ON DETECTION AND TRACKING OF THE VEHICLES FROM THE REAL TIME VIDEO STREAM USING BACKGROUND SUBTRACTION PROCESS WITH BLOB TRACKER ALGORITHM

Maqsudur Rahman[1], Md. Tofael Ahmed[2], and A. Z. M. Touhidul Islam[3]

[1]Department of Computer Science and Engineering,
Port City International University, Chittagong, Bangladesh
[2]Department of Information and Communication Technology,
Comilla University, Bangladesh
[3]Department of Electrical and Electronic Engineering,
University of Rajshahi, Bangladesh

ABSTRACT

Vehicle detection is an ultimate result of identifying the vehicle as objects and analysis the object parameter like position, total counts and individual speeds to infer the decisions about the smart transportation. There are lots of technology have been formed in the same fashion to detect vehicle on the real time road. Various BS techniques are used to prevail over the issues of illustration variation, shadows, background cutter and camouflage. In this study, a method of tracking and detecting the vehicles from the real time video steaming using a single camera on the road has proposed in which the blob tracker algorithm is used with background subtraction (BS)process to achieve a real high-performance system. The proposed method has real time potentiality and any additional sensor input is not needed to perform this operation. The system's operation is performed on huge number of still images of vehicles and multiple video scenes in terms of completeness, correctness and overall quality parameters. The performance is evaluated on a data set collected from Bangladesh motorways provided with approximate ground truth gained from laser scans and also evaluated using real time video.

KEYWORDS

Blob Tracker, Video steam, Completeness, Correctness, Quality, Performance measure

1. INTRODUCTION

Vehicle detection and tracking system becomes a significant technology on both the private and public sectors of our country. All the traffic planning of smart transportation system has completely depends on this system for surveillance control and management. Nowadays, the traditional vehicle systems have declined due to the poor road signals, obstacles from the background, bad weather and occluded by other vehicles. So, vehicle detection system becomes the most eminent research for the evaluation of modern road system. Good traffic image increase the performance of these type of systems. Minimum energy consumed, light, robust and cheap single camera is used to collect the video scene for processing in our system. A motorbike or bicycle easily can mount and forward or rear facing the camera for capturing objects. Multiple single camera system is more complex and high energy consumed which is impractical to use in live monitoring. The angle and ranges of the complex camera is not compatible for sensing live

videos due to its high functionalities. To extract the visual details from the foggy conditions and sun light using the vision sensing device is complicated process. We introduced the vehicle detection