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Automated License Plate Detection and Speed Estimation of Vehicle using Machine Learning - Haar Classifier Algorithm

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ABSTRACT

A well-ordered traffic management system is required in all types of roads, such as off roads, highways, etc. There has been several laws and speed controlled measures are taken in all places with different perspectives. Also Speed limit may vary from road to road. So there are number of methods has been proposed using computer Vision and machine learning algorithms for object tracking. Here vehicles are recognized and detected from the videos that taken using surveillance camera. The aim is to identification of the vehicles and tracking using Haar Classifier, then determine the speed of the vehicle and Finally Detecting the License plate of the vehicle. Detecting the License plate and vehicle speed using machine learning is tough but beneficial task. For the past few years Convolution Neural Network (CNN) has been widely used in computer vision for vehicle detection and identification. Dlibs are used to track the multiple objects at the same time.

KEYWORDS: *License plate Detection, Character Recognition, Speed estimation, Vehicle detection, HaarClassifier, dlibs*

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I. INTRODUCTION

Vehicle speed estimation and License plate detection is one of the most important concepts in traffic controlling systems. Since, speed limit violation needs to be control and thus prevent drivers from excessive speed. Also, Road accidents cases can be decreased and we can try to make the road safer with the stringent traffic rules. Main objective is to identify the over speed vehicles, then automatic detection of the License plate and drivers are getting fined. Currently using Radar concepts which need manual intervention to detect the over speed vehicles. However with the latest growing technology we can identify the over speed vehicles without manual intervention. Computer Vision and Machine learning technologies helps to automatically detect the license plate of 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 detecting the license plate and speed estimation still continue. Taking the video from surveillance camera is much easier and cost effective. Hence considering the cost and maintenance, video cameras plays a good role to detect the over speed vehicles and automatically detect the License plate of the vehicle.

With the conventional method of artificial observation alarming, this method has advantages detection has advantages of lower manual intervention, fast reaction, high detection rate, treatment and responsibility identification for post-accident since it needs to be addressed and to make a road safer with the use of fast growing technology, research on this filed has the high demand. In this paper vehicles are identified using computer vision technique and machine learning algorithms, for automatic License plate detection and speed of the vehicle.

II. RELATED WORK

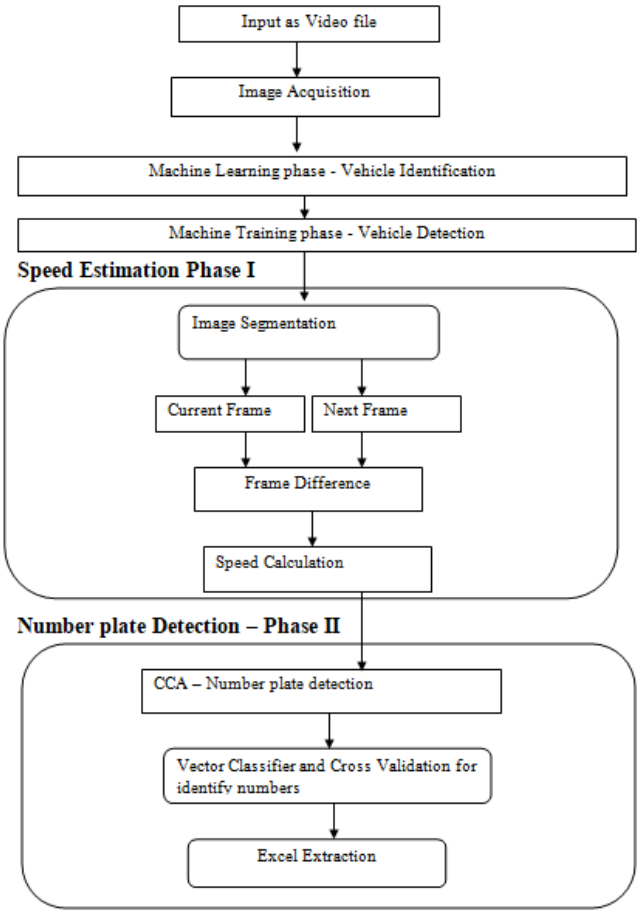
There are many studies with the identical topic for estimating speed of the vehicle based on image processing and automatic License plate detection using machine learning algorithms. Survey 1: Vehicle Speed Estimation Algorithm Based on DTW Approach -IEEE SENSORS JOURNAL, VOL. 17, NO. 8, APRIL 15, 2017 [4].Experimental results show it has achieved 96% of accuracy. DTW is the most significant expanse for time series study. But In DTW, heavy burden in computational analysis and it is necessary to find the finest time alignment path. Also DTW is Quadratic Complexity - Performance is directly relative to the square size of the input data set. Survey 2: A Novel Motion Plane-Based Approach to Vehicle Speed Estimation [5].Here Centerior of License plate is considered for the speed estimation and displacement is calculated for each frame to determine the speed of the vehicle.

