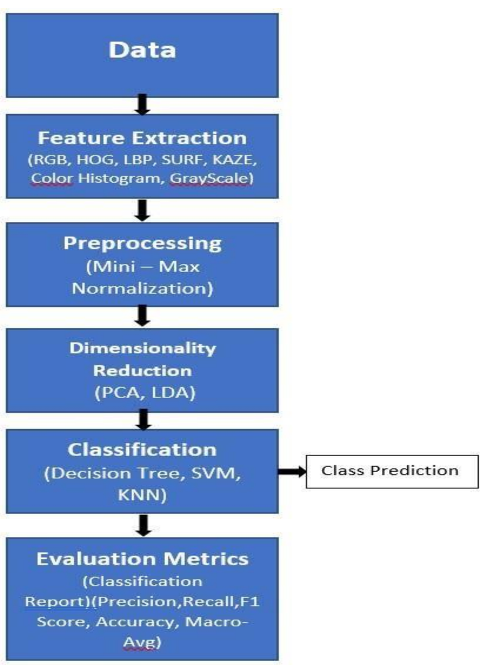

Fig. 1. Algorithm workflow

1.1 Convolutional Neural Network:

A Convolutional Neural Network (CNN) is a deep neural network as it has so many layers. Convolutional Neural Network is used in image classification, image processing, object detection, pattern detection. Fig. 2 portrays a convolutional neural network that contains several layers as first it takes an image as a input and extracts the important features from the image using its CNN layers and provides an output [3].

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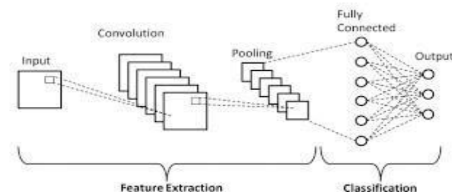

Fig. 2. Convolutional Neural Network layers

1.2 Computer vision

Computer vision is an integrative discipline that instructs a computer on how to learn about characteristics from photos and videos in order to achieve high accuracy in a deep learning model. Object tracking, object detection, semantic segmentation, and other techniques are all part of computer vision.

2. Literature Survey

Madhuchhanda Dasgupta, Oishila Bandyopadhyay, Sanjay Chatterji, Computer Science & Engineering IIIT Kalyani West Bengal India," Automated Helmet Detection for Multiple Motorcycle Riders using CNN"[1]. Any effective traffic management system must have theability to continuously monitor vehicle compliance with traffic laws. Because there are so many people in metropolitan areas in India, motorbikes may be one of the most popular ways of transportation. According to reports, the majority of motorcyclists do not utilise head protection in city traffic or even on the highway. Many studies have demonstrated that wearing a helmet while riding a motorbike minimisesthe risk of head and brain injuries in the event of a collision. The majority of traffic and safety rules are currently monitored by a traffic video surveillance camera system, allowing them to be detected utilisingbreach nowadays. This study presents a useful method for confirming single or numerous motorcycle passengers with or verifying their movement, or "dual," as the designers term it. YOL will be used to see if an object is present when someone (say, a motorcycle rider) enters thescene at the start of the experiment. To study the starting point, YOL3, the state-of-the-art, will be used. ConvolutionalNet, the second neural network design, was created to detect motorcyclists using a technique called pattern matching and edge detection. As a result, the findings imply that using a CNN model on the same traffic recordings is more promising than using alternative methods.

Fahad A Khan, Nitin Nagori, Dr. Ameya Naik, Department of Electronics & Telecommunication K.J.Somaiya college of Engineering Mumbai, India," Helmet and Number Plate detection of Motorcyclists using Deep Learning and Advanced Machine Vision Techniques"[2]. They presented the recent surge in motorcycle use has made it more difficult to maintain the roads clear, and there has been an increase in incidents and injuries. One of the main reasons of this is the motorcyclist's failure to wear a helmet. Currently, to locate any motorcyclists who are not wearing helmets, a person needs perform a physical search or have CCTV footage at a different intersection from that provided by the Department by those motorcyclists inspected by law.

