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Survey on Various Techniques for Over-Speed Detection of Vehicles

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Abstract: Traffic flow prediction and vehicle speed estimation is one of the most important research topics of recent years. The rapid recent advancements in computation ability of everyday computers have made it possible to widely apply deep learning methods to the analysis of traffic surveillance videos. Traffic flow prediction anomaly detection, vehicle re-identification and vehicle tracking are the basic components in traffic analysis. Good solutions to this problem could prevent traffic collisions and help improve road planning by better estimating transit demand.

In this paper, we detect the vehicles and track them in traffic videos and estimate their speed. We follow 'detect then track' approach. Machine learning and Computer vision approaches are used for object tracking. An algorithm is used for creating classifier, which is used for detecting objects. The vehicle motion is detected and tracked along the frames using dlib library. It is based on the correlation of pixels in bounding boxes containing detected objects in consecutive frames. A data driven approach is used to estimate the speed of vehicle. A model is built for detecting vehicles, correlation trackers are used for tracking vehicles in traffic videos based on detect then track paradigm coupled with data driven speed estimation approach.

Keywords: Tracking, Classifier, Vehicle Detection, Speed estimation.

I. INTRODUCTION

The rapid recent advancements in the computation ability of everyday computers have made it possible to widely apply deep learning methods to the analysis of traffic surveillance videos. Traffic flow prediction, anomaly detection, vehicle re-identification, and vehicle tracking are basic components in traffic analysis. Among these applications, traffic flow prediction, or vehicle speed estimation, is one of the most important research topics of recent years. Good solutions to this problem could prevent traffic collisions and help improve road planning by better estimating transit demand. In this paper, modern machine learning models are combined with classic computer vision approaches to propose an efficient way to predict vehicle speed. Here detect and track approach is used to find the speed of the vehicle.

The continuously increasing number of on-road vehicles has put a lot of pressure on road capacity and infrastructure, making traffic management difficult and giving way to problems like congestion, collisions, and air pollution, among others. These problems have significant impact on our daily lives. A robust and efficient traffic management system is required to reduce their effect. A large amount of traffic data is generated daily. Traffic data contains information related to traffic flow, distribution, pattern, and collisions, which can be used to solve various traffic related issues. Traffic collisions can be analyzed to see the correlation of traffic volume and number and severity of collisions. This helps us to analyse the urban traffic videos and improve traffic conditions and prevent traffic collisions. Also, various statistical parameters, such as the average number of vehicles on the road at a certain time, and the state of congestion can also be studied.

II. RELATED WORK

To ensure decline in road accidents speed control techniques such as speed using RF transceiver, automatic braking systems, Camera based speed detection. Traditionally radar systems were usedA radar speed gun is a device used to measure the speed of moving objects It measures the speed of the objects at which it is pointed by detecting a change in frequency of the returned radar signal caused by the Doppler effect, whereby the frequency of the returned signal is increased in proportion to the object's speed of approach if the object is approaching, and lowered if the object is receding. Such devices are frequently used for speed limit enforcement, although more modern LIDAR speed gun instruments, which use pulsed laser light instead of radar, began to replace radar guns during the first decade of the twenty-first century, because of limitations associated with small radar systems. The radar system is not able to become popular in traffic surveillance system due to high cost of radar, less accuracy, it requires line of sight connection between vehicle and radar equipment. Many algorithms and methodologies have been proposed for detection of vehicle speed through traffic videos. Many methods have been developed that use classic computer vision and machine learning approaches for object tracking.

Existing methods used Euclidean distance to estimate vehicle speed. Pairs of successive frames were preprocessed, run through the optical flow algorithm to estimate speed. But the existing systems cannot predict the accurate speed as optical flow is more prone to noise. Vehicle tracking is required in order to build a robust vehicle speed estimation model. However the existing techniques are still not efficient to reduce the number of accidents.