3D position of the License plate is considered for the speed estimation. And problem is Time consuming as Template

matching procedure applicability is limited and tedious for the big image patterns. Survey 3: An efficient license plate recognition system using convolution neural networks- 2018 IEEE International Conference on Applied System Invention (ICASI) [6].Advantages is Conventional Neural network applied for detecting and recognising the License plate even for the blurred images.. Drawbacks are this approach is not used for the commercial purpose on Roadways for the moving vehicle.

III. SYSTEM ARCHITECTURE

In formal system, the speed estimation of the vehicle can be taken from different sensors such as camera sensor, acoustic sensor, loop detector, ultrasonic sensor etc. In this paper speed of the vehicle and License plate of the corresponding vehicle can be detected using the videos that taken from surveillance camera.



A. Input Video and Image Acquisition

Mostly each main roads has the surveillance camera and it can be calibrated to certain distance which can capture the moving vehicles, those videos can be taken as the input. It quite easy and nowadays it's been installed in most of the houses. The initial stage of video processing in the computer vision is the image acquisition stage. Once the video has been has been processed, it makes the videos with number of frames. Also there are number of methods in which processing is applied to the image to carry out the many different vision tasks that are required. Image Processing includes the stages such as

1. Pre-processing,
2. Back ground subtraction,
3. Smoothing and
4. Shadow removal.

However, if the required image has not been acquire suitably then the intentional tasks need to be repeated. Speed is a measure of the moving objects and these objects in multiple frame needs to be tracked in each frame to identify the speed. Hence, to estimate the speed of the vehicle, video is broken into frames, then the vehicle being travelled from one frame to a new frame is traced out. Distance travelled and time taken to move from one pixel to another is estimated to determine the speed of the vehicle. A key benefit of a digital image processing is that having numeral of copy and loss data of very fewer. Extracting sequence of images from a video, then analysis them using cv2 (Open Source Computer Vision) library

B. Machine Learning – Haar Classifier: Vehicle Identification

Vehicle classification or Identification refers to the computer or software systems is able to trace vehicle in an image/scene and recognize each vehicle if we have multiple image in each frame. Object detection has plays a very important role in identifying the objects in the given image such as face detection,, pedestrian counting, vehicle detection security systems, web images, and driverless cars. These object detection has been used in many applications with fast growing technology. Like other Technologies, it has the wide uses and amazing creative applications has been adopted. Here such object detection of vehicles is done with the help of Machine learning algorithm named as Haar cascade classifier. Steps for identifying the objects are

1. Collecting data – Positive and Negative images.
2. Training system
3. Validating Result

Collecting Data

The initial stage of Haar classifier algorithm is the gathering of data set and here we may need to train the system with lot of positive images and negative images. Here Positive images such as vehicles and Negative Images are other than Vehicles.

- Vehicle
- Non Vehicle Images.

It is required to assemble thousands of images i.e. Positive Images – True images of vehicle which needs to be recognized by the system. Negative Images – False Images, which system wants to omit. Applying the positive and Negative Images to the system makes it to identify which is vehicle and which is non – vehicle.

Vehicle detection in Haar cascade classifier has 4 stages:

- Selection of objects to be identified
- Modelling Integral Images
- Adaptive boosting Training
- Cascading Classifiers for multiple detect : Cascade Classifier and detect Multi Scale

With the training set, system is slowly learnt the true and false objects. With the validation set, system can be tested to recognize the true and false images.

