AUTOMATIC DETECTION OF HELMET VIOLATION

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Abstract - *Riding motorcycles without wearing a helmet is the violation of an important traffic rule – 'Mandatory Wearing of Helmet by motorcyclists'. The mortality rate is higher in two-wheeler accidents as compared to that of others. The current systems include conventional methods that involve police officers observing violators by patrolling the roads or via traffic surveillance cameras. This requires a lot of time and manpower. It is impossible to catch and impose fines on every violator using these methods. This paper proposes a method for helmet detection and license plate recognition to detect and identify the two-wheeler riders without helmet and thereby penalizing them. Object detection using YOLOV4 is the main concept involved. Object detection is performed at different levels to identify the helmet law violator and their license plate number. Using a License Plate Recognition API, the license plate number is then extracted. A database is maintained that consists of details of two-wheeler owners. An email consisting of violation details and a link to pay the penalty is sent to the helmet law violators. An interface is developed using Tkinter that can be used by the administrative officer to check for violators in the videos provided as input and also to monitor the entire process.*

Key Words: **Yolo, Yolov4, Tkinter, SQLite3, OCR**

1.INTRODUCTION

In the current situation, we come across various problems in traffic regulations in India which can be solved with different ideas. Riding motorcycles without wearing a helmet is a traffic violation which has resulted in the increase in the number of accidents and deaths. Travelling on a motorcycle carries a much higher risk of injury and death than driving a car. In fact 60% of all Traumatic Brain Injury (TBI) is caused by Road Traffic Accidents (RTA). In account of the number of accidents, India is ranked third in the TBI research output in Asia. In order to reduce the number of accidents, various measures have been adopted to keep a check on the traffic law violators. Most of these methods are manual and require a lot of manpower and time. Automation of these processes will aid its effective implementation. The significance of automated frameworks in traffic control has been expanding in the ongoing years. This will improve the use of a traffic flow system, which in turn would compel them to adhere to the rules and regulations. The best possible solution is to build an artificially intelligent framework that can be mechanized to perceive this sort of issue without human cost. We need methods to distinguish the bike and rider from the video frames in order to recognize riders without helmets. Further, we need to recognize an area of the biker's head and classify whether the rider is wearing a helmet and extract the license plate of these traffic law violators. The objective of this paper is to propose a method to detect riders without helmets using pre-recorded videos which could be developed in future into a system that does continuous surveillance on the motorcyclists.

2. RELATED WORK

Kunal Dahiya et al.[1] proposed an approach in which detection of bike riders are performed from surveillance videos using the methods of background subtraction and object segmentation. Then it uses histogram of oriented gradients (HOG), scale-invariant feature transform (SIFT), and local binary patterns (LBP) for classification.

Practical safety helmet wearing detection method based on image processing and machine learning [2] used the ViBe background modelling algorithm to detect motion, followed by HOG and SVM and colour feature recognition to detect safety helmets.

Various existing methods proposed approaches that employ CNN algorithms, SVM classifier, OCR[3][5] to detect helmet law violators and their vehicle's license plate to send SMS to these law offenders.

Another existing method uses YOLOv2, YOLOv3[4] to detect helmet law offenders and to identify them by extracting their license plate number. This method takes video as input and frames are extracted from this to perform detection.

3. STATE OF THE ART

3.1 Yolo

You Only Look Once (YOLO) is a real-time object recognition system that can identify multiple objects in a single frame. Up to 9000 classes and even unseen classes can be predicted. It is based on a single Convolutional Neural Network (CNN). The CNN divides an image into regions and then predicts the boundary boxes and probabilities for each region. During training and testing, YOLO views the whole picture so that it indirectly encodes contextual details about classes as well as their appearance. It applies a single neural network to an entire image and performs all detections at once. It recognizes objects more precisely and faster than other recognition systems.