A novel motion plane approach to vehicle speed detection uses many ways such as making the center of license plate as the point of interest and tracking the vehicle [1]. Speed of each vehicle is estimated by the displacement of its license plate in the time seen by camera .A 3D plane is estimated, on which license plates move, and displacement is calculated with respect to this plane, called “motion plane”. The displacement on the motion plane is more accurate than the displacement on ground plane .

For a 640 × 480 input image, the complete detection system, including fast pyramid construction and sliding-window detection, runs at over 30 frames per second. Experimental results show that the proposed system can process 15 frames per second which is adequate for online processing. Bad weather condition can only affect the license plate detection

Even with usage of UAV’S i,e., Unmanned Aerial Videos tracking becomes difficult due to movement in cameras as well as vehicles[2]. In this method interest points are determined, tracked. Connectivity of two points is determined by the rule stating that interest points from one vehicle should have similar positions and velocities .The speed of a vehicle can be calculated as the average speed of all interest points on that vehicle. This method works well for free-flow and moderately congested traffic flow conditions because the motion criteria depend on similar movement of both background and traffic interest points. Similarly this method works well for traffic on straight road segments but fails in heavily congested traffic conditions and curved road segments

Vehicle speed estimation with optical flow can also be done where the method works well for free-flow and moderately congested traffic flow conditions because the motion criteria depend on similar movement of both background and traffic interest points [3].

Optical flow calculates the motion vector of each pixel and tracks these pixels, but this approach is complex and time-consuming [6]. Background subtraction such as GMM are widely used in vehicle detection by modeling the distribution of the background and foreground [21]. However, these approaches cannot classify and detect still vehicles.

3D Deformable model is used for vehicle detection. By capturing the 2D image of an object, 3D image is built and speed of vehicles is calculated by determining highest velocity and calculating the speed of remaining vehicles as a relative of this highest possible speed [1]. While some tracks show expected smooth transitions indicative of normal traffic, many display sudden spikes in speed, which seems to indicate the corner feature detector may be choosing alternate similar corners in some frames. While some variability is expected due to normal traffic, this model shows excessive variability, when the vehicles have non-uniform speed. When the videos capture quality was impaired by constant camera movement due to wind or bridge vibrations, performance of this model is worse

Hand-crafted feature approaches such as deformable part-based model (DPM) [22] have achieved the state-of-art performance [5]. DPM explores improved HOG (Histogram oriented gradients) feature to describe each part of vehicle and followed by classifiers like SVM and Adaboost. However, hand-crafted feature approaches have low feature representation.

The proposed system uses detect and track approach where the total process takes place three steps where the final step is the estimation of speed of the detected vehicle. For detecting the vehicle Haar feature classifier is used. For the tracking the correlation tracker is being used and then the speed is being estimated.

III. METHODOLOGY

The major steps in the proposed approach are illustrated in Fig.1. The algorithm has three main stages: 1) Vehicle Detection 2) Vehicle Tracking 3) Speed Estimation. The system takes videos which contain traffic signs. The output of this approach is the video in which speed of a recognized vehicle is labelled along its boundary.

1) *Step 1:* The input video is taken.
2) *Step 2:* The input video taken is converted into gray scale image.A *grayscale* (or graylevel) *image* is simply one in which the only colors are shades of gray.
3) *Step 3:* Here Haar Cascade Classifier is used to detect the vehicle.
4) *Step 4:* With the correlation tracker from the dlib library the vehicle is tracked.
5) *Step5:* We are calculating the distance moved by the tracked vehicle in a second, in terms of pixels. With distance travelled per second in meters, we will get the speed of the vehicle.

