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APPLYING MACHINE LEARNING AND OBJECT DETECTION FOR IDENTIFYING TRAFFIC RULE VIOLATION: OVER SPEEDING

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Abstract: **We have observed that traffic offences are manually inspected by the traffic department in many developing nations, such as India. Such systems enable traffic management and traffic law enforcement. Following this, the present study focuses on Traffic violations as one of the key issues hindering the efficient operations and safety aspects in the urban traffic area. Currently, traffic violations are controlled using enforcement measure that demands a high manual workforce, and resource which entails high economic cost. Contrary, the use of automatic traffic violation detection systems in many of the urban cities of the developed and developing countries is being implemented for a higher degree of traffic enforcement and adherence to the traffic operation rules. Following this the present study focus on the applicationof machine learning for automatic traffic violation detection for weak- lane disciplined mixed traffic conditions. The resulting exhibit that the developed model can detect traffic violations of over-speeding at an accuracy of 95%. The traditional methods like speed camera use the basic principle of the Doppler Effect and RADAR technologies but at present, Due to their drawbacks which vary from the expense of purchasing equipment, increase in work and labour costs, and lack of monitoring, they are ineffective. As a result, it is a straightforward, affordable, and practical speed detecting method in Mixed traffic conditions. So here, we prefer automatic speed violation detection. The suggested solution will be highly accurate and cost-efficient.**

Keywords: **Mixed traffic condition, Traffic violation, Object detection, Automatic traffic violation, Traffic Enforcement**

I. INTRODUCTION

Background

Road safety is a rising health risk and one of the main reasons why people die. India ranks first in the total number of road traffic deaths observed. According to Road accident report by Ministry of Road Transport and Highway of India, 1,15,451 road accidents and 47,670 road accident deaths were caused due to traffic rule violations (MoRTH 2020). To overcome this issue for road safety there is a need for proper addressing (strict traffic enforcement) to minimize road accidents. Currently in India, traffic enforcement and violations of rules is still monitored by manual ways mostly (traffic police) equipped with speed measuring equipment's like speed radar guns. Alternatively, video cameras are installed, through which operators monitor for traffic violations like red-light running and helmet adherence. However the task is still labours, and more than often offenders are not adequately punished and hence resulting in weakenforcement. The availability of man force per capita at highly populated metropolitans like Delhi, Mumbai (Bombay), Kolkata (Calcutta), and Banglore it's virtually impossible to detect all the violation physically by RTO official on road. With advent of technological advancements like machine learning and computer vision many different detections and tracking technologies are being used to detect various traffic violations like helmet detection, speeding, wrong lane driving, Unsafe Lane Changing, Texting while Driving, etc. Still, in many places, traditional techniques like detection of speeding and helmet violations detect physically by the officers on the road are being used to minimize the traffic violations on road. Road accident report (2020) states that from the reported accidents due to traffic violations, 75% of the accidents and 69% of the deaths were due to over speeding vehicles. From However, the dominant limitations of this traditional way of monitoring traffic violations are that it is very time-consuming and keeping in mind all these issues that are faced, the current purpose of study is to provide a remedy for this problem by simply automating the process of detection and identification of traffic violations by the passing vehicles. To understand the speeding violation, it is apparent that most of the over-speeding of vehicles is done on the vacant road where there is no traffic police present. Speed Detection of vehicles is done by using Object Tracking with the help of OpenCV also the system will detect the vehicles and capture the images and mark them if anyone violates the permitted speed limit. In the future these systems can be combined with high-end robust cameras to detect othertraffic violations also.

II. LITERATURE REVIEW

Over the years, several automated traffic violation detection systems have been developed to facilitate robust traffic enforcement. Vehicle Tracking and Speed Estimation of moving vehicles proceeded toward in order to determine the speeds of the vehicles travelling on the road, a study in 2009 was done to construct a vehicle speed recognition system from a video [1]. Also prosperous in their job enough in calculating vehicle speeds, but because to the system's poor functionality and effectiveness, the system was ineffective for real-time use. Additionally, it takes a lot of time to compute. The system has paucity whereas a more effective system can be made using the method.

