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A Cascade Classifier Based Approach on Enhanced Safety of Motorcyclist

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Abstract - In India, the motorcycle is a popular means of transportation for a daily commute. Motorbike accidents have been rapidly increasing throughout the years.1214 road accidents occur every day in India. Two-wheeler accounts for 25% of total road accident deaths. According to the Motor Vehicle Act, every motorcyclist ought to wear a helmet while riding and avoid riding triples/quadruples or more on two-wheeler. The helmet is the prime safety equipment of motorcyclists but many drivers ignore it. If motorbike riders ride without wearing a helmet, an accident can be fatal. The maximum load for motorcycles averages at 120-140kg (which is nothing but the average weight of two people). When we overload, the center of gravity will be uncontrolled and the rider could easily lose the balance. The traffic control unit tried to control this issue manually but it is insufficient for the real situation. The ideal solution is to develop a smart helmet detection system that can be automated to recognize this kind of problem without human cost. Our proposed model recognizes moving objects using background subtraction and object detection from the surveillance video in real-time. The helmet images are trained using cascade GUI trainer.The motorbike is detected using Single Shot Multibox Detection Neural Network Approach and the triple/quadruple riders are detected using boundary identification obtained from morphological processing. The helmet and non-helmet riders are also classified using a machine learning approach called Haar Cascade classifier Neural Network Approach. The detected violator images along with their number plate image segmented from the binary image are sent to the traffic control unit through electronic mail.

***Key Words*: Cascade GUI Trainer,HaarCascade classifier, Haar feature extraction, *Single Shot Multibox Detection (SSD),morphological processing*.**

1. INTRODUCTION

In India and other developing countries, the motorcycle is the convenient mode of transportation and cost-efficient compared to four-wheeled cars. [12]According to statistics taken on motorcycles, it accounts for an increase from the previous number of 168,975.000 Units for Mar 2016. India's Registered Motor Vehicles averaging 7,739.000 Units from Mar 1951 to 2017, with 61 observations. However, there is an increased risk of riding a motorbike without prescribed safety measures. Motorbike accidents have been rapidly increasing throughout the years. According to the National Highway Traffic Safety Administration (NHTSA), In 2017, 5,172 motorcyclists died in bike crashes. Two-wheeler accounts for 25% of total road accident deaths. According to the Motor Vehicle Act, every motorcyclist ought to wear a helmet while riding and avoid riding triples/quadruples or more on a two-wheeler. When a motorcyclist meets an accident the rider thrown away due to sudden deceleration. If the head strikes an object causing severe damage to the brain or inner part of the skull. A helmet reduces this risk of head injury by the impact of a collision is observed by the cushion inside the helmet the metal head also spreads the impact to larger area these lower the risk of severe injury this can be achieved only by good quality helmets other major problem for a motorcycle accident is overloading of vehicle. The maximum load for motorcycles averages at 120-140kg (which is nothing but the average weight of two people). When we overload, the components of the bike such as suspension and engine might act weird. The vehicle's structural rigidity will be stressed out. The center of gravity will be uncontrolled and the rider could easily lose the balance. Thus traffic rules are framed to bring a sense of discipline. [14]Under Section 194D, helmet-less riding will attract a fine of Rs. 1000, along with the 3-month suspension of license. Under Section 194C, riding a two-wheeler with more than two passengers (overloading) will be fined for Rs. 2000, along with the suspension of license for 3 months.A surveillance camera is fixed and monitored manually by police officials but this needs lots of concentration and human resources. Cities with a huge population and vehicles cannot afford this inadequate manual method.

Thus we propose an automatic method of helmet and triple riding detection using a machine learning algorithm. Our proposed model first input the video buffer frame and perform background subtraction to extract all moving object. Then the images are fed to pre-trained machine learning classifiers to classify motorcycles and non-motorcycles. The motorcycle image obtained is cropped for the head part and morphological processing, Boundary identification to counting heads for triple/quadruple rider detection. Further, it is fed to classifier for helmet detection the detected violator's images along with their number plate image of the vehicle are sent to the traffic control unit through the mail for further investigation.

