A Survey and Comparative Study of Real Time Vehicle Detection Methods for Road Traffic Applications

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ABSTRACT
Vehicle count is increasing by the day in urban area. Vehicle detection plays an important role in road traffic applications. By using vehicle detection methods different traffic parameters such as vehicle speed, density, volume, traffic flow rate, travelling time, congestion level can be calculated and these methods can be applied for vehicle tracking, vehicle classification, parking area monitoring , road traffic monitoring and management etc. Various real time vehicle detection methods have been proposed by researchers. The objective of this paper is to present the various approaches for real time vehicle detection using image processing, also to provide comparison of these methods along with pros and cons of each method.

Keywords
Real time vehicle detection, traffic monitoring,vehicle tracking, image processing

1. INTRODUCTION
The first step in the analysis of video is the vehicle detection. Moving vehicle detection is the study of motion of vehicles from the video. Moving vehicle detection is very crucial part in the video surveillance system. A lot of research is being done in the field of computer vision for real time vehicle detection. Real time vehicle detection methods use CCTV system and other technologies. Vehicle detection is extraction of useful information from the CCTV video images.

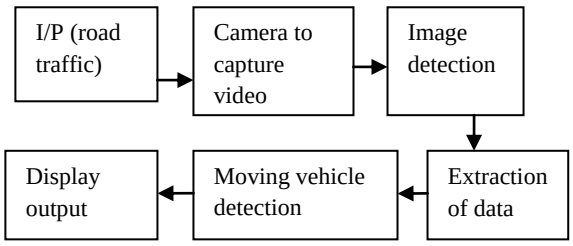

Fig 1: Vehicle detection system from video

As depicted in Figure 1, vehicle detection system captures road traffic video using CCTV system. Single or multiple cameras can be used. Video is then converted into images and moving vehicle can be detected by using detection method. The information at the output can be used for evaluation of various traffic parameters also it can be applied for various road traffic applications.

2. PROBLEMS IN REAL TIME VEHICLE DETECTION
To be an effective real time vehicle detection system, the system should meet the following requirements:

2.1 Accurate detection of vehicles
Vehicles must be detected accurately from the background as well as from the other vehicles.

2.2 Work for different traffic conditions
Vehicles should be detected for different traffic conditions such as, congested traffic, smooth flow of traffic, varying speed traffic etc.

2.3 Work for different environmental conditions
The system should work accurately under different environmental conditions such as, cloudy, fair (shadow), rainy, night, night & rainy, snowfall etc.

2.4 Effective real time operation
Detection of vehicles under real time condition is really a challenging task. System should give accuracy in the detection of real time vehicles.Even though, various methods have been proposed for real time vehicle detection by many researchers, these methods do not necessarily meet these requirements. In this research paper, various real time vehicle detection methods have been discussed along with pros and cons.

3. VEHICLE DETECTION APPROCHES
Detection of a moving vehicle from a captured video is a challenging task in the field of computer vision. Many methods were proposed for moving vehicle detection. In this section, various approaches proposed by various researchers have been discussed.

3.1 Background Subtraction Method
Background subtraction method is widely used method for moving object detection from static cameras. As the name given, background subtraction, this method is a process of extracting foreground objects from the background. To detect the moving vehicle, this method uses the difference of current image and background image. Thus, Background subtraction is a method to clean the background and detect the moving vehicles by comparing it with the current frame. Background

subtraction method involves conversion of video into frames, conversion of color images into grey images, spatial smoothing of an image, background modeling, subtraction of current frame from the background image by applying threshold operation and applying morphological operation. By applying all these steps moving vehicle is detected.This method of vehicle detection gives accuracy in detection but it does not work accurately against changes in illumination also in different weather conditions. Also this method reacts slowly to the changes in background such as starting and stopping of vehicles etc [1].

3.2 Frame Differencing Method

Frame differencing method of real time vehicle detection is similar to background subtraction method with a difference of pixel to pixel subtraction. It is a method of real time vehicle detection in which the difference between the pixels of consecutive images is calculated. If the difference in the pixel values is small, then it is considered as background and if the difference in the pixel values is large, then it is considered as moving vehicle pixels [2].

Frame differencing technique for real time vehicle detection is a fast technique also easy to implement, but it fails to detect slow moving vehicles or static vehicles. Therefore, background subtraction method and frame differencing method can be combined for accurate detection of vehicles.

3.3 Feature Based Method

In feature based method, moving vehicle is detected by extracting the features from the vehicle regions such as rear lamps, license plate, rear view mirrors, edges and corners of vehicles etc. These features are processed to track the vehicles correctly.The first step in feature based method is vehicle segmentation. In this step, background mask is established and foreground objects i.e. moving vehicles are separated from the background. In the next step, features of vehicles such as, color, shape, and texture can be extracted. Further vehicles are classified by extracting the features like area ratio, compactness etc [3]. Thus in feature based method of vehicle can be detected, by collecting and analyzing the features moving vehicles segmented from the background image [4]. As compared to the background subtraction method, this method has low complexity and it is fast but if the features are not grouped accurately, then there may be failure in the detection of vehicle.