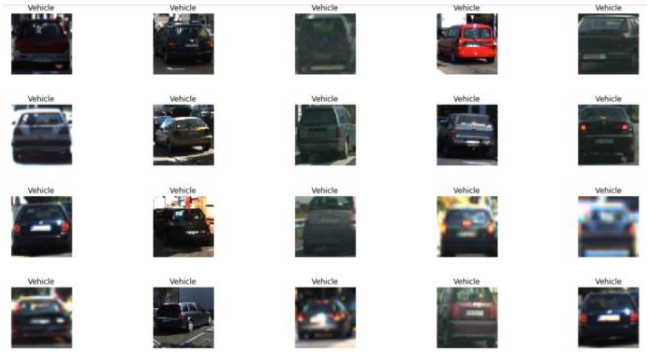


Fig 1-Positive Images

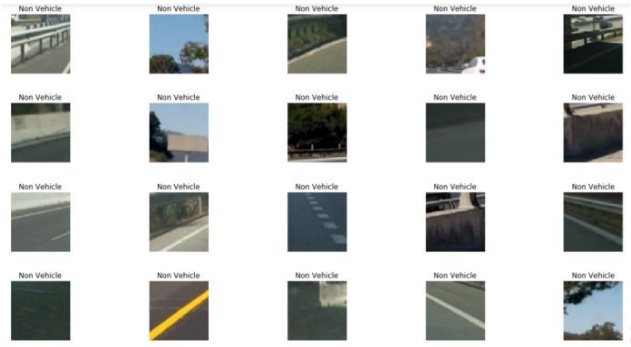


Fig 2- Negative Images

Capturing of all vehicles in the frame is always a critical and challenging task. Hence we need to train the system with the lots of images with training set and validating set. It uses Haar features for vehicle detection, which is similar to face recognition. Haar cascade classifiers is one of the effective object detection method which is proposed by Viola and Jones.

A Haar Cascade is fundamentally a classifier used to detect the certain object from the given image. The Haar Cascade is trained by superimposing the true image over a set of false images. It is generally done on the server with the number of stages. Best results with good accuracy can be achieved by quality of image set and number of stages. Results achieved in this method is reasonably prompt and successful in recognizing cars with the videos such as from surveillance camera or cctv footages.

C. Tracking of Vehicle

Here Tracking refers to each and every vehicle is identified and track in it each frame to determine the speed of the vehicle. It can be achieved by using the correlation tracker in python using dlibs function. The main goal is here to track the multiple vehicle at the same time by assigning Tracking ID of ach vehicle and keep monitoring how it moves from one frame to another in each frame. Speed is estimated by calculating the object distance moved from one frame to another. i.e object travelled from one pixel to another pixel in each frame. This speed calculation is iterated and average of speed within certain speed is taken and reported as the speed of the vehicle. Hence for every two frames speed has been calculated and stored internally, then the average speed is calculated and we can return the average speed of the vehicle within ROI. Similarly when the object is moved out the region of Index, the Correlation ID , tracking process is withdrawn and tracking ID is destroyed.. So multiple tracking of same vehicle can be avoided. Hence this phase mainly aims to assign an ID to the object, track the object in each frame, calculate the distance travelled in each frame with ROI and eliminates the tracking ID once it moves out of ROI. At the end we may have the average speed of the vehicle can be estimated. Dlibs is one the library function in python helps to track the multiple objects at the same time.

D. Speed Estimation

In General speed is estimated by calculating the distance travelled of the same object from one frame to another. The usual method of using Euclidean distance calculation is used and then calculate the pixels per meter moved by the vehicle. Here we have started our calculation using the WIDTH and HEIGHT of the video is taken and adjusted. We considered these plays the important role in estimation speed of the vehicle.. The formal method of the Euclidean distance which is used to calculate the speed of the vehicle, let Cn(a,b) and Cn+1(c,d) is point of the object in frame n and n + 1 respectively.

The distance d1 is calculated by Euclidean distance is mentioned below

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

PPM refers to pixels per meter. This value is estimated manually using the WIDTH and HEIGHT of the video that varies in each video taken from the camera. Hence values may be vary from each video and that needs to adjusted manually. Video processing helps to identify these values. Also WIDTH of the road plays the important role in speed estimation of the vehicle. In the above Euclidean calculation, d_pixels is the distance moved by the vehicle from one frame to another. So for the standard conversion i.e. it would need to calculate the distance in meter say d_meter which is calculated as follows

D_meters = d_pixels / pixels per meter

Another interesting factor is Frames per second which is how many frames can be obtained in a second. So by knowing these values, speed of the vehicle can be estimated in Km/Hr.