2. RELATED WORKS

Computer vision provides a wide range of applications to extract information from an image/video source. To obtain particular data need lots of filtering algorithm to remove noise from the video frame.

The first proposed system for automatic motorcyclist helmet detection as done by [1]Chiverton. Motorcyclist head portion is cropped and the feature is extracted from this image and trained on an SVM Classifier. The Shape and illumination property of the helmet is extracted. The circular arc method strategy with the Hough Transform is utilized to detect helmet. The shape is only feature extracted from the image this leads to misclassification between the helmet and the other circular objects.[2]Chen et al introduced a significant way of tracking and classifying vehicles in urban rush-hour roads using Gaussian mixture model. This system utilizes a Kalman filter and further classification is done using the dominant part voting. [3]Chiu and Ku et al formulated algorithm based on aspects ratio and pixel ratio to classify motorcycles by detecting the helmet through features.[4] [5]Romuere silva et al proposed a method for extracting features using LBP descriptor, HOG and hough transform.[7]Xinhua Jiang et al integrated a Grey level co-occurrence matrix along with LBP.YOLOv2 and COCO data set are utilized to detect and classify different types of objects. Jie Li et al used SVM based on the HOG (Histogram of Gradient) feature to classify. Motorcycle vs motorcycle and helmet is detected using hough transform based on color and geometric shape. Kang Li et al performed color space transformation and feature discrimination for helmet detection.[6]Pathasu Doungmala el al used Haar feature extraction to classify half and full helmet. It is performed using a decision tree classifier using AdaBoost. License plate and extracted characters are done using OCR, Open ACPR, Mobilenets, Inception-v3. [8]K. Dahiya proposes a model for both helmet and motorcyclist detection using SVM classifier the features are extracted by HOG, SIFT and LBP. [9]Vishnu introduces a convolutional neural network for helmet classification and motorcyclist Classification.[10]B.V.Kakani incorporates number plate detection with an existing model based on optical character recognition using neural networks. The results of N. [11]Boonsirisumpun experiment were looking good. In the classification step, It is found that MobileNets (85.19%) and Inception V3 (84.58%) achieved better accuracy than VGG16 (78.09%) and VGG19 (79.11%). the best part is the SSD technique can detect these images by using only one single runtime and require no other image pre-processing algorithms.

3. PROPOSED SYSTEM

Our proposed system aims at detecting both helmet and triple riders along with their number plate image from the surveillance video. The video footage obtained from the existing surveillance camera installed on every road. (The captured video is 25fps and image size was of 1280x720). The video frame first background subtracted and motorcycle/non-motorcycle are classified using a deep learning algorithm. Then the binary image vertical projected to count rider heads. The helmet/helmetless classifies the violators and the number plate is segmented and send to the traffic authority.

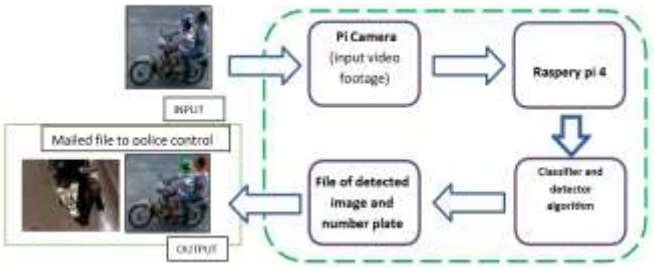

Figure.3.a. Block diagram of proposed model.