A succinct analysis of vehicle detection and tracking methods is provided, the authors presented a conciliatory overview of analysis tools and image processing methods used to construct these previously referred to applications are used in constructing traffic surveillance infrastructure. More specifically, and in opposition to other reviews, for more explanation and to better describe the traffic systems, they have divided the processing techniques into three groups. Vehicle detection, tracking shadow and classification, along with traffic surveillance. Using data acquired from the separation between the ends of the front and rear tyres, this technique validates the size characteristics of automobiles. Beneath the vehicle' shadow to indicate the extant vehicles with in highways. In this research paper, the data is presented as pictures of traffic flow taken from a camera mounted in a low-lying area, like a roadside or pedestrian walkways, etc. Because it is utilised to create and enhance a backdrop image, this technique also provides accurate vehicle detection, Aside from that, estimating and upgrading the value of the automatic background-subtracted threshold of photos[2].

Vehicle Number Plate Detection and Speeding Radar uses a radar system to calculate the speed of a vehicle through a radar gun and radar detector. This system gets cosine error when the direction of the radar gun is not on the direct path of a vehicle also this system is very costly and it only gives the speed of those vehicles which is within the radar limit. The justification of the automobiles' speed tracking [1]. They created a system that detects and edge detection was used to track the vehicles. However, the Speed they determined was not particularly precise. Additionally not appropriate for real-time purposes because of more number of approaches to image processing. This approach comprised Morphology procedures and background subtraction, and noise removal, can result in numerous calculations. As a result, it is impossible to implement this system in a real-time environment.

The Vehicle Detection and Tracking Techniques using the Images of vehicle traffic movement captured by a camera installed in a low location, such as a walkway, the side of the street, etc. Moreover, this technique creates and enhances a backdrop image, which allows for precise vehicle detection, additionally, approximate and modernizing the automatic background subtraction image finalisation threshold value.

Video-Based Traffic Violation Detection System, this paper is used for traffic rule violations that help us to reduce manual work and control traffic but this system is not easily manageable and has a lot of complications regarding implementation and output. This system is created to reduce the traffic flow and help the officers to work efficiently but it doesn’t come in use for real-time issues as it is never implemented. In this system they are using a radar system if the vehicle is on the radar then only it will get checked and only one at a time. This is the limitation that they have faced in this system.

III. METHDOLOGY

For automated over speeding detection, the present study, uses field recorded video traffic data of an urban road with low to medium density of vehicles is used. Images of vehicles are cropped and extracted from the video for training purpose. The steps towards completing this are explained further.

REGION OF INTEREST

The region of interest is to be defined for the purpose of identifying the vehicles and determining the vehicle's speed. The suggested method is based on video obtained from a single forward-facing, standard optical camera. The approach is to first extract information about objects moving in the field of view of the camera, then to further process this information to determine which regions contain objects that may pose the “Regions of Interest” [3]. The flowchart in Figure 1 shows the different stages of the algorithm. The components of the algorithm are described further in the following sub-sections.

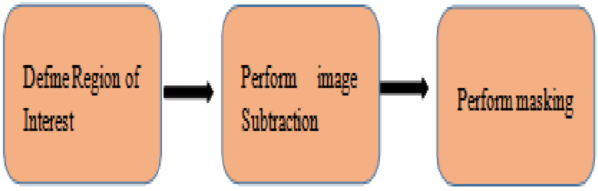


Fig.1. Flowchart of Algorithm

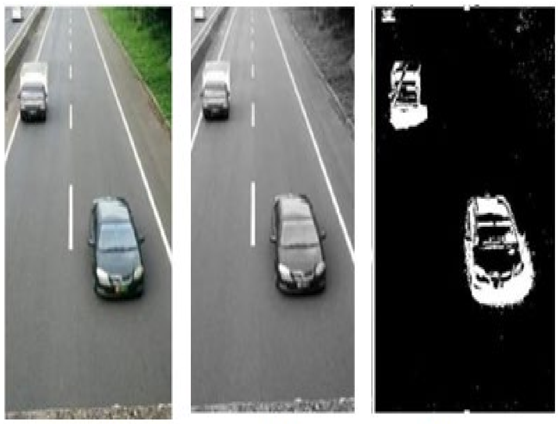
MASKING

Region of Interest (ROI) takes a smaller portion of the original video. There are two regions: the regions you are interested in and the region you are not interested in. If you want to mask out the region that is the region you are not interested in, then complement the mask of the ROI [3]. On this ROI, Image subtraction is carried out to find a moving vehicle. Masking is performed to make the moving vehicles appear white and the rest of the image black. This method has a weakness because it relies on identifying the object at various points in time rather than tracking it.

