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Vehicle Speed Estimation using Haar Classifier Algorithm

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ABSTRACT

An efficient traffic management system is needed in all kinds of roads, such as off roads, highways, etc... Though several laws and speed controller has been attached to the vehicles, Speed limit may vary from road to road. Still Traffic management system faces different kinds of challenges everyday and its being a research area though number of proposals has been identified. Many numbers of methods has been proposed in computer Vision and machine learning approaches for object tracking. In this paper vehicles are identified and detected using a videos that taken from surveillance camera. The objective of the present work is to identification of the vehicles is done by using Computer vision technique and detection of vehicles using Haar cascade classifier. Detecting the vehicles using machine learning and estimating speed is tough but beneficial task. For the past few tears Convolution Neural Network (CNN) has been widely used in computer vision for vehicle detection and identification. This method manages to track multiple objects at real-time using dlibs.

KEYWORDS: *Speed estimation, Vehicle detection, openCV, HaarClassifier, dlibs, Computer vision*

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I. INRODUCTION

Vehicle speed estimation is one of the most important concepts in traffic controlling systems.. Since, speed limit violation is vital to control the roadways and prevent drivers from excessive speed.

Also, proper management of roadways decreases the dangerous accidents and makes the roads safer. One of the objective is to identify the over speed vehicles and drivers are getting fined. Manual operations are being done everywhere using radar concepts to detect the over speed vehicles. However with the fast growing technology we can detect the over speed vehicles without manual intervention. Computer Vision and Machine learning technologies helps to automatically detect the over speed vehicles and drivers can be fined. Even though, various methods and techniques have been proposed to estimate the speed of vehicles, there still remain some limitations, and thus, studies on speed estimation still continue. Recently, digital cameras provide high quality images, which are even well-situated for speed estimation. Not only are digital cameras much less expensive but also they needed simple installation and maintenance than the other similar gadgets. Hence considering the cost and maintenance, video cameras plays a good role to detect the over speed vehicles.

Compared to conventional artificial observation alarming, this detection has advantages of lower manual intervention, fast reaction, high detection rate, treatment and responsibility identification for post-accident so it has become a popular research direction in intelligent traffic field.

Video surveillance has attached more and more people's attentions. In this paper vehicles are identified using computer vision technique and machine learning algorithms, then object being tracked using dlibs functions.

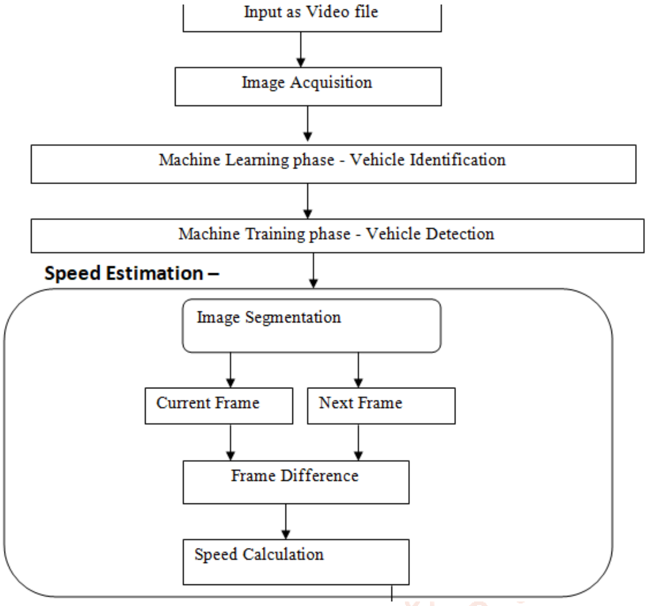
II. RELATED WORK

There are many researches with the same topic for estimating vehicle speed based on image processing. Survey 1: A Vehicle Speed Estimation Algorithm Based on Dynamic Time Warping Approach -IEEE SENSORS JOURNAL, VOL. 17, NO. 8, APRIL 15, 2017 [1].Advantages of this paper is Experiment results show that the algorithm detection accuracy is better than 98%. DTW is the most relevant distance for time series analysis. But In DTW, heavy computational burden is required to find the optimal time alignment path. Also DTW has the Quadratic Complexity - Performance is directly proportional to the squared size of the input data set. Survey 2: A Novel Motion Plane-Based Approach to Vehicle Speed Estimation [2].Advantages are The centre point of vehicle's license plate is considered as the reference point for the car and speed of each vehicle is estimated by the displacement of its license plate in the time seen by camera.

