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Real Time Vehicle Speed Estimation Techniques – A survey

Aditya Singh, Bhavya Pandey, Devashish Dana, Harsh Vikram Singh, Sandhya.N

Dayananda Sagar Academy of Technology and Management, Bangalore, India

ABSTRACT

Video and picture handling has been utilized for traffic observation, investigation and checking of traffic conditions in numerous urban areas and metropolitan territories. This paper focuses on present another way to deal with gauge the vehicles speed. In this examination, the caught traffic films are gathered with a fixed camera which is mounted on an expressway. The camera is aligned dependent on mathematical conditions that were upheld straightforwardly by utilizing references. Item following methods are then utilized on the live video that is being caught by the camera and the movement of the vehicle is being followed and shown on the screen. Utilizing this video and article following procedures, important information is being separated from the video and the qualities are then placed into the condition from which the speed isdetermined..

Keywords: Sugar, Ethanol, global demand, sugar production, COVID-19

1. Introduction

Individuals in their everyday lives experiences more issues as the populace is consistently expanding and street traffic turns out to be more blocked due to popularity and less degree of street limit and foundation. It is imperative to look for proficient answers for lessen these issues as they are a lot of common in the reality. Vehicle speed recognition is significant for noticing speed impediment law and it likewise shows traffic conditions. Customarily, vehicle speed discovery or reconnaissance was acquired utilizing radar innovation, especially, radar indicator and radarfirearm.

This strategy, with spatial conditions and supplies, gets the speed of a moving vehicle. Notwithstanding, this strategy actually has a few weaknesses, for example, the cosine blunder which occurs if the radar weapon isn't pointing towards the course of the approaching vehicle. Likewise, the expense of hardware is one of the significant reasons, and furthermore radio obstruction are two other powerful factors that cause blunders for speed location lastly, the way that radar sensor can follow just a single vehicle whenever is another impediment of thistechnique.

In this paper, we are preparing a survey report through researching on our project topics by reading through various IEEE paper and research papers that have implemented the related technique. This survey paper will compare those research papers on the basis of their techniques used, advantages, feasibility, accuracy and number of disadvantages. This survey report will give a basic idea about the techniques that have been used till now on the respective project and also about the advancement made till date in the domain.

2 Related Work

Volkan Cevher et.al **[1]** presented a method to determine a vehicle's speed via its acoustic drive-by sounds recorded at a microphone, by formulating the problem as a joint speed and acoustic pattern estimation problem. They achieve this estimation using a vector that profiles the directional variation of the vehicle acoustic pattern.

Parameters λv and λf of the vehicle profile vector can improve the confidence of the correspondence matches, also allowing minimal communication between a calibration microphone and a control microphone. However, given the difficulty of the correspondence problem, one should not expect perfect performance for all cases even with the vehicle profile vector. While determining the vehicle speed, they relied on the signal power calculations and

* *Corresponding author.* Bhavya Pandey
E-mail address: bhavy.pandey@gmail.com

argued that the signal frequency information (Doppler) was not useful when only a single microphone is used.

On the other hand, when an array of microphones is available, one can also obtain information from the phase of the received acoustic data across the array. In this case, they expect that the performance should improve more than what is gained from multiple independent amplitude observations. They envision that when multiple vehicles are present, the array can provide the acoustic beam steering necessary to remove the cocktail party effect on the ES components.

Shubhranshu Barnwal et.al [2] performed evaluation on data that has been done for simplistic cases, and this shows promising results. Estimates are within an acceptable range given that a passive sensor is being used and the approach is computationally inexpensive.

In a few cases the harmonics were not dominantly visible and pre-processing of audio to enhance spectral peaks is a viable option. For the controlled experiments reported in this paper, though, such pre-processing was not required. One can also notice clearly, when a gear shift takes place (both the up shift, and down shift), and state if the speed is increasing or decreasing. They were exploring approaches to combine Doppler Effect and the engine RPM–vehicle speed relation to track variable vehicle speeds.

Osman Ibrahim et.al [3] presented the alternative method for calculation of speed of moving objects. Instead of using expensive radars or sensors authors used Computer Vision techniques to implement the same logic and that too with same accuracy or even better. SDCS processes can be divided into four successive phases :-First phase is **Objects detection phase**, which uses a hybrid algorithm based on combining an adaptive background subtraction technique with a three-frame differencing algorithm which ratifies the major drawback of using only adaptive background subtraction.
Second phase is **Objects tracking**, which consists of three successive operations, Object segmentation, Object labelling, and Object canter extraction. Objects tracking operation takes into consideration the different possible scenarios of the moving object like:- Simple tracking, object has left the scene, object has entered the scene, object cross by another object, and object leaves and another one enters the scene.
Third phase is ***Speed Calculation phase***, which is calculated from the number of frames consumed by the object to pass-by the scene.
Final/Fourth phase is ***Capturing Object's Picture phase***, which captures the image of objects that violate the speed limits.