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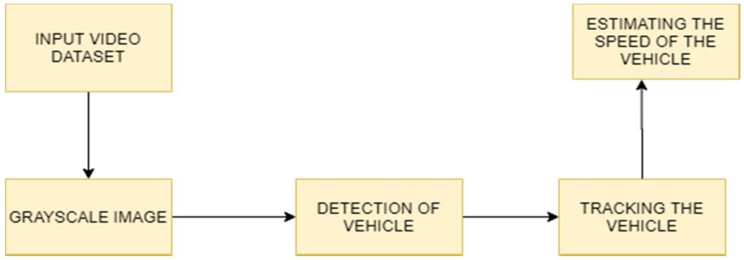

Fig.1.Flow diagram

A. Vehicle Detection

We are usingHaar Cascade Classifier to detect the vehicle from the traffic videos. Object Detection using Haar feature-based cascade classifiers is an effective object detection method proposed by Paul Viola and Michael Jones. It is a machine learning based approach where a cascade function is trained from a lot of positive and negative images. It is then used to detect objects in other images.

Initially, the algorithm needs a lot of positive images (images of cars) and negative images (images without cars) to train the classifier. Then we need to extract features from it. For this, Haar features shown in the Fig 2 image are used. They are just like our convolutional kernel. Each feature is a single value obtained by subtracting sum of pixels under the white rectangle from sum of pixels under the black rectangle.

Now, all possible sizes and locations of each kernel are used to calculate features. Different windows that is a small region within a image are considered for calculating haar features. For a given image, large number of windows can be considered thus creating lot of features. For each feature calculation, we need to find the sum of the pixels under white and black rectangles. To solve this, the concept of integral image is used. However large the image is, it reduces the calculations for a given pixel to an operation involving just four pixels. But among all these features we calculated, most of them are irrelevant. For example, consider the image below. The first feature selected seems to focus on regions consisting of corner of cars.

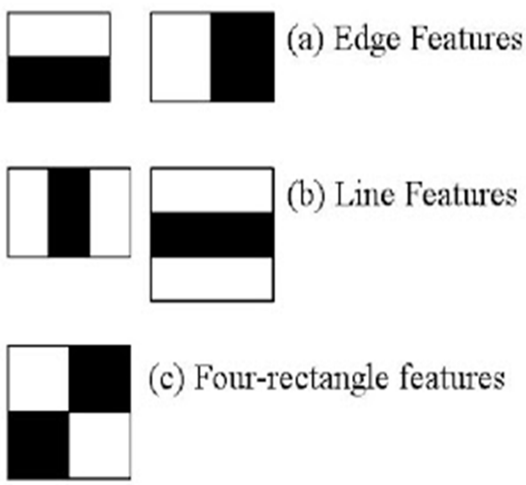

Fig.2.Haar features

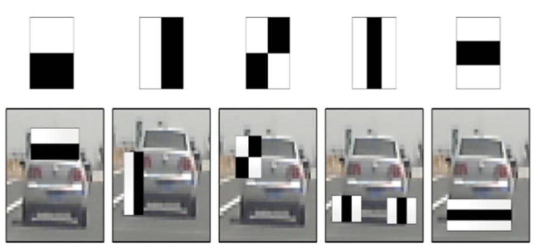

Fig.3.Haar features in an image. (Source : Adapted from web)

The second feature selected can be the region like number plate, headlights. But a window that is a particular region selected in the image, consisting of the surroundings of car, any other place without car is irrelevant. There are around 160000+ features for an image. Each feature acts as a weak classifier. Selecting the best features is achieved by Adaboost.It finds the best threshold which will classify the images to positive and negative. But obviously, there will be errors or misclassifications. The features with minimum error rate are selected, which means they are the features that best classifies. The process is not as simple as this. Each image is given an equal weight in the beginning. After each classification, weights of misclassified images are increased. Then again same process is done. New error rates are calculated. Also new weights. The process is continued until required accuracy or error rate is achieved or required number of features are found). Final classifier is a weighted sum of these weak classifiers. The final classifier obtained is a XML file which consists of stages that are used while detecting object of interest from individual frames