Fig.2. Masked Image

BACKGROUND IMAGE SUBTRACTION

A common machine vision method for separating foreground items is removing the backdrop from a picture. These areas of interest could be extracted to provide more contextual information about an image. In scenarios where the image capture cameras have a constant focal length, this strategy is helpful, and Don't tilt or pan, so maintaining the camera's focus on a moving foreground and background. There are a variety of methods for removing the best backdrop from the incoming image stream to retrieve the desired objects so that they can be processed further [3].



(a) (b) (c)

Fig.3. Steps of Image subtraction

In Fig. 3. Image Subtraction for counting (a) Original Image, (b) Grayscale conversion from RGB, and (c) Subtraction of background. Here, Vehicle detection was automated by using the pre-processing steps, conversion of greyscale to binary with background subtraction, and operation of the morphology as depicted in figure 3.

IV. COUNTOUR DETECTION AND OBJECT DETECTION

Contour is a characteristic of an imagery object, and hence, computer vision experts have trouble detecting it. Fundamentally, completing practical tasks requires contour detection techniques, that is scene understanding and object identification. Numerous researchers have continuously researched the issue up until this point, and have achieved notable successes [4].

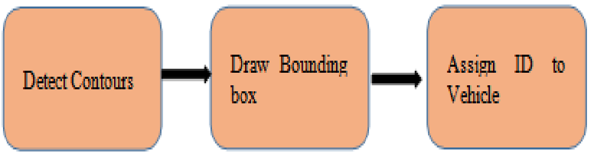


Fig.4. Flow chart of Object Detection Algorithm

DETECTING CONTOUR AND DRAWING BOUNDING BOX

The threshold is used to avoid detecting contours of smaller moving objects that are not vehicles. Based on the area threshold of several pixels, the contours are detected and the object is tracked based on the distance between two contours between frames. An ID is assigned to each contour as shown in Figure 5.

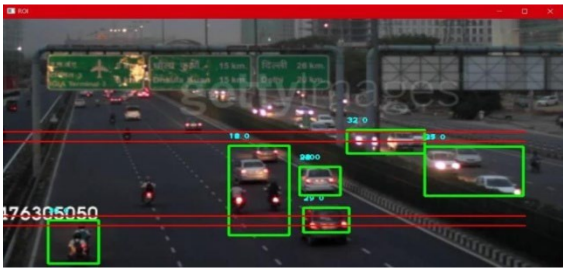
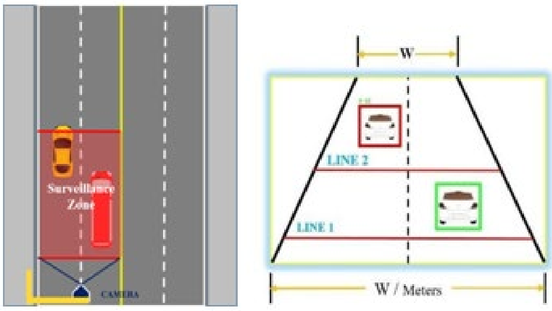


Fig.5. Contour Bounding Box Detection

SPEED ESTIMATION

The process of locating and tracking vehicles, whose actual speeds are subsequently calculated, is known as vehicle speed estimation. Typically, the task is assessed based on the recall and accuracy of the observed vehicle tracks. Along with the mean or median errors of the predicted vehicle speeds. The delay in between time the position of an automobiles is calculated and the speed is calculated based on the formula. When the vehicle reaches the first line, the timer begins, and when the vehicle crossed the second line, the timer stops. According to Fig. 6.



(a) (b)

Fig.6. Diagram for (a) Surveillance Zone and (b) Speed Estimation

As shown in Fig. 6. The area between the Line 1 and line 2 is the surveillance Zone where the calculations are takes place for estimating the vehicle speed, and Line 1 is the entry point of the vehicle and Line 2 is the exit point of the vehicle. When vehicle crosses the Line 1 the timer for speed detection is started as soon as the Vehicle crosses the second line which is Line 2 the timer ends and the speed is estimated based on time.