Estimates the motion plane using 3D position of license plates, which are estimated by Shape-from-Template (SfT) technique. And Drawbacks are Template matching techniques applicability is limited mostly by the available computational power, as the identification of big image patterns is time-consuming. Survey 3: A Deep Learning Approach for Localization Systems of High-Speed Objects [3].Advantages is Deep learning approach effectively suppresses the potential divergence of the modified EKF. Drawbacks are this approach is not used for the commercial purpose on Roadways. It is suitable to use in Aircrafts and Military purposes. High cost.

III. SYSTEM ARCHITECTURE

Input to the speed check can be different sensors includes inductive loop detector, image (camera) sensor, acoustic sensor, GPS infrared sensor ultrasonic sensor etc. Here in this project Input for the speed check is taken in a video format.



A. Video Input and Image Acquisition

Videos taken from the surveillance camera are being used as the input. Nowadays in most of the all roads we could get the vehicles passed by videos from those cameras easily. The first stage of video processing is the computer vision system is the image acquisition stage. After the image has been obtained, number of methods of processing can be applied to the image to carry out the many different vision tasks that are required. This stage includes the operations such as Pre-processing, Back ground subtraction, Smoothing and shadow removal. However, if the image has not been acquired satisfactorily then the intended tasks needs to be iterated.

Speed is a relative measure of the moving objects and these objects needs to be tracked in each frame. Hence, to calculate speed video images are broken into frames, then the object being travelled from one frame to another frame is traced out. The distance and time taken between these frames are calculated to estimate the speed of the object. A main advantage of a digital image processing, versus an analog image , we may have number of copies and loss data of very less... Extracting series of images from a video one by one, then reading them using cv2 (Open Source Computer Vision) library

B. Machine Learning : Vehicle Identification

Vehicle Identification refers to the ability of computer and software systems to trace objects in an image/scene and recognize each object. Object detection has plays a vital role in face detection, vehicle detection, pedestrian counting, web images, security systems and driverless cars. There are number of ways for object detection, can be used well in many fields of practice. Like every other fast growing computer technology, a wide range of creative and amazing uses of object detection. In this paper, object detection is done by using Machine learning algorithm called Haar cascade classifier.

Collecting Data

The first stage of Machine learning algorithm is the collection of data set and here we need to have two sets of data:
- Vehicle
- Non Vehicle Images.

Need to collect thousands of images i.e. Positive Images – True images which needs to be identified by the system. Negative Images – False Images, which system needs to discard.

In this Haar cascade classifier system gets learned by applying positive image on Negative Images.

Vehicle detection has been done using Haar Cascade Classifier. Algorithm includes 4 stages:
- Haar Feature Selection
- Creating Integral Images
- Adaboost (Adaptive boosting) Training
- Cascading Classifiers Functions Used: Cascade Classifier and detect Multi Scale

Train the classifier using 'training set', tune the parameters using 'validation set' and XML () file is the output for this process.