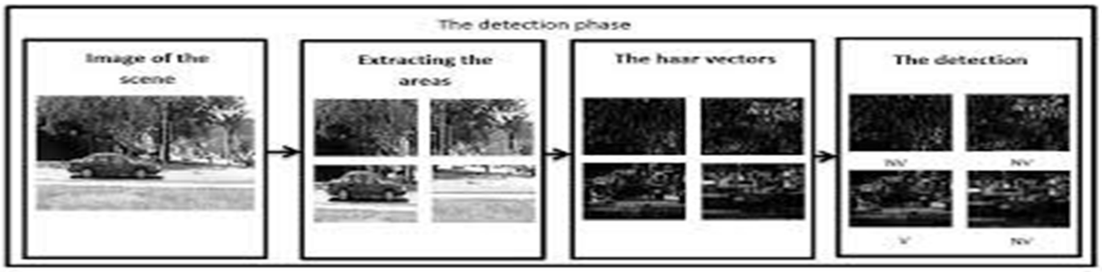

Fig.4. Detection of an object using haar features (Source : Adapted from web)

OpenCV comes with a trainer as well as detector. Classifier for any object like face, planes etc can be trained using the images containing object of interest

B. Vehicle Tracking

Here we are tracking the vehicle using correlation_tracker from dlib library. Dlib uses a correlation tracker which works by correlating a set of pixels from one frame to the next frame This is a tool for tracking moving objects in a video stream. You give it the bounding box of an object in the first frame and it attempts to track the object in the box from frame to frame. This object lets you track the position of an object as it moves from frame to frame in a video sequence. To use it, you give the correlation_tracker the bounding box of the object you want to track in the current video frame. Then it will identify the location of the object in subsequent frames.

Dlib library is used for tracking the vehicle. Dlib uses a correlation tracker to track an object in real-time in a video stream.

The correlation_tracker from the dlib Python library. tracks the position of an object as it moves from frame to frame in a video sequence. To use it, the correlation_tracker has to be given the location or coordinates of bounding box of the object that is to be tracked in the current video frame.

Then the location of the object in subsequent frames is identified by the tracker.

```
tracker=dlib.correlation_tracker()
img=dlib.load_rgb_image(f)
tracker.start_track(img,dlib.rectangle(74,67,112,153))
tracker.update(img)
```

C. Speed Estimation

The speed is calculated using the change in the position of detected object between two consecutive frames in the video. Two consecutive locations of a detected object is given by the correlation tracker. The distance between the two locations is obtained in terms of pixels. Then the pixel value is converted to real distance using ppm value. Pixels Per Meter is a measurement used to define the amount of potential image detail that a camera offers at a given distance. The PPM value defines the number of points or divisions for each meter of the subject that the camera is imaging. For estimating PPM, the actual width in metres of the road has to be known. Also, the video frame is taken and the width of the road in pixels digitally is calculated. Now, the width of the road in metres from the real world is known and in pixels from the video frame. To map the distances between these two worlds, pixels per metre is calculated by dividing distance of road in meters with distance of road in pixels. For the input dataset we considered, the PPM value of the video file is found to be 8.8 d_pixels gives the pixel distance travelled by the vehicle in one frame of the video processing.

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Pixel per meter is the measurement used to define the amount of potential image detail that a camera offers at a given distance. For estimating ppm, the actual width in metres of the road has to be known, for this one can use google to find the approximate width of the road in any country. Also, the video frame is taken and the width of the road is calculated in pixels digitally.

Now, the width of the road in metres from the real world and in pixels from our video frame is calculated. To map the distances between these two worlds i.e; the real world and the video, pixels per metre is calculated by dividing distance of road in pixels to metres.

To estimate speed in any standard unit first, d_pixels should be converted to d_metres. Then the speed can be calculated
(speed = d_meters * fps * 3.6).

d_meters is the distance travelled in one frame. The fps is provided in the data set description.So, to get the speed in m/s, just (d_metres * fps) will do. To convert it into km/hr estimated speed is multiplied by numeric value 3.6.