A suggestion involves using a computer framework to evaluate images of motorcycle riders in order to distinguish between those who wear helmets and those who do not, allowing for more exact identification of motorised cycle users. In general, the machine acquires items based on their characteristics and subsequently discards them. YOL-Dark architecture, which employs convolutional neural networks trained on Common Objects in an a la carte fashion. Convolutional net deep learning models for object recognition and computer vision are available from Cena. The wavelet layers of YOL's classifier are changed to differentiate between three known classes, and the technique is implemented as a sliding window. The test results, which provided a significantly more accurate representation of the map's extent (to a greater extent), averaged 81 percent precision. Ankita Manocha, Dikshant Manocha, Yatin Chachra, Namit Rastogi, Varun Goel Department of Electronics and Communivcation.

Communication Engineering Jaypee Institute of Information Technology Noida, India presented project with "Helmet Detection Using ML & IoT"[3]. This study leverages data from two-circling bikers to anticipate unhelmet demand in the absence of a centralised authentication system. It also helps to make the imposition charge process more user-friendly. After the vehicle recognitions and vehicle instances are created on the collected traffic using the first-in-one-first-out (FIFO) or best-in-first-order, and two-out-first (FIR) approaches, the distinctions are formed using the two-in-two-out (TIR) or leastrecent-in-first-out (LFO) approach. After determining whether the riders and passengers are present in the vehicle, OpenCV is used to determine whether the pillion riders or the bike are not wearing helmets. When a motorcycle driver, pillion passenger, or motorcycle rider does not wear a helmet, it is scanned and tracked by digital imaging, and the potential driver, pillion passenger, or motorcycle rider is labelled as unauthorised (OCR). A fine will be produced after receiving the vehicle's registration number, and all information will be mailed to the person who was cited, as well as an E-mail and a text message to the vehicle's owner. The user may be given access to an account (through an app or a website) that allows them to pay their court expenses.

Convolutional Neural Networkbased Automatic Extraction and Fine Generation"[4] by Y Mohana Roopa, Sri Harshini Popuri, Gotham Gowtam sai Sankar, Tejesh Chandra Kuppili, Computer Science and Engineering Institute of Aeronautical Engineering, Hyderabad, India Humanity, particularly as human people, has a tendency to discern links between causes and effects while ignoring what is connected, overlooking what has little bearing on the event, and perceiving flaws in things that are not present. Helmets and other protective gear are also offered as a vital safety precaution for individuals who know the reasons for the or checking current capabilities. Because there is a clear link between traffic flow and human activity, humans are believed to be the primary actors in the situation. It is physically impossible for a police officer to do so when enforcing the rules of the road, the officer should be a part of the flow. A small group of people will be required to complete a major project successfully, and many will be required to assist them.

The number on the helmet must be taken into account in this situation: two people are expected to emerge from the pile of plates. This is to enable better vehicle identification, as opposed to the opposite extreme, where many numbers from multiple sources are registered on the same car out of expediency.

3. Dataset

Table 1 represents that Dataset consists of 3500 images that contain images of people with helmets and 3500 images of people without helmets which means there are a total of 7000 images. Hence, the Dataset is categorized into two classes; people with a helmet and the second is individuals not wearing a helmet. Fig 3 represents the images of riders with a helmet from the dataset and Fig. 4 represents the images of riders without a helmet.

Table 1 - Dataset Description

Description	No. of Images
Riders with helmet	3500
Riders without helmet	3500

Fig. 3. Riders with helmet

Fig. 4. Riders without helmet

4. Proposed Revised Model

The proposed approach target to recognize whether the riders is wearing a helmet or not in images/videos, with the help of Open-cv, Computer Vision, and Tensorflow libraries

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4.1 Data pre-processing:

The first stage is to load the dataset. Then, Data pre-processing takes place, in which images are resized into 62 X 62 dimensions. Furthermore, the images are converted into the array form and at the last Label Binarizer techniques are applied.

4.2 Splitting of the Dataset:

In the second step, the dataset is divided into the training and testing set. The test size is taken as 0.2, that indicated 80% of images are splitter as the training images. While the other as the testing visuals.

4.3 Model building and training:

For building the Model, Data Augmentation is applied. It is similar to regularization technique which makes adjustments to the images by cropping, flipping, rotating, padding etc. It also prevents over fitting as its increases the size of training data by its own, as a result it reduces over fitting. It is trained on a large amount from the Image Net database.