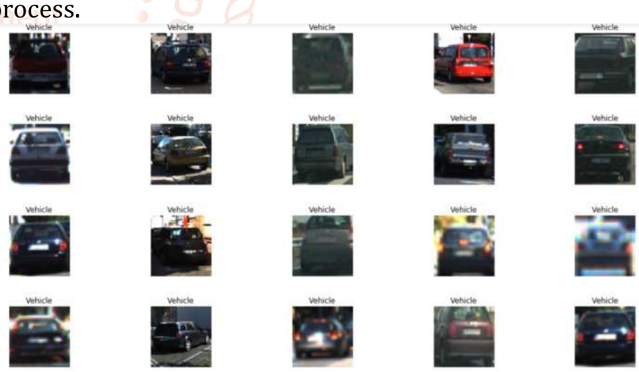


Fig 1-Vehicle Images

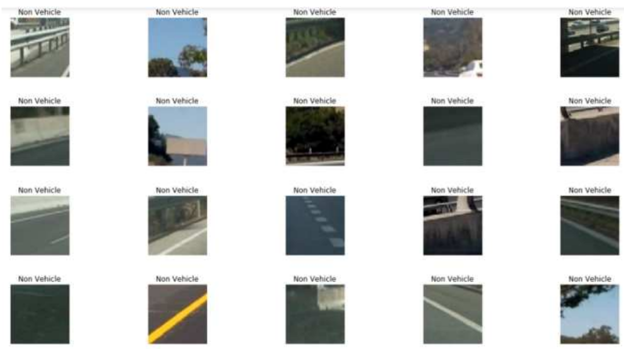


Fig 2- Non Vehicle Images

However in Object detection for capturing all types of vehicles, always it is considered to be a challenging task. Due to the lack of training data in this challenge, a retrained model has been selected for object detection. The system uses Haar like features for vehicle detection, which is generally used for face detection. Haar feature-based cascade classifiers are an effective object detection method first proposed by Viola and Jones.

A Haar Cascade is basically a classifier which is used to detect the object for which it has been trained for, from the source. The Haar Cascade is trained by superimposing the positive image over a set of negative images. The training is generally done on a server and on various stages. Better results are obtained by using high quality images and increasing the amount of stages for which the classifier is trained. Results show this method is quite fast and effective in detecting cars in real time CCTV footages.

C. Tracking

Tracking is a process that gives an ID for the detected object to know the same object at next frame. This can be done using the correlation tracker in Dlibs library. It's being used to track the multiple objects at the same time and each ID monitors the object that is being shifted from one frame to another. While the object is in ROI, the object will be traced in every frame and system will calculate the distance travelled and then calculated the estimated speed between two consecutive frames. This estimated speed calculation is iterated for number of frame in ROI. So system keeps calculated the speed for number of frames and stored the internal value and then we can publish the average speed of the vehicle. When the vehicle is moving out of ROI, then particular Correlation ID removed from the tracking process. This is being done to avoid the multiple tracking process of the same vehicle. So the result of this phase is system is able to identify the vehicle and assign an ID to trace the path and distance that is being travelled between the frames. Finally average speed of the vehicle can be obtained. Dlibs from python are used to track the Multi objects in the frame.

D. Speed Estimation

Speed estimation is done by calculate the distance travelled by the object for two consecutive frames. The conventional method of using Euclidean distance calculation is being used and then applies it to pixels per meter travelled by the vehicle. First of all we need to have the WIDTH of the road in meters. Speed limit can be fixed by the width of the road. Hence I would like to consider the Width of the road as one of the factor for this speed calculation. To calculate the distance travelled by the object for two consecutive frames using Euclidean distance, let Ct(a,b) and Ct+1(c,d) is centroid point of the object in frame t and t + 1 respectively.

The distance d calculated by Euclidean distance is given below

$$d = \sqrt{(a-c)^2 + (b-d)^2}$$

Then Pixels per meter is calculated as ppm. This value can be estimated manually for the particular road using video processing techniques. Therefore values may be varying from Road to Road and this values needs to be adjusted.

The actual width of the road is taken in similar way, each country follows some common value for the width and this can be obtained by doing the field study when the desired road's width needs to be taken.

From the above Euclidean calculation, d_pixels is the distance travelled by the object between frames. Hence for the standard conversion i.e. from converting Pixels to meter d_pixels need to converted to d-meters,

d-meters = d_pixels / ppm

So to calculate the final speed of the vehicle, in Km/hr we need to calculate the fps. This can done by using video processing technique in pre processing stage.

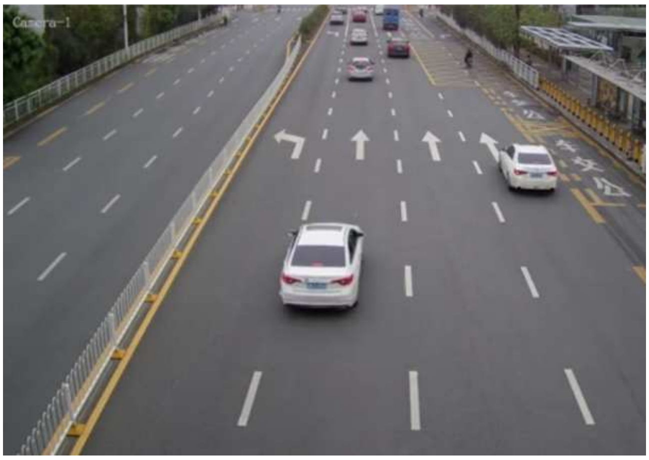
Speed = d_meters * fps*3.6 which gives the speed of the vehicle in km/hr.