D. Dataset

The Track 1 Chinese dataset [23] contains 8 one-minute 1080p videos (1920x1080) recorded at 30 frames per seconds (fps). Those videos are captured at 4 different locations, locations 1 and 2 being highway and 3 and 4 intersection locations, respectively.

The videos are recorded with the help of the stationary camera. The classifier is generated by training it with positive and negative sample images. The cars data set used for this purpose which consists of images of cars and without cars, is Stanford data set.[24] The Cars dataset contains 16,185 images of 196 classes of cars. The data is split into 8,144 training images and 8,041 testing images, where each class has been split roughly in a 50-50 split. The data set consists of positive and negative images. The positive images are the ones with the car in Fig.5 and negative images are the one without any vehicle as in Fig.6. Classes are typically at the level of Make, Model, Year, e.g. 2012 Tesla Model S or 2012 BMW M3 coupe.

The classifier used for detection of vehicles is trained using these images. The final classifier obtained after training ,testing is a XML file which consists of stages that are used while detecting object of interest from individual frames

Fig.5 Positive Image

Fig.6 Negative Image

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IV. EXPERIMENTAL RESULTS

The result of this approach is a video with detected vehicles highlighted with a bounding box, boxes are labelled with speed of vehicle within the box After executing the code, a video file pops up, which is created in the speed_check file. The images present in input video are manipulated by drawing bounding boxes around the detected vehicles, by labelling the bounded boxes with their respective speed calculated. The video is created by writing these manipulated images. Pictures below Fig 7, Fig 8 are the screenshots of the video generated from the code. When a vehicle enters the video (field of view of camera) it is detected and then it is assigned an id(numeric value). A tracker object is created for the detected vehicle. Two locations in consecutive frames are stored. When the vehicle leaves, all information is deleted. This information related to tracking of vehicle is displayed simultaneously with the output video. Fig 9 shows this tracking information of the vehicles

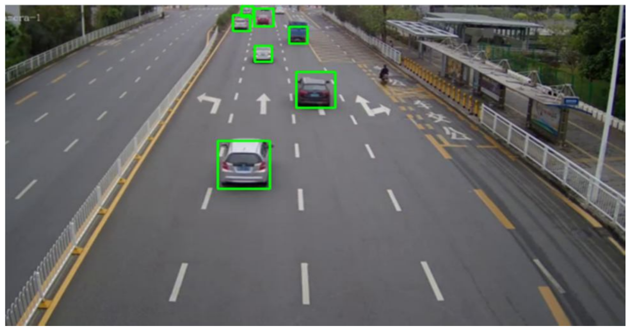

Fig.7. Detection of The vehicle

In the above fig 6 a rectangle box indicates the vehicle which tells that the vehicle is identified. Here Haar cascade classifier is used to identify the vehicle.