Speed = D_meters * frames per second *3.6

which gives the speed of the vehicle in km/hr(3.6 is standard conversion of converting meter into kilometre).

Each object is tracked using the correlation tracker and bounding box is applied on the vehicle inside the ROI. Average speed of the Vehicle is displayed over the bounding box. So the output video has the speed mentioned and displayed over the each vehicle.

E. License Plate Recognition.

License Plate Recognition makes use of concept of optical character recognition to read the number plate characters one by one. Simply Images of the vehicle is given as Input and ALPR reads the characters using Machine learning Algorithms. Using this machine learning technique accuracy can be improved by training process. i.e mapping a character like image to its real characters and distinguish As, Bs etc.

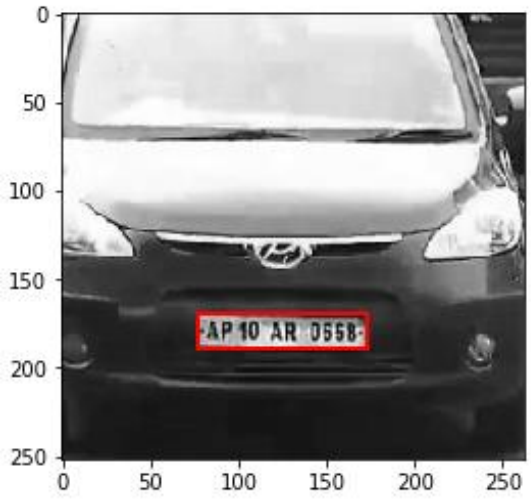
LPR is also called ALPR (Automatic License Plate Recognition) that consists of 3 major stages. 1. Detecting the License Plate. 2. Character Segmentation. 3. Character Recognition.

Approach as follows:

1. Detect the contours of the image.
2. Find the Bounding rectangle of all contours.
3. Compare the validate the height of the License plate ratio.
4. Apply the image segmentation to find the characters in it.
5. Using OCR method with KNN and SVC model under supervised learning, recognize the characters in the license plate.

a. Detecting License Plate

In this stage License plate of the vehicle is detected. But its particularly difficult to detect the position, too many styles and pattern.

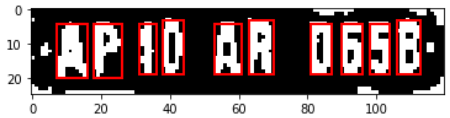


Using Machine learning Classification Algorithms, it's quite possible to detect the plate from the image of the vehicle . Aim is to crop the Regions of the original image with good classification results are retained and others are discarded. Thus region detection and image classification algorithm plays a vital role in detecting the License plate of the vehicle. Connected Component analysis approach helps to group and label the connected region.

b. Character segmentation

Character segmentation is the critical in OCR Process. This stage helps to mapping the characters in the license plate using CCA and segmented into Individual images. From the cropped image of the License plate, characters are segmented and each character is resized into 20x20 pixels as separate image. The plate_like_objects is referred to the list of region that are similar to the license plate region. From the image, three regions were identified as candidates for a license plate. This process helps to identify the actual content of license plate image and eradicate the other regions. Then a Connected component analysis was done on the license plate and each character image is resized to 20px * 20px. From the segmented character image, system can do the recognizing the character process.

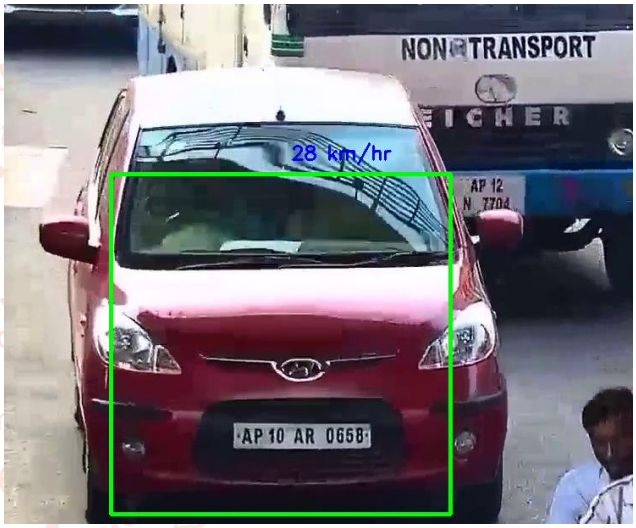
To keep track the order of the image i.e. segmented character – column list is introduced in which each image is recognized sequentially. Finally it can be sorted and printed in the order in which the License plate string can be detected.



c. Character Recognition.