3.2 Yolov4

YOLOv4 is a real-time object detector that can detect multiple objects in an image, predict the classes of the detected objects, and to identify the location of the objects in the image without the loss of too much accuracy. It is faster and more accurate than YOLOv3, as it has the accuracy and FPS increased to 10% and 12% respectively when compared to that of the latter. Moreover, it can process videos in 65 FPS and is trained in COCO dataset by default. The architecture of YOLOv4 consists of 4 stages: input, backbone, neck and head. The input stage is to feed in the images. The backbone stage is to extract the features using a feature map. Among the feature extraction models (like ResNet, DenseNet etc.), CSPDarkNet53 has given more optimal results after experimentation. It is used to enhance the learning capability of CNN. The backbone stage also contains Bag of Freebies (BoF) to increase the cost of training leaving the cost of interference low, and Bag of Specials (BoS) which significantly improve accuracy. The neck stage contains the extra layers that go in between the backbone and the head. It is used to extract different feature maps at different stages of backbone. Spatial Pyramid Pooling (SPP) is added to increase the receptive field and separate out the most significant context features. It is used as it produces a fixed length output size regardless of the input size given. The head stage contains YOLOv3 for sparse detection and is incharge of actually performing the object detection.

3.3 TKINTER

Tkinter is one among the most commonly used Python's Graphical User Interface(GUI) programming toolkits. Python when combined with Tkinter provides a fast and easy way to create GUI applications. Tkinter provides various controls such as buttons, labels and text boxes. These controls are commonly known as widgets.

A tkinter app can be created easily by importing the tkinter module, then creating a main window followed by adding widgets to this window and applying event triggers on them.

3.4 Optical Character Recognition

Deep text recognition can be implemented by using a feature extractor ResNet or RCNN with a sequence processing model BiLSTM which effectively increases the amount of information available to the network, improving the context available to the algorithm. A model with an accuracy of almost 100% is required for the recognition of license plates. Training requires images of license plates with a wide variety of fonts used in license plates and shape of the license plates available within the country. Image dataset should be as large as possible and the training iteration should also be a higher value in order to increase the accuracy of the model. For instance, a dataset containing a minimum of twenty-thousand images and three lakh training iterations could make an accurate model. 98–100% accuracy is considered ideal for the recognition of license plates.

3. PROPOSED SYSTEM

The main objectives of the system are to reduce the number of helmet violation cases, continuous surveillance of motorcyclists without helmet, generation of email and storage of violator details with little or no manpower.

