Paper Car Speed Detection Using Computer Vision

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***Abstract*— When it comes to road safety, detection and monitoring of car speed is one of the major tasks. The use of a simple camera and image processing software eliminated the primary tools of speed detection like handheld radar gun. In these techniques, the speed is calculated as the car passes through the camera's field of view (FOV). The speed is calculated by noting the time taken by car between entering and exiting FOV. Some systems used individual cameras at entry and exit FOVs. Thus, it does now calculate the speed in between this interval. This paper proposes a technique to measure speed of car the moment it enters into the camera's FOV till the time it exits the FOV. Using the Deep Learning Single Shot Detector (SSD) implemented using Convolutional Neural Network (CNN), the cars entering FOV are detected and based on the distance they travel in FOV and time taken to cover that distance the speed of car is calculated.**

Keywords— ***Field of view (FOV), digital image processing, deep learning, convolution neural network (CNN), Single Shot Detector(SSD), Computer vision***

I. INTRODUCTION

Monitoring of car speed is one of the major aspects of road safety. The number of cars on road are increasing every day. With the increase in the number of cars on road, there is an increase in the number of accidents [1]. Most of which are mainly due to car over speeding. Most of these accidents due to over speeding are mainly because the driver drives his car at a speed more than the defined speed limits. It is also shown evident that the behaviour of driver changes with the strictness of fining imposed [2]. This would only become possible with a better monitoring of each and every car on the road. Thus, monitoring and tracking over speeding cars is a major issue. This monitoring would help the road safety department to prevent such actions that may lead to an accident by identifying the car and its owner and taking appropriate actions.

The field of computer vision enables computer to see real time objects the same way as a human see them. These days the field of computer vision is being implemented in almost every sector. The concepts of image processing and deep learning when combined together enables a computer to identify and detect objects in real world. The camera of computer takes video (which is a periodic sequence of image) or a single image as input. By applying the concepts of image processing features are extracted from the input image(s). These features are then passed to the artificial Neural networks which is a primary component of deep learning. The neural network then processes these input features and helps in object detection. The following concept when applied to the field of road traffic monitoring and speed detection helps in an automated and more efficient road safety management.

The main objective of this paper is to create a car speed detecting software which can inform the concerned authorities if a car is over speeding. This software allows monitoring of cars through a single digital camera. Car and its speed are calculated the moment car enters into the region of camera's FOV. This would help in more efficient and software- based surveillance.

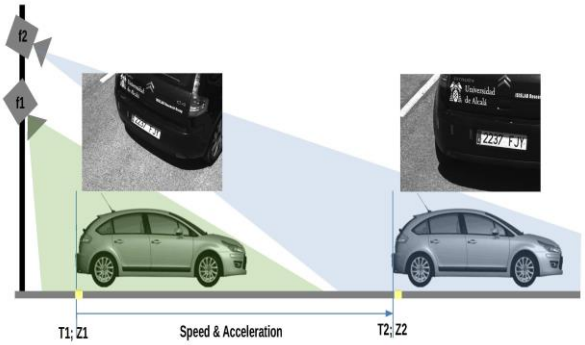
II. RELATED WORK

Earlier, in the past decade the technologies used for this task were more hardware based. This included a handheld speed monitoring gun [3]. The traffic officers used to hold this gun in their hand. Aiming towards the speeding car they used to get to know its speed. These devices were based on Doppler's Effect [4]. These sent a beam of radio waves to the moving car and then speed was calculated based on the change in the reflected frequency waves. These devices worked well when there was only one car in the field of view of the gun sensor.

Radar gun used for monitoring car speed

Many drawbacks were accounted with these devices, major ones are: - Monitoring multiple cars concurrently with same gun was not feasible. Cosine error, which occurred if the radar gun was not in the line of sight to the car had major effect on the accuracy of speed calculation.

In the previous years, with the development in the field of image processing new devices were deployed for traffic monitoring [5] An approach was based on the use of two digitals cameras [6].



2 camera setup for car speed detection

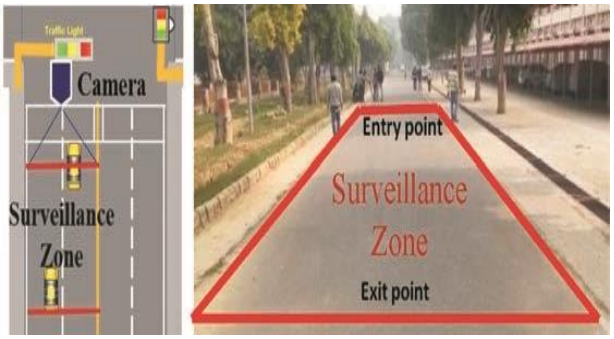
These cameras FOV were placed at some distance apart on the roads. One camera used to detect the car and note the entry time (t1) as soon as the car enters into its field of view (FOV). The other camera's FOV placed distance (d) apart used to identify the car again and note its time exit time (t2). Based on the in time and out time taken by car to travel the distance between the two camera setups, its average speed (s) was calculated as:

$$s = d / (t2 - t1)$$

These systems helped in the reduction of human effort for monitoring the speed. Multiple cars can be monitored at the same time with a single setup. Also, as soon as a car is found over speeding, its number plate is detected and extracted from the video captured and further actions are taken accordingly by the authorities.