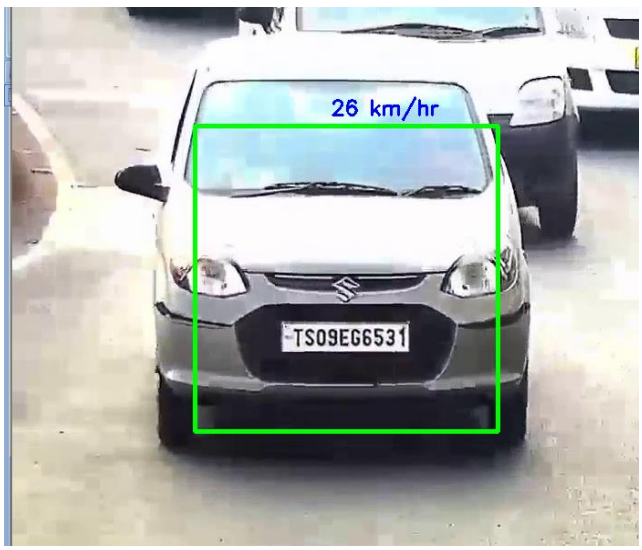
It is the Final stage of the License plate detection. Machine Learning algorithms are applied here to recognize the character in the license plate automatically. Simply it is defined as the branch of AI that deals with data and processes it to discover pattern that can be used for future predictions. The three major classifications of machine learning are supervised, unsupervised and reinforcement learning. Supervised learning gives the best accuracy as system is trained under fixed dataset with expected predictions. So for character recognition we know how the each character should be. Hence Supervised learning helps here. Supervised learning again can be divided into two category; classification and regression. Character recognition belongs to the classification category K –Nearest Neighbour algorithm is used for recognition under supervised learning of characters.

Training data set is provided to choose a supervised learning classifier, train a model, test the model and see how accurate it is, then use the model for prediction.



IV. RESULTS AND DISCUSSIONS

It is well-ordered and commercial than conventional system by applying machine learning and Image processing to estimate the speed of the moving object and License Plate of the vehicle. Speed estimation and License plate detection of the vehicle is one the main process in traffic and management system, such as delay cost estimation incident detection, flow monitoring, etc.



This method is comparatively efficient than conventional methods such as radar ,loop detector, magnetic poles etc . Using camera videos is beneficial and low cost. Using computer vision and Machine learning technique fast developed, this study tries to extract vehicle speed and License plate recognition from surveillance video data. This paper aims to work out the 2018 AI City Challenge Track 1. Three steps are taken: a) multi-object detection, correlation, tracking using Faster R-CNN, b) speed estimation of the vehicle, and c) Image acquisition and multi tracker of the object. d) License plate detection of the vehicle using Machine learning algorithms. The results show that by using this approach, the speed estimation and License plate number of the vehicle can be traced on any roads can be attain a good performance.

Hence this approach using Machine Learning and Image Processing technique supports to detect the Over speed vehicles automatically with their License plate for each vehicle without manual intervention. It can acts as model which can be urbanized and complex for larger system to build a absolute ITS system for smart city development.

V. CONCLUSIONS

Speed estimation and License plate recognition is one of many important parts of Intelligent Traffic System (ITS) which can be done by using machine learning algorithms. It is more proficient and cost-effective than conventional technique without using image processing, for example: using speed radar and manual inspection of vehicle's number plate. A study in this paper is interesting for other researches which are discussed the same subject in which this paper shows that there is an influence between speed estimation, camera angle, and ROI selection while using Euclidean distance, Later License plate has been detected automatically using machine learning algorithms that gives its best accuracy. So that, this paper can be a reference for further researches about speed estimation on moving vehicle using image processing and Euclidean distance, then License plate recognition.

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