4. METHODOLOGY

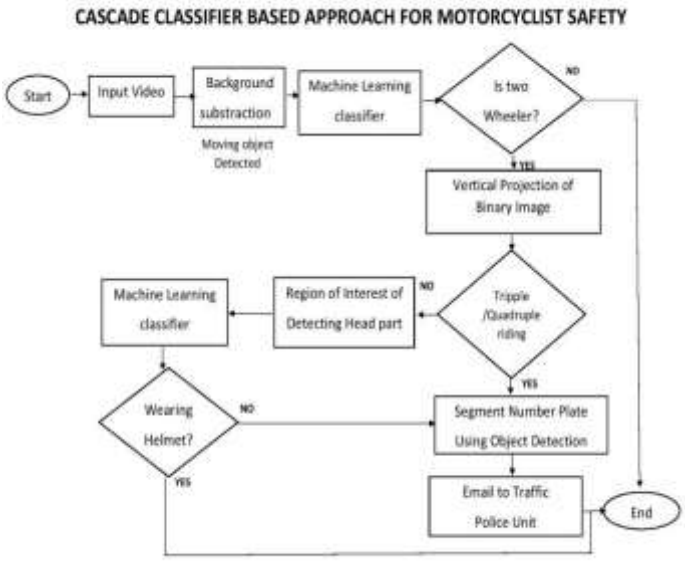

Fig.4.a. Methodology of proposed system.

4.1. Moving Object Detection

The Input Video frame is the first background subtraction to detect the moving object. The video is buffered to obtain a video frame and the Canny Edge detection algorithm is used to identify moving objects. At first, the video frame is filtered using a lowpass filter to reduced noise. The Canny Edge Detection algorithm is proposed by John F Canny is the most widely used algorithm for edge detection of a frame/image. Canny Edge Detection algorithm is applied on each frame and the absolute difference between two consecutive frames is calculated. This algorithm detects the complete edge pixel of the image/frame efficiently. Then Fuzzy C means clustering algorithm segment the pixel along the boundaries of clustering to obtained the moving object from the frame.Then Morphological Operation like median filtering &

Thresholding is carried out to reduce noise and fill gaps to form a coherent blob. The raw image behind the blob (connected region) is extracted.

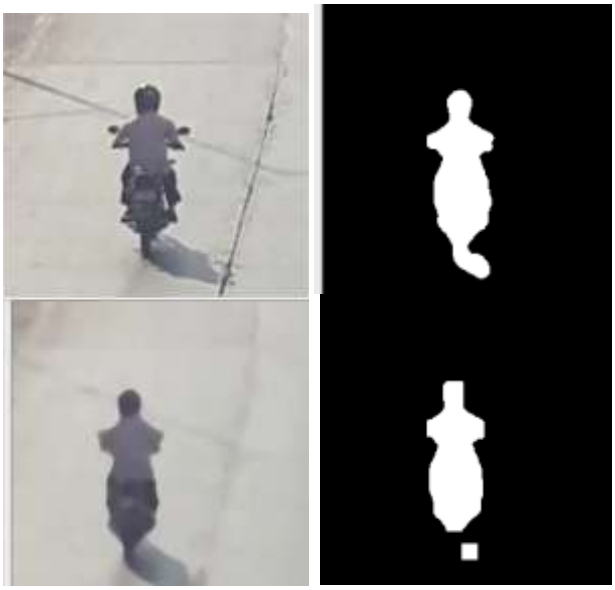

Fig.4.1(a.) fig.4.1(b.)

(a) Input video frame b) canny edge detected image.

4.2. Motorcyclist vs Non-Motorcyclist classifier

The purpose of the project is to detect helmet and triple riders on motorcycle. Thus motorcycle should be detected clearly. This is the challenging problem in image processing. They need several pre-processing techniques like HOG & HAAR. But advancement in SSD and neutral Network technique have promised to process in only one image runtime. The obtained image is fed to Single Shot Detector(SSD) Convolutional Network to detect Motorcyclist/Non-Motorcyclist. This algorithm learns the common hidden feature from the set of trained sample data to differentiate among Motorcyclist/Non-motorcyclist.

SSD(Single Shot Multibox Detector):

Single Shot Multibox Detector SSD is from the deep neural NW model that design to use only one single network to do the task of image recognization at the same time. Single shot multi box detection uses VGG 16 to extract feature maps. It calculates the location and class scores as small convolution filters. After feature map extraction, it applies convolution filter for each cell to make prediction just like regular CNN to detect motorcycle from binary image.