Each vehicle is identified by the correlation tracker and bounding box is applied to trace the moving vehicles. And speed of the vehicle is mentioned over the bounding box. Hence by seeing the output video, one can identify the speed of the vehicle.

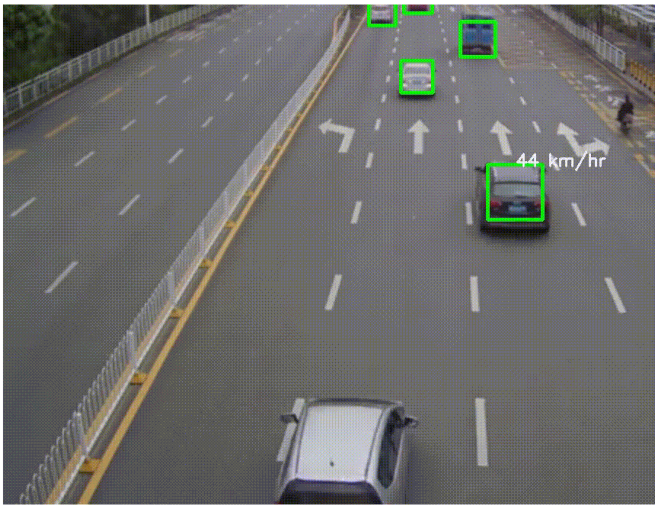
IV. Results and Discussions

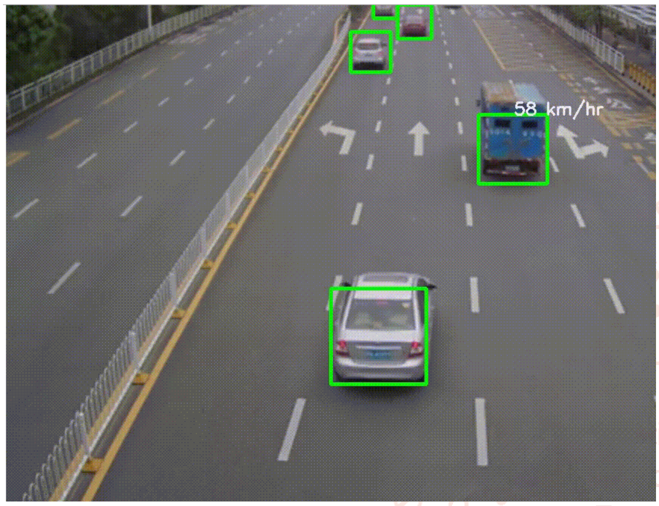
It is more well-organized and cost-effective than conventional technique by applying machine learning and Image processing to estimate the speed of the moving object. Also Width of the road is taken in an account for estimating the speed, hence speed limit of any off roads may be fixed and over speed vehicles can be easily identified.

Traffic speed estimation is important in many aspects of traffic operation and management, such as flow monitoring, incident detection, and delay cost estimation, etc. Current data collection methods like radar sensor or inductive loop detector are costly and surveillance cameras are only used for manual check now. Turning low-cost cameras into effective sensors is a beneficial challenge. With computer vision and Machine learning techniques rapidly developed, this study tries to extract vehicle speeds from surveillance video data. This study aims to solve the 2018 AI City Challenge Track 1. Three steps are taken: a) multi-object detection using Faster R-CNN, b) multi-object tracking based on correlation tracker, and c) speed conversion Image acquisition and computer vision technique. The results show that by using this approach, the speed estimation on any roads can be achieved a good performance.



Hence this approach using Machine Learning and Image Processing technique supports It's to detect the Over speed vehicles automatically for each vehicle without manual intervention. It can acts as prototype which can be more developed and be more complex for larger system to build a complete ITS system for smart city development.





V. CONCLUSIONS

Speed estimation is one of many important parts of Intelligent Traffic System (ITS) which can be done by using image processing technique. It is more efficient and economical than conventional technique without using image processing, for example: using speed radar and manual inspection. Research in this paper is a complement for other researches which are discussed the same topic in which this paper shows that there is an influence between speed estimation, camera angle, and ROI selection while using Euclidean distance. So that, this paper can be a reference for further researches about speed estimation on moving vehicle using image processing and Euclidean distance. The system in this paper acts as prototype which can be more developed and be more complex for larger system to build a complete ITS system for smart city development.

VI. REFERENCES

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