Arash Gholami Rad et.al [4] have presented video and image processing has been used for traffic surveillance, analysis and monitoring of traffic conditions in many cities and urban areas. Camera is used to detect speed and camera calibration plays a very vital piece for the process. Other information needed can be obtained by the software like fps megapixel etc. Second Step involves extraction of background (background refers to the stationary object in a video/image). After that foreground is extracted using CVS. It is preferred as it produces same results irrespective of the conditions. After this speed is detected using making a box around detected vehicle and considering the distance travelled by its centroid.

G Chandan et.al [5] have considered a small window on the image then scan the whole image, looking for corners. Shifting this small window in any direction would result in a large change in appearance, if that particular window happens to be located on a corner. Flat regions will have no change in any direction. If there's an edge, then there will be no major change along the edge direction. After the corner detection, tracking is being done for the detected corners. The pixel under consideration, and solves the basic optical flow equations for all the pixels in that neighbourhood, by the least squares criterion. The Lucas–Kanade method assumes that the displacement of the image contents between two nearby instants (frames) is small and approximately constant within a neighbourhood of the point p under consideration. Speed Estimation of Multiple Moving Objects from a Moving UAV Platform

S.S.S. Ranjit et al [6] have developed a vehicle speed detection algorithm is based on the vector-valued function and motion vector technique that estimates the velocity of moving vehicle.The motion vector technique is applied after the block extraction and subtraction is used to estimate the pixels changes among the two blocks to measure the speed of the moving vehicle. The vector-valued function is applied into the motion vector to demonstrate the vehicle speed detection algorithm for the video from surveillance cameras. The developed algorithm provides much more accurate results in different weather condition and light conditions.

Jozef Gerát et.al [7] have developed a system which can accurately detect speed of the vehicle irrespective of the weather conditions or light condition. Optical low method with Kalman filter tracking to solve the problem with overlays with static foreground objects and also improve speed detection. Foreground detection by Gaussian mixture model was combined with DBSCAN clustering to create more precise object representation better and much accurate speed detection at night and in different weather conditions

Debojit Biswas et.al [9] have implemented a speed detection system for multiple moving objects on the ground from a moving platform in the air. A detect-and-track approach is used for primary tracking of the objects. Faster R-CNN (region-based convolutional neural network) is applied to detect the objects, and a discriminative correlation filter with CSRT (channel and spatial reliability tracking) is used for tracking. Feature-based image alignment (FBIA) is done for each frame to get the proper object location. In addition, SSIM (structural similarity index measurement) is performed to check how similar the current frame is with respect to the object detection frame. This measurement is necessary because the platform is moving, and new objects may be captured in a new frame. We achieved a speed accuracy of 96.80% with our framework with respect to the real speed of the objects

Tarun Kumar and Dharmender Singh Kushwaha [10] have proposed an efficient and novel approach for the detection of moving vehicles as well as estimation of their speeds by using a single camera in daylight or properly illuminated environment.

3 Comparative Study

The table 1 suggests a comparative study that has been conducted amongst various research papers belonging to one common domain i.e. vehicle speed detection. The table therefore tells the key features, advantages and disadvantages of various approaches. One important observation that can be made from the table is that there are majorly two different ways of estimating speed of a moving vehicle. One, is based entirely on hardware, which includes various sensors for tracking the vehicle and calculating speed. Second, is based on the use of software for calculating the speed of the vehicle. Both approaches have their own advantages and disadvantages. One common advantage of hardware based estimation, as observed from the comparative study,

would be the accuracy with which it can detect the speeds, on the contrary, this approach is quite expensive as it involves the use of expensive sensors and other hardware components. This is overcome by the software approach, where speed of multiple moving vehicles can be calculated in a single frame with ease and is on the cheaper side as computer software used in this method is usually free of cost, however, this approach lacks the accuracy of the hardware based estimation techniques.

