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

Swati N. Divatankar  
Research student  
R & D Centre, Dept. of Electronic Science, Modern College of Arts, Commerce and Science  
Pune-411005, India

Umesh N. Hivarkar  
Research guide  
R & D Centre, Dept. of Electronic Science, Modern College of Arts, Commerce and Science  
Pune-411005, India

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.

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 APPROACHES
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.
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 gamma-delta filter and this approach was applied for urban road traffic scenes [12]. By using artifical 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. Gyauourova, 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. COMPARISON OF VARIOUS APPROACHES

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

<table>
<thead>
<tr>
<th>Method</th>
<th>Detection accuracy</th>
<th>Detection in congestion</th>
<th>Working in different weather conditions</th>
<th>Shadow removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Background subtraction</td>
<td>Good</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Frame differencing</td>
<td>Medium</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Feature based</td>
<td>Good</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Region based</td>
<td>Medium</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Active contour based</td>
<td>Medium</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Optical flow</td>
<td>Good</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>Method</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Background subtraction</td>
<td>• Accuracy of detection is good</td>
<td>• Very sensitive to environmental changes</td>
</tr>
<tr>
<td></td>
<td>• Simple technique to apply</td>
<td>• Affected by noise and shadow</td>
</tr>
<tr>
<td>Frame differencing</td>
<td>• Easy to implement</td>
<td>• Unable to detect slow moving or static vehicles</td>
</tr>
<tr>
<td></td>
<td>• Fast technique</td>
<td></td>
</tr>
<tr>
<td>Feature based</td>
<td>• Low complexity</td>
<td>• Failure in the detection if features not grouped accurately</td>
</tr>
<tr>
<td></td>
<td>• Handle occlusion</td>
<td></td>
</tr>
<tr>
<td>Region based</td>
<td>• Applicable to free flowing traffic</td>
<td>• Can’t handle shadow and occlusion</td>
</tr>
<tr>
<td>Active contour based</td>
<td>• Low</td>
<td>• Can’t</td>
</tr>
</tbody>
</table>

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.

7. REFERENCES