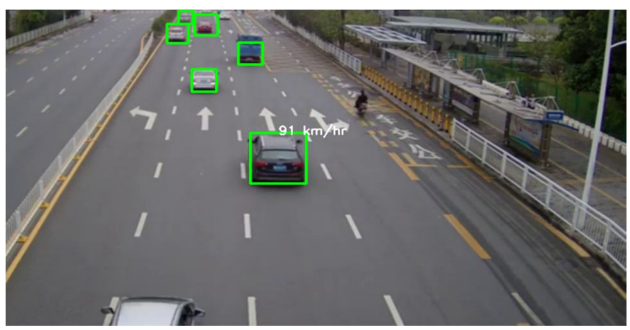

Fig.8. Estimation of speed

Vehicle speed is estimated which is shown in fig.78

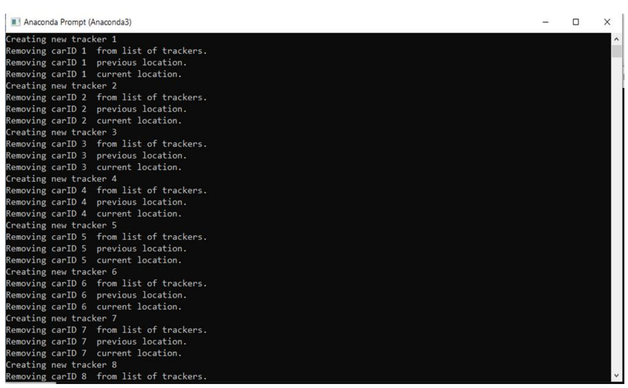

Fig 9 Information about the tracking of vehicles

From the above fig the information about the tracking of vehicles i.e; removing the carID from list of trackers, previous location, current location.

Existing system tracks the vehicles by identifying the number on the number plates of the vehicles. This is not reliable as identifying the number on the number plate correctly is not possible all the time in a video when an obstacle covers the number plate. Here tracking using dlib involves a correlation tracker which works by correlating a set of pixels but not a particular area of detected vehicle (like number plate based tracking) hence our solution has better performance. The optical flow algorithm is not so appropriate for these traffics because they do not have any salient movement in most case. Instead, they maintain some consistent shapes. The shapes mostly show the rear side of the car. To detect the rear shape of the car we choose to use Haar-like feature detector because it is fast and efficient. In general, template-based methods are slow for real time detections. The execution time of the methods is proportional to the number of templates we have. That is, the execution time increases when we have more templates. However, Haar-like feature detector searches the frame once. The detector also generates many false positives because the detector represents the various shapes of the vehicles. If we only focus on the shapes of the cars in the training data set, the detector easily finds those cars

V. CONCLUSION

In this project, we introduced a model for detecting vehicles in traffic videos, tracking is done based on a detect-then-track paradigm. Object detection, localization task is done in the detection step. Models chosen for detection step models provide a series of bounding-boxes for each frame that contain objects. A library is used for tracking based on the correlation of pixels in the bounding boxes containing detected objects in consecutive frames. Tracking is also improved by computing through correlation tracker. We extract all frames from the videos. The change of in-frame location of these detected objects contribute the necessary information for estimating the vehicle's speed.

VI. FUTURE SCOPE

Further, after detecting the speed of the vehicle an alert can be sent to the driver or owner of the vehicle in case if there is any speed violation. Even in case of bad weather conditions also the process can be done. The traffic flow can be estimated and then it can warn the drivers to choose some other route. Even the traffic collisions can be avoided if the traffic flow is known.