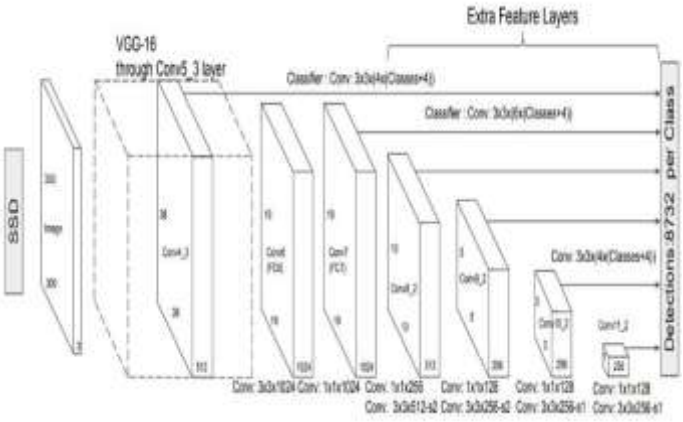

Figure.4.2.a. Single Shot Multibox Detector methodology

4.3. Triple/Quadruple Riders count

To count the numbers of riders of the motorbike, the head portion is counted. The upper 25% of the height of the binary image is taken as a region of Interest(ROI). The following steps are proceeded to count the riders

I. **Vertical Projection of image:** The cropped ROI image is vertically projected and projection profiles are constructed. This is the method of the frequency distribution of head pixels on to the projection line Thresholding is done to reduce noise and smooth curves.

II. **Boundaries Identification:** The second step is to figure the boundaries of the projected profiles of the head from left and right and viceversa. To Identify these boundaries, the profile is scanned along the horizontal line for Pixels change and the corresponding location is noted for avoiding re-occurance.

III. **Head counting:** The number of peaks in the projection profile is the number of riders heads riding on motorcyclist. For this another scan line is used to count the number of peaks. The scanning count the change of pixels from black to white in order to count the valleys of profiles. This gives the rider count and decision algorithm is used to check whether the riders are more than two.

If the rider count is more than two the image along with the cropped license number plate image is attached in the file, and sent to Traffic Control Authority via email, otherwise next algorithm for helmet detection is processed.

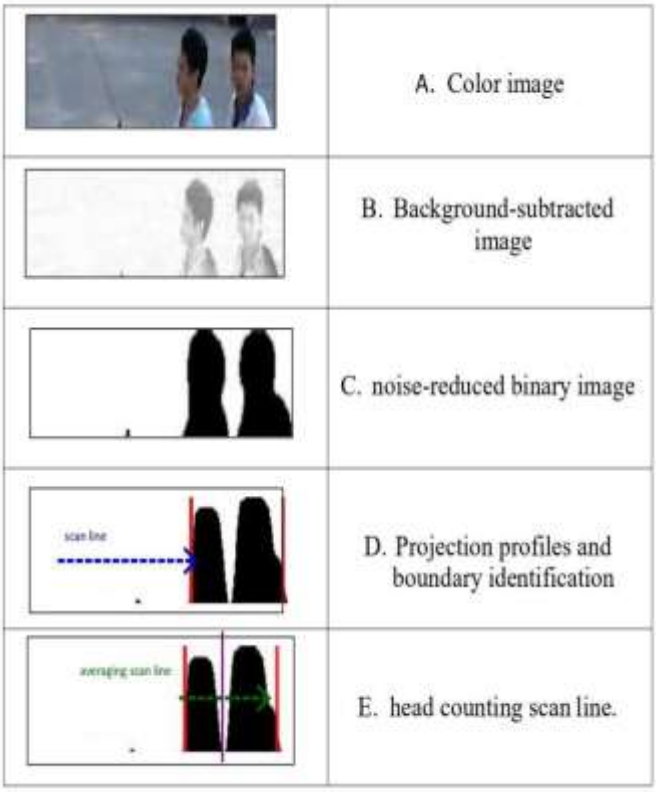

figure.4.3.a.triple /quadruple rider dectection steps.

4.4. Helmet/Helmetless classifier

Haar Cascade Classifier model is used for helmet and helmetless classification. If this classifier classifies the head portion image as non-helmet, then the original motorcyclist image is forwarded for number plate detection, otherwise the image is discarded.