For estimating the vehicle speed we use this Speed Formula in our Program:

```
def getsp(self,id):
if (self.s[0,id]!=0):
s = 214.15 / self.s[0, id]else:
s = 0
```

Here, 214.15 is the number we got based on the Distance Calculation and based on the Frame rate [2]and estimation by utilizing the frame count, the vehicles' speed is calculated as:

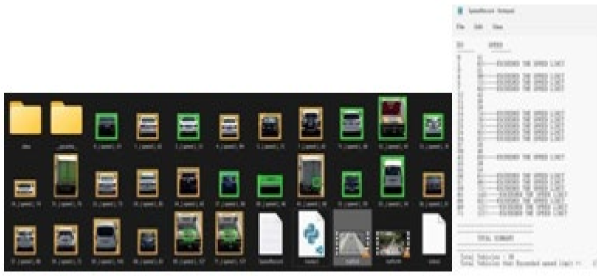
$S = d \times f / n$

Where, n represents the vehicle's frame count, d is the scanning area's length in meters, where f denotes the camera's frame rate in frames per second. Once the vehicles are successfully detected, vehicle tracking begins. Comparing the respective positions of the vehicle's region is the foundation of vehicle tracking in contour illustrating the location of each and every vehicle's region which the subsequent frames detected and stored in a short-term buffer [1]. The short-term buffer involves Every vehicle specification, such as its Vehicle-Id, which is automatically generated. Whenever any new vehicle is spotted in the region of interest.

V. RESULT

The proposed strategy is successfully able to track vehicles with an accuracy of 95% and estimate their speed for all the identified vehicles. Multiple vehicles can be detected, and their speeds can be estimated. However, if two vehicles are moving extremely close to each other, it may be detected as a single object (hence the loss of 5%). For vehicles moving sparsely (very low density), accuracy in detecting vehicles is 100% as long as there is no movement in the camera. Estimation of speed can have a difference of 0-2 Km/Hr depending on the program execution speed.

This project requires the camera to be as still as possible, as movement is used to distinguish vehicles from the background. This project would be able to successfully determine the speed of a vehicle and save the vehicle picture in the same folder as shown in Figure 7. This proposed approach focuses on vehicle detection and speed monitoring. Utilizing OpenCV, the proposed approach is put into practice with the help of python. The presented method of action changes as the light's potency changes. As we tested the proposed approach under different conditions. For Example, as shown in figure 5. As the sunlight in the evening becomes less intense, the efficiency of the suggested method has decreased slightly. As well as in the late afternoon light, this suggested approach also has outstanding precision.



(a)

Fig.7. (a) Folder of Saved Vehicle Image (b) Total Summary

As shown in fig.7(a). All the vehicle images are stored in a specified folder that passed the surveillance zone. In the present study the enforcement speed limit was set at 60km/hr. The vehicle which exceeds the speed limit is bounded by an orange box and the vehicle which did not violate the proposed speed limit is bounded by a green box. The program automatically gives a total summary of all vehicles in the text file which passed through the surveillance zone. It also provides the total number of vehicles that violate the speed limit along with their unique ID, so that it can be useful for several future enhancements works.

The program was able to identify speed violation in real-time as the video was being played. And reported 173 cases of speed limit violations observed from a video file of 25 minutes duration. With additional processing the recorded video was replayed at higher speeds, and similar results were obtained within 13 minutes of program runningtime.

VI. CONCLUSION

In developing countries like India with the increasing population every single day, the number of vehicles on road is also increasing exponentially which increases the chancesof traffic violations. It is pivotal to find a better and more automated way to monitor these traffic violations for further actions to be taken. The use of the human workforce for doing this job is time-consuming, costly, and traditional as we have discussed so farin this paper.

In this paper, we propose an approach to detection and tracking of the vehicle combined with speed estimation of vehicles, also in the end it gives the total count of the vehiclethat is passing through the surveillance zone to know the density of traffic which can use it to control the traffic and for several future enhancements. A novel approach of replacing this with an automated monitoring system using OpenCV on roads that will detect, monitor, and capture the images of traffic violations is a better and more advanced way of coping with the increase in traffic-related cases. The use of this system will mitigate the problem of monitoring traffic violations on vacant roads where there are higher chances of speeding. We have successfully demonstrated that this system is capable of detecting, tracking, monitoring, and capturing the images of the vehicles which could be used to share with RTO authorities for further actions. However, the ability of this system depends on the quality of cameras being used and the enhancement of camera quality will result in higher and more accurate results.

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