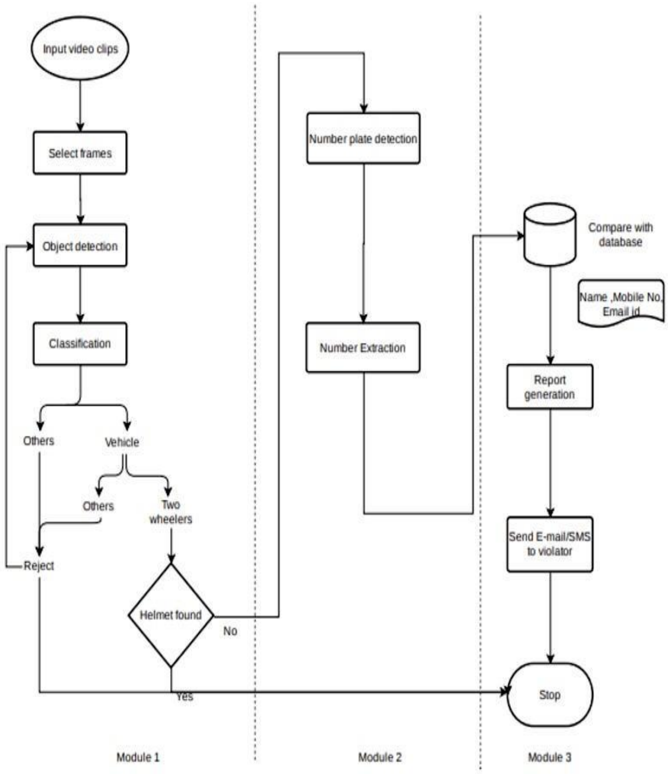

Fig -1: Architectural Diagram

In this system, video input is fed to the YOLO algorithm to determine whether motorcyclists are wearing helmets or not. The object detection is performed at three levels. Firstly, a motorcycle(s) with a person on it is identified and then the helmet is detected. If the model identifies that the person is not wearing a helmet, then the license plate recognition is done. All these stages are implemented using YOLOv4. After object detection, the number plate of the vehicle is extracted using an Optical Character Recognition. API. The cropped image of the license plate is fed to the OCR. The extracted number plate is compared with information of motorcyclists stored in a database using SQL queries and an email consisting of violation details and a link to pay the penalty is sent to the violator. The admin monitors this entire process using an application. This application uses the Tkinter interface. It provides a way to enter the vehicle owner details into the database, upload video for checking the violators, showing details of violators and notification of email being sent successfully to the law offender. This application can only be accessed by the admin and is password protected.

4. IMPLEMENTATION

4.1 Collection of Dataset

Images of custom classes: 'person_bike', 'no_helmet', 'helmet' and 'license plate' can be collected from sources like Kaggle and Google Open Images Dataset. A minimum of 700-1000 images are needed to minimize the loss while training. Annotation for every image in yolo format should be done and saved as a .txt file with file name same as the corresponding image. Manual annotation can be done with the help of LabelImg, a graphical image annotation tool. A dataset for each class contains images and the same number of .txt files containing the coordinates of the bounding box. A total of four dataset is prepared and is fed to the training system.

4.2 Training the model

The first step is to enable the GPU within a laptop or desktop. Then clone and build Darknet, enable OpenCV and GPU for darknet. After that the pre-trained YOLOv4 weights are downloaded. It has been trained already on the COCO dataset which has 80 classes that it can predict. These pre-trained weights are used so that YOLOv4 can be run on the pre-trained classes and obtain the detections. These also help in training the first few layers to extract generic features from the images. Now only the last few layers need to be trained for our specific use case. The next step is to run detections with Darknet and YOLOv4. Then custom files should be configured accordingly for training. Further download the pre-trained weights for the convolutional layers. Finally, train the custom object detector and test it.

4.3 Detection

The Darknet model is converted into TensorFlow framework to support single GPU usage and to achieve proper optimizations. The weight files acquired from training are used to infer the saved model's prediction box and confidence scores. The bounding boxes are obtained for frames with crop rate set as required. From these cropped frames, no helmet class is selected and then the license plate of the motorcycle is detected.

Fig -2: Detection at different levels

4.4 License Plate Recognition

Crop the YOLOv4 detected license plate image to sub image and resize it. A license plate recognition API or a deep text recognition OCR model with an accuracy of about 100% can be used to segment out individual characters and numbers. It recognizes characters, appends them together and produces a text string. The output is compared with the database containing vehicle owner details to find a match.
The correct recognition of each character in the license plate is crucial as this ensures that the violator is penalized indubitably.

4.5 Database

Storing information in DBMS is much more robust than using a '.txt' file. SQLite3 is a lightweight disk-based database system that can be implemented easily and gives the advantages of a RDBMS. Vital information like Name, License Number, Email and Phone number of individuals are to be stored in the database. Login credentials along with encryption of passwords can be used which gives an advantage of secured storage.

Violator's plate number can be cross-checked with the database containing every two-wheeler's entry. Retrieval of full detail about the violator can be done. Entries of every two-wheeler can be stored in DBMS as it supports a large number of records.

4.6 Application Interface

The interface is created using Tkinter GUI. It contains a homepage, login page and registration form. It also includes a page to upload the video and a page to display the list of violators. An administrator can register and login to upload and process video(s). After processing, the violator's list is displayed. Meanwhile, an email is delivered to the violator, the application shows the list of helmet law violators identified in the input video with messages indicating successful detection and extraction of the license plate of violators. These violators will be notified via email comprising their penalty details.