To make the mode more robust, two dense layer with 100 neurons and having activation function as 'relu' are added. Then dropout layer is also added, which drops 0.75 neurons, and then the last dense layer contains 2 neurons and having activation function as SoftMax. After this, the next step is model fitting in which the batch size is taken as 120, with optimizer as "Adam" .The Modified model is trained over 14 epochs.

4.4 Helmet detection using webcam:

Once the Model is trained, then the detection of the vehicle, helmet and number plate using opencv libraries such as OCR. Once it visualizes the helmet and vehicle, it converts the RGB image to a Gray scale. Then, Resizing of the image is done into 64 X 64.

4.5 Loading the trained classifier:

Once the classifier is trained, then the trained classifier is loaded, and now the model is ready to predict whether the riders are wearing a helmet and or not. As the Dataset [12] has two classes so with helmet class is specified as with green color and without helmet class as red color. Finally, when the rider is detected without helmet than an email is generated automatically to the Traffic police department with the photo of number plate.

5. Evaluation Metrics

Evaluation metrics holds a notable role in the field of Artificial Intelligence. It evaluates the performance of model using precision, recall, confusion matrix, classification accuracy.

5.1 Precision:

Precision expresses the likelihood that a genuine prediction will be right in a given percentage of the time [10]. In order to obtain precision, takes the TP in the numerator and adds the TP and FP in the denominator.

Precision = TruePositives / (TruePositives + FalsePositives)

5.2 Recall:

It indicates what percentage of true positive values are correctly categorised by the classifier [10]. In order to reach the recall result,) takes the TP in the numerator and adds the TP and FN in the denominator.

Recall = TruePositives / (TruePositives + FalseNegatives)

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5.3 F1-score:

It is the harmonic mean of Precision and Recall, which is calculated from the number of mispronunciations recognised by both the machine and the human evaluator [11]. The F1 score is calculated using by multiplying precision and recall by 2 and dividing by the sum of precision and recall.

F-Measure = (2 * Precision * Recall) / (Precision + Recall)

6. Discussions

Machine and Deep learning algorithms are incredibly effective in a variety of ways, and they have the ability to recognise a helmet in an image or video. On each dataset, four models are used in this approach: modified model (CNN), SVM, KNN, and decision tree.

Table 2. Comparison of Model on the basis of validation accuracy

CNN Model	Accuracy
Decision Tree	85.27%
SVM	97.27%
KNN	93.45%
CNN	99.1%

Based on comparative analysis Table 1 represents that Support Vector Machine and K-Nearest Neighbour have higher validation accuracy i.e 97.27% and 93.45% respectively as compared to Decision Tree which obtain an accuracy of 85.27%. But Modified is performing very well among the other models

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7. Results

In this paper, the data is trained on Decision Tree, Support vector machine, K-nearest neigbour and convolutional neural network mode. Among all, modified CNN model has been employed, which gives 99.1% validation accuracy throughout the training process as compared to other transfer learning models in classifying persons with or without helmets which we have discussed in section 5 on the basis of evaluation metrics. In Fig.5 The underneath graph portrays the highest true positive rate with the lowest false positive rate using the modified Modified model.

Fig.6 depicts the accuracy result of the trained Modified model, and in Fig. 7, the graph portrays the accuracy and loss of validation data and training data over only fourteen epochs and the graph also manifests that as the epochs are increase, the accuracy gets better and the loss gets decreased over the increasing epochs which means the model is performing well.

Based on the Model's performance, Fig.8 shows the result related to the person wearing the helmet, whereas Fig.9 represents the results related to the person without the helmet, Fig.10 Results of motorcyclist Number plate whose riders are without helmet. These predictions are done using cv2.VideoCapture (0), which helps in capturing the videos using the webcam.

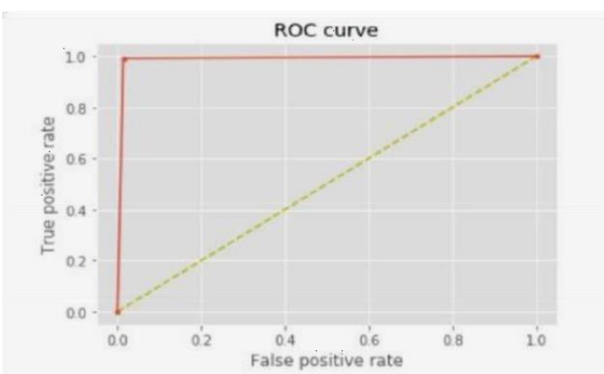

Fig. 5. The receiver operating characteristics curve (ROC) of the Modified classifier.