Cascade Classifier: A cascade classifier is a machine learning approach trained from a large number of positive and negative images. It is a popular algorithm to detect faces, body parts in an image and can be trained to identify almost any type of object. This is achieved using a concept called Adaboost which selects the best features and trains the classifiers to use them. The "strong" classifier is constructed as a linear combination of weighted simple "weak" classifiers. The Cascade Classifier algorithm consists of a collection of stages, each stage is a group of weak learners. A huge number of Haar Cascade features are required to describe an object to be detected with satisfactory accuracy and are correlated into cascade classifiers to build a strong classifier. Cascade classifier training is performed using a set of positive samples and a set of negative images. A set of positive images is provided with regions of interest specified as positive samples.

4.5. License plate detection:

If the helmet is not found and the rider count is more than two, license plate detection and extraction takes place. For traning purpose, 100 images were collected. For dataset which were images of bike with their license plate. Then using the labelling tool to segment the image of the license plate.i.e., a bounding box is created around license plate. The information in the bounding box is stored in .xml file with name being same as image name. Then license plate image is extracted and the co ordinates were stored in .json file. The extracted images are attached to the email and sent to predefined mail id.

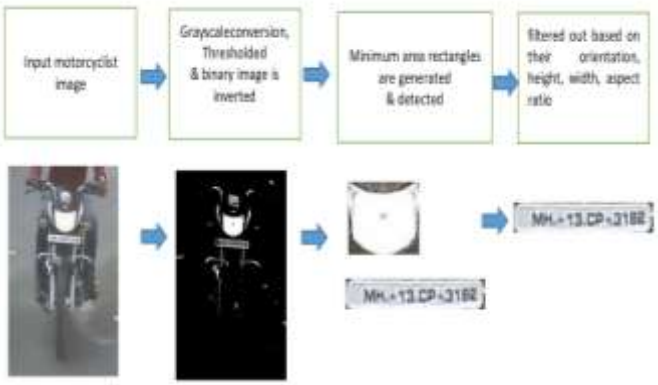

Figure.4.5.a.Initial steps on Number plate localisation.

5. PERFORMANCE EVALUATION:

The system uses python-2.7.12 for computer vision and image processing along with the libraries such as OpenCV-3.3.0. For building backend, CNN TensorFlow-1.4.1 is used scikit-learn-0.19.1 for machine learning. The multidimensional arrays, mathematical functions and linear algebra for NumPy-1.14.0. These experiments are required to perform on a 64-bit Windows 10 operating system. The specifications of the system are 4GB RAM, 4 Intel PENTIUM quad-core processors and no GPU.

The dataset requires 200 images for training purposes. In this dataset 150 images are needed for training motorcycle images and 150 images are required for training non-motorcycle images. A total of 100 images is used for testing purpose. Then 80 images are with motorcycles and 20 images are without motorcycles. Out of 80 images, 50 images are with helmet and 30 images are without a helmet. As shown in the table, out of 80 motorcycle images are used for testing, 70 images were correctly detected as motorcycles. For motorcycle versus motorcycle classification, out of the total 100 images used, 70 images were correctly identified which gives an accuracy of 87.5%. Out of 50 images with helmet, 35 images are correctly detected as "helmet detected", out of the 30 images without a helmet, 15 images are correctly detected as "no helmet detected" that makes the helmet vs non-helmet classification which gives an accuracy of 70%. From fig.5.a. the output of this model is the mail with attachment file of offender's image and number plate image.

Figure.5.a. Attachment image of the mail(output).

CONCLUSION

In this paper, we developed real-time detection of motorcycle riders who are violating the traffic rules by not wearing the headgear, over-riding and automatic retrieval of vehicle license number plate for such motorcyclists. A canny edge detector, cascade classifier, single-shot multi-box detection, and morphological processing has helped in achieving good accuracy for detection of moving object, riders not wearing helmets and their counts. The system also segments the number of plates of their motorcycles and sends mail to the traffic control unit to get information about the motorcyclists from their database of licensed vehicles. Concerned motorcyclists can then be penalized for breaking the law. The accuracy can be improved by increasing the cascade GUI trainer.

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