3.4 Region Based Method

This method subtracts image frame containing vehicles from the background or previous frame and then processed to obtain vehicle regions. In this method connected region of the vehicle that is "blob "associated with each vehicle is identified and vehicle is tracked [5].This method is useful for free flowing traffic and insensitive to occlusions but gets affected by shadows.

3.5 Active Contour Based Method

This method uses contours of vehicles (boundaries of vehicles) and tracks the vehicle. This method has low complexity as compared to the region based method but has difficulty to track occluded vehicles [6].

3.5 Optical Flow Method

This method of vehicle detection uses motion of the vector characteristics. This method calculates relative motion between camera and the traffic flow. This method gives good performance by using moving cameras but it needs many calculations and complexity is more also it is sensitive to noise. Therefore, this method is rarely used for real time vehicle detection [7].

4. RELATED WORK

Researchers have proposed many approaches for detection of vehicle from video. In this section, review of real time vehicle detection system has been given in brief.

Y. Wang [8] presented a real time vehicle detection system for automatic traffic monitoring with shadow removal. L.-W. Tsai, J.-W. Hsieh and K.-C. Fan [9] have detected vehicles by using colors and edges. But, in traffic congestion, system does not work well. Intraframe, interframe and tracking levels were used by W. Zhang, Q. M. J.Wu, and X. Yang [10] to solve the problem of occlusion of vehicles. Occluded vehicles were separated by also N. K. Kanhere and S. T. Birchfield [11], this approach uses feature points movements. Enhanced background subtraction algorithm was proposed by M. Vargas, J. M. Milla, S. L. Toral, and F. Barrero that uses sigma delta filter and this approach was applied for urban road traffic scenes [12]. By using artificial techniques, R. Cucchiara, M. Piccardi, and P. Mello [13] proposed an approach for detection of vehicles. Optical flow method for detection of vehicle was proposed in traffic surveillance system. Optical flow algorithm and background subtraction method have been used by S.S. Paygude, Dr. Vibha Vyas, and Manisha Chaple for vehicle speed calculation and traffic monitoring [14].

A. Gyaourova, C. Kamath, S.-C. Cheung proposed block matching technique for vehicle detection in from traffic scene by using motionless airborne camera [15]. Hasegawa O. and T. Kanade [16] proposed a system for vehicle detection. This system not only identifies the vehicles but also classify the vehicles. D. Beymer, P. McLauchlan, B. Coifman and J. Malik [17] propose measurement of the traffic parameters using feature based method. J. C. Lai, S. S. Huang, and C. C. Tseng proposed a traffic surveillance system for highway that tracks the vehicle using background subtraction and uses geometric features to improve detection accuracy [18].Although researchers have proposed various methods of vehicle detection, these methods are subject to some problems like, detection accuracy, change in the environmental conditions, and detection in congested traffic, occlusion of vehicles etc.

5. COMPARISION OF VARIOUS APPROCHES

In this research paper, various approaches for vehicle detection have been reviewed. In this section, these approaches have been compared by using the Table 1. Comparison is made on the basis of detection accuracy, detection in congested traffic, working under different weather conditions, shadow effect removal.

Table 1: Comparison of various methods of vehicle detection

Method	Detection accuracy	Detection in congestion	Working in different weather conditions	Shadow removal
Back-ground subtract-tion	Good	Yes	No	No
Frame Differ-encing	Medium	No	No	No
Feature based	Good	Yes	Yes	Yes
Region based	Medium	No	No	No
Active contour based	Medium	No	No	No
Optical flow	Good	Yes	No	Yes

In Table 2, pros and cons of various methods have been discussed.

Table 2: Pros and Cons of various methods of vehicle detection

Method	Pros	Cons
Background subtraction	• Accuracy of detection is good • Simple technique to apply	• Very sensitive to environme ntal changes • Affected by noise and shadow
Frame Differencing	• Easy to implement • Fast technique	• Unable to detect slow moving or static vehicles
Feature based	• Low complexity • Handle occlusion	• Failure in the detection if features not grouped accurately
Region based	• Applicable to free flowing traffic	• Can't handle shadow and occlusion
Active contour based	• Low complexity	• Can't handle occlusion
Optical flow	• Accuracy of detection is good	• Needs many calculation s & complex

6. CONCLUSION

In this paper different technologies used for real time vehicle detection have been discussed. Also comparison of the different technologies was given. Literature survey shows that, real time vehicle detection has scope for future research, as it can be used various road traffic applications. As a result of comparisons, no method outperforms the other ones. It is necessary to improve the robustness against the effects of the environment such as noise, illumination changes, occlusions and etc. It is a big challenge for researchers to make a decision on which detection & tracking algorithm is more suitable. Combination of these methods can be used for the accurate detection of the vehicle.

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