Fig. 6. Screenshot of Classification report of trained Model

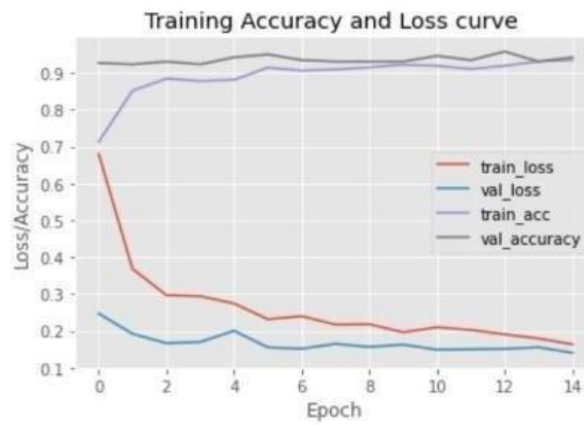

Fig. 7. Graph of training Accuracy and loss

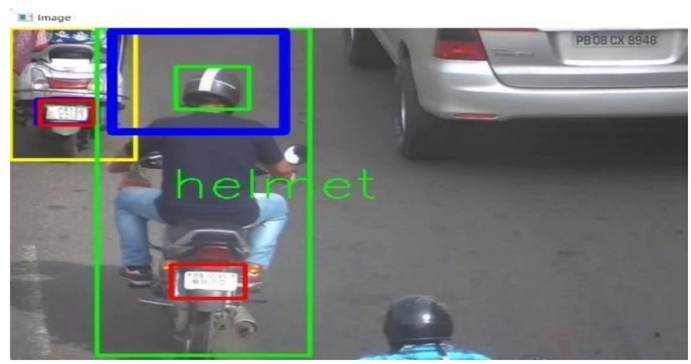

Fig. 8. Results of person a helmet

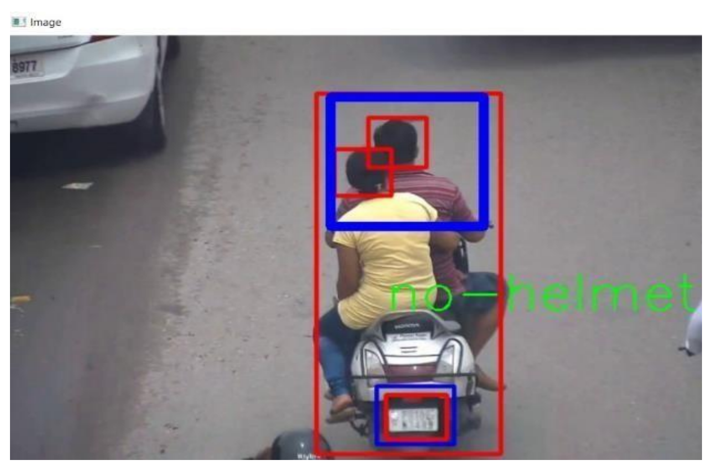

Fig. 9. Results of person without a helmet

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Defaulters Number Plate
PB 10 GF 2816
PB 10 EN 3439
PB 43 C 7737
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Fig. 10. Results of motorcyclist Number plate whose riders are without helmet.

8. Conclusion

For a given stream of video as well as picture input, the system used here enables thorough and accurate helmet detection and licence plate recognition against the given dataset. Despite the fact that a variety of similar initiatives have been proposed using various combinations of machine learning algorithms, the accuracy of practically all of them varies. Some are better at some tasks than others, which makes the system inefficient. We used CNN for helmet detection and a mixture of Character Segmentation and CNN for licence plate recognition, which balanced the accuracy of both tasks and produced better results. The License Plate Recognition (which is accurate in most of the proposed models) is affected by video quality, day and night light effects, and other factors.

The accuracy obtained for the Decision tree classifier is 85.27%, for the Support vector machine is 97.27%, the K-nearest neighbor is 93.45% and for Convolutional Neural Network is 99.1%. In the future this system could be modified for helmet detection and license plate recognition using better equipment and advance deep learning algorithm.

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