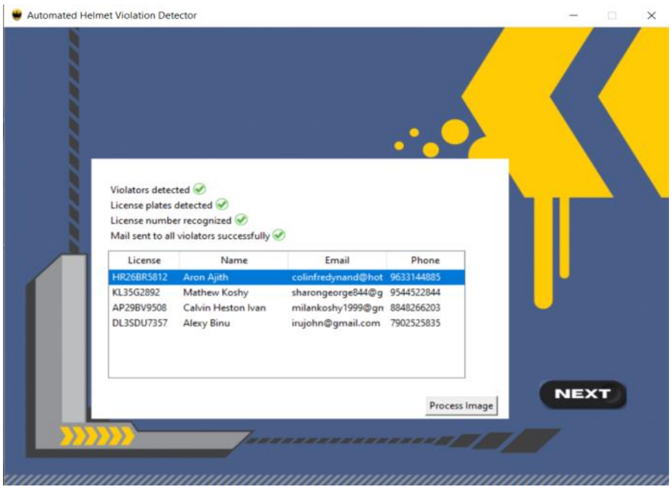

Fig -3: Violator Details

4.6 Email and Payment

An email sent to the violator that comprises their violation details. It embeds a payment link, that redirects to the Razorpay payment gateway, the violator can utilize this to pay the fine. Here the vehicle owner has to enter their 'name', 'email', 'phone number' and make necessary payments using any of the online payment methods available. Contact details have been provided in case of any assistance needed. On successful payment, an email will be sent to the payer which contains a downloadable payment receipt.

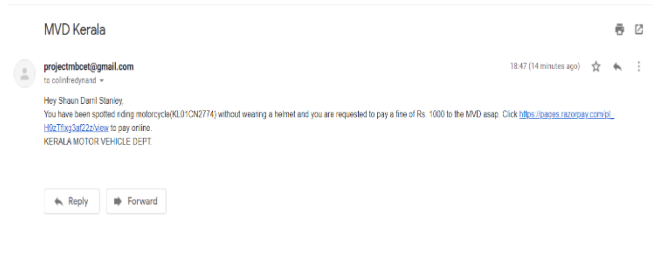

Fig -3: Email

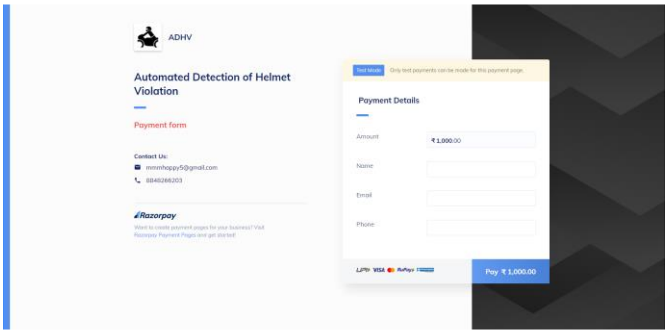

Fig -4: Payment Gateway

5. CONCLUSION

This paper mainly focuses on detecting the violation of an important traffic rule - 'Section 129 Mandatory Wearing of Helmet by motorcyclists'. The input of our application is a set of pre-recorded videos of two-wheeler riders. Eventually this application can be integrated with the traffic surveillance cameras to perform real time detection. This system can also be improved by enlargement of the database with the details of all two-wheeler owners in India. The dataset could be extended to include images that can avoid erroneous detections, like misinterpreting a cap or a scarf as a helmet, to detect helmet law violators riding at night time and also to identify any pillion rider without a helmet. SMS feature also can be added along with email in the future to notify the violator. This model could further be improved in terms of speed and accuracy.

Nowadays, there is a tremendous increase in the number of road accidents. The mortality rate is higher in case of two-wheeler accidents. The law of wearing safety helmets was mandated to safeguard the life of people from these fatal conditions. Although manual methods exist to ensure that people abide by the rule, they trail behind when it comes to efficiency. Automation of this process can aid in the accurate and systematic imposal of fine on the law offenders. In this paper, we have put forward a method to identify two-wheeler riders travelling without helmets automatically, and to find an efficient way to penalize them. This model can be developed further in future to ensure that the society truly benefited from this and people are persuaded to wear helmets while riding motorcycles

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