REFERENCES

[1] Shuai Hua, Manika Kapoor, David C. Anastasiu, "Vehicle Tracking and Speed Estimation from Traffic Videos", IEEE Trans. Department of Computer Engineering ,San Jose State University, San Jos, vol. 10 ,June 2018
[2] Detection using optical sensors: a review (2004), pp. 585–590 From Aerial Videos"IEEE Trans. National Natural Science Foundation of China , vol. 18, July 2017.
[3] Mahmoud Famouri, Zohreh Azimifar, "A Novel Motion Plane-Based Approach to Vehicle Speed Estimation",IEEE Trans. The Natural Sciences and Engineering Research Council of Canada, vol. 20 ,Nov 2019.
[4] Ruimin Ke, Zhibin Li, Sung Kim, John Ash, Zhiyong Cui, and Yinhai Wang "Real-Time Bidirectional Traffic Flow Parameter Estimation
[5] SukHwan Lim, John G. Apostolopoulos, Abbas El Gamal, "Optical Flow Estimation Using Temporally Oversampled Video"IEEE Trans. the Programmable Digital Camera Program by Agilent, Canon, Stanford University ,vol. 14, 2005.
[6] Chong Chen , Dan Schonfeld, "A Particle Filtering Framework for Joint Video Tracking and Pose Estimation"IEEE Trans. Department of Electrical and Computer Engineering, University of Illinois at Chicago, Chicago, vol. 19, June 2010 .
[7] Z. Sun, G. Bebis, R. Miller, in The International IEEE Conference on Intelligent Transportation Systems, 2004. Proceedings. On-road vehicle
[8] M. Da Lio et al., "Artificial co-drivers as a universal enabling technology for future intelligent vehicles and transportation systems," IEEE Trans. Intell. Transp. Syst., vol. 16, no. 1, pp. 244–263, Feb. 2015.
[9] Jianping Wu , Zhaobin Liu , Caidong Gu , Maoxin Si , Fangyong Tan,"An algorithm for automatic vehicle speed detection using video camera",Vol.3,
[10] 2009.
[11] Fumio Yamazaki ,Wen Liu , T. Thuy Vu,"Vehicle Extraction and Speed Detection from Digital Aerial Images",Vol.3,2008.
[12] Jin-xiang Wang, "Research of vehicle speed detection algorithm in video surveillance",Vol.4,2016.
[13] Jozef Gerát ,Dominik Sopiak ,Miloš Oravec , Jarmila Pavlovicová, "Vehicle Speed Detection from camera stream using image processing methods",Vol.6,2017.
[14] Xiao-Feng Gu , Zi-Wei Chen , Ting-Song Ma , Fan Li , Long Yan,"Real-Time vehicle speed detection and tracking using deep neural networks",Vol.6,2017.
[15] M.D. Enjat Munajat , Dwi H. Widyantoro ,Rinaldi Munir, "Vehicle detection and tracking based on corner and lines adjacent detection features", Vol.4,2016.
[16] Panya Chanawangsa , Jingyan Wan ,Changxu Wu , Chang Wen Chen, "A novel 2D-3D hybrid approach to vehicle trajectory and speed estimation", 2014.
[17] Seongrae Kim , Junhee Lee , Youngmin Kim, "Speed-adaptive ratio-based lane detection algorithm for self-driving vehicles",2016 International SoC Design Conference (ISOCC),2016.
[18] K.V. Kiran Kumar ,Pallavi Chandrakant , Santosh Kumar , K.J. Kushal," Vehicle Speed Detection Using Corner Detection",2014 Fifth International Conference on Signal and Image Processing,Vol.5,2014.
[19] Marcin L. Eichner , Toby P. Breckon, "Integrated speed limit detection and recognition from real-time video",2008 IEEE Intelligent Vehicles Symposium,Vol.7,2018.

[20] [18] Praveen M Dhulavvagol , Abhilash Desai , Renuka Ganiger, “Vehical Tracking and Estimation of Moving Vehicle for Traffic Surveillance Applications”,2017 International Conference on Current Trends in Computer, Electrical, Electronics and Communication (CTCEEC),2017.
[21] Xiao-Feng Gu , Zi-Wei Chen , Ting-Song Ma , Fan Li , Long Yan,“Real-Time vehicle speed detection and tracking using deep neural networks”,Vol.6,2017.
[22] Ruimin Ke, Zhibin Li, Sung Kim, John Ash, Zhiyong Cui, and Yinhai Wang "Real-Time Bidirectional Traffic Flow Parameter Estimation From Aerial Videos"IEEE Trans. National Natural Science Foundation of China , vol. 18, July 2017.
[23] C. Stauffer and W. E. L. Grimson, Adaptive background mixture models for real-time tracking, in Computer Vision and Pattern Recognition, 1999. IEEE Computer Society Conference on, Fort Collins, 1999, p. 252 Vol. 2
[24] Felzenszwalb, RB. Girshick, D. McAllester, and D. Ramanan, Object detection with discriminatively trained part-based models. IEEE Trans. Pattern Anal. Mach. Intell.
[25] Dataset of traffic videos http://aiskyeye.com/Dataset of images used for training classifier https://ai.stanford.edu/~jkrause/cars/car_dataset.html