The advancement in the domain of Artificial Intelligence and concepts of Deep Learning helped to increase the accuracy of car detection. Moreover, a single camera setup now enabled monitoring of cars.

However, the monitoring with single camera setup also used the same concept as that of the setup with two cameras placed some distance apart [7]. The entry time of car was noted as soon as the car enters into a predefined region of FOV of camera and its exit time is noted as soon the car exits that region.



Single camera setup for car speed detection

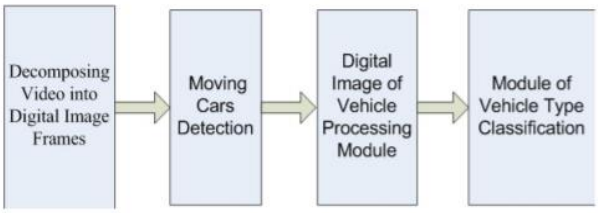
In proposed technique, the monitoring of car and calculation of its speed is done as soon as the car enters into the defined region of camera's FOV. The following technique is implemented in Python using OpenCV and TensorFlow. The software for this technique is developed using a laptop and the video data through a traffic camera is used as input.

III. METHODOLOGY

The proposed software consists of 2 components which help to detect the cars on road as soon as a car enters into the camera's FOV, tracks the movement of car on road and calculates the speed of car. These are: -

i.*Car Detection & Car Tracking* –

We use Single Shot Detector (SSD)[8] for this task after performing pre- processing on the input image(s). The output of this model is given to a tracker. The tracker maintains the coordinate position of every car and its movement.



Block diagram representing the proposed model till car detection phase

ii.*Car distance calculation* –

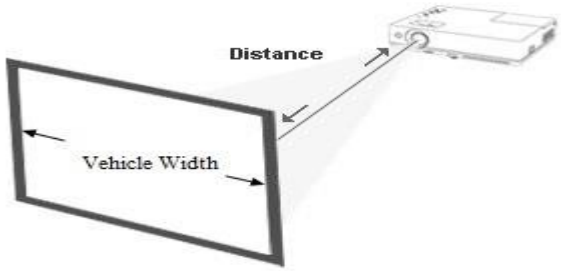
This is done using the average width of car *W*, the known distance of camera from some fixed point on road *D*, the measured width of car in the picture of camera in pixel *P* are used to calculate the focal distance *F* between camera and the car. This is done using the pigeonhole projection formula [9].

$$P / F = W / D$$

Once the focal distance *F* of the camera is obtained, it can be used to calculate the distance between camera and car using the triangle similarity as-

$$D' = ((W * F) / P)$$

As soon as the car enters the range of focal distance *F* of FOV of camera, its distance from camera is calculated. The displacement made by car between two consecutive video frames is calculated and capture time of frames is noted based on these measurements the speed of car between two subsequent video frames is calculated.



Calculating distance of vehicle using its width

Capturing speed based on the above approach and combining all the speeds calculated of a vehicle's average speed would tend to give higher accuracy as compared to single enter – exit FOV based speed detector.

IV. Advantages

The advantages of the proposed system are: -

- Real-time video processes in the video network and density of cars can be broadcasted instantaneously.
- Can access the real-time video data using any remote computers, laptops, mobiles, etc.
- This software model can be implemented on any pre - established digital camera used for traffic surveillance.
- Reduces physical space and storage space by capturing the video, only when the movement is found.
- Power efficient and cost-effective.
- Possible to detect multiple cars through a single camera and process them in parallel.
- Works in an efficient and accurate manner compared to previous works.

V. Conclusion

The proposed model is implemented based on the methodology defined in this paper. This system is different from previous work as it is calculating the speed of car based on the distance of car from the camera. This approach is cost-effective as and works efficiently on all digital surveillance cameras. Detection of cars is more reliable now and tracking of cars made by the system is more accurate. The algorithm proposed in this paper focused on fast detection of cars using the SSD and the calculation of the speed of car is done using pigeonhole projection concept and triangle similarity. The use of SSD helped in the detection of multiple cars on the road with a single camera and calculate their speed.

VI. Limitations

The proposed model focuses on detection of car using SSD and calculation of its distance using Pigeonhole projection concept which takes the average width of car. This parameter is predefined by the user himself. Thus, it gives an approximate accuracy. Moreover, it cannot accurately detect the speed of big trucks and other cars whose width vary a lot in comparison with the average width of car.

VII. Future Work

The future work on the proposed model is to find a more reliable and accurate method of finding the speed of car. If applying the same pigeonhole projection concept, the more appropriate way of finding the width of car more accurately needs to be implemented, so that the type of vehicles. Detecting different type of vehicles, their speed and identification of vehicle and its number plate are all can be implemented to make this system more reliable.

VIII. References

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