Table 1: COMPARATIVE STUDY

TITLE	OBJECTIVE	TECHNOLOGIES USED	ADVANTAGES	DISADVANTAGES
[1] Vehicle speed estimation using Acoustic Wave patterns.	Authors aim to present a method to estimate vehicle's speed via its acoustic drive-by sounds recorded at a microphone, by formulating it as a joint speed & acoustic pattern estimation problem.	Omni-directional microphones, video cameras, Doppler's effect techniques, ES (Envelope Shape) components.	When an array of microphones are used, performance improves more than what is gained from multiple independent amplitude observations.	More expensive due to number of sensors used. Needs improvement in its performance, when the vehicle's CPA's are relatively large.
[2] Doppler based Speed Estimation of vehicles using Passive Sensor.	Authors aim to develop a system for estimating a vehicle's speed using the phenomenon of Doppler Shift.	Passive audio microphones, knowledge of Doppler Shift, Spectrogram.	The estimated speed of vehicles varied by only by 0-10 kmph. Vehicles moving at lower gears are louder and higher in frequency, thus displaying a larger shift in harmonics giving accurate results.	Too expensive. This method will be helpful if the vehicles move with constant speeds (i.e., change in RPM doesn't occur). Error due to Doppler Shift was seen higher in lower speeding vehicles.
[3] Speed Detection Camera System (SDCS) using Image Processing techniques on Video Streams.	Authors aim to develop a software that is Easy-to-handle and provides nearly 100% accurate results for speed estimation on moving vehicles.	High resolution cameras, Python, NumPy, OpenCV and Computer Vision techniques.	SDCS is a cheap alternative to Radar system. SDCS is considered as a good application for some difficult Image processing algorithms and theories. SDCS doesn't need any professionals to deal with it as it has a simple interface and good design.	The camera required for video extraction should be of high resolution. For smooth running of the software the system should have i5 processors with at least 4GB RAM.
[4] Vehicle Speed detection in Video Image Sequences using CVS method.	Authors simplified the techniques and aim to detect and track an object in real-time using OpenCV.	OpenCV and Image Processing techniques in Python.	Object detection and tracking using Software methods resulting in an affordable system. Ability to track multiple objects at a given time. The system is not affected by weather and performs same in every condition.	Precision and accuracy are not fully correct. Needs improved background filtering methods/algorithms.
[5] Real-time object detection and tracking using Deep	To detect and track an object in real-time using Deep Learning and	Knowledge of Deep Learning, OpenCV libraries and Image Processing	A software based approach on Object Detection and	Lacks the accuracy and precision of hardware based Object tracking

Learning and OpenCV.	OpenCV.	techniques in Python.	tracking, resulting in an affordable system. Ability to track multiple objects at a given time.	devices.
[6] Real-Time Vehicle Speed Detection Algorithm using Motion Vector Technique	Development of vehicle speed detection algorithm is based on the vector-valued function and motion vector technique that estimates the velocity of moving vehicle.	The motion vector technique is applied after the block extraction and subtraction is used to estimate the pixels changes among the two blocks to measure the speed of the moving vehicle. The vector-valued function is applied into the motion vector to demonstrate the vehicle speed detection algorithm for the video from surveillance cameras.	Faster and needs less resources.	Accuracy is less.
[7] Vehicle Speed Detection from Camera Stream Using Image Processing Methods	Development of a system which can accurately detect speed of the vehicle irrespective of the weather conditions or light condition.	Optical low method with Kalman filter tracking to solve the problem with overlays with static foreground objects and also improve speed detection. Foreground detection by Gaussian mixture model was combined with DBSCAN clustering to create more precise object representation.	Better and much accurate speed detection at night and in different weather conditions.	Time consuming and needs lot of resources.
[8] Vehicle Speed detection using deep learning and Image processing techniques.	Speed detection of vehicles using Image processing techniques on Video streams in OpenCV.	Computer Vision and Image Processing techniques in Python's OpenCV.	Efficient object detection and tracking method based on a software. Easy-to-handle and economic way of speed detection. Can be also used in preventing road accidents.	Doesn't provide precise and accurate results.
[9] Speed Estimation of Multiple Moving Objects from a Moving UAV Platform.	Speed detection system for multiple moving objects on the ground from a moving platform in the air.	Faster R-CNN is applied to detect the objects, and a discriminative correlation filter with CSRT is used for tracking. FBIA is done for each frame to get the proper object location. In addition, SSIM is performed to check how similar the current frame is with respect to the object detection frame.	Extremely fast object detection.	Less accurate.
[10] An Efficient Approach for Detection and Speed Estimation of Moving Vehicles.	Efficient and novel approach for the detection of moving vehicles as well as estimation of their speeds by using a single	Vehicle's tracking is based on the relative positions of the vehicle in consecutive frames. This information may be used in the Automatic Number Plate	Minimize the scope of any false positive detection on both sides of road.	Accuracy of only 87-90%.

	camera in daylight or properly illuminated environment.	Recognition (ANPR) System for selection of those key frames where speed limit violation occurs.		

4 CONCLUSION

This paper provides a detailed summary related to different vehicle speed estimation techniques. Some techniques were found useful while some were not optimal. Here we will discuss about the best technique which is the SDCS technique. There are three steps to realize such processing namely, background subtraction, object extraction and speed detection. In the first step the mean filter for background generation that was one of the effective ways for background extraction was used. In the second step, a novel algorithm which takes advantage of the two-colour based characteristics and combines them for object extraction is introduced. This approach is more robust against misdetections and the problem of the merging or splitting of vehicles and finally, in the third step the vehicle speed is determined. The approach used is not affected by weather changes. Vehicle extraction and speed detection had been implemented using the Python.

Also, SDCS system provides a software package specifically designed to manage a vehicle's traffic provides a number of benefits:

- SDCS is a cheap alternative system to the traditional radar system and the need for expensive sensors is also
- SDCS is considered as a good application for some difficult image processing algorithms and theories (Object Motion Detection, Shadow Removal, and Object Tracking).
- SDCS doesn't need professional persons to deal with it as it has a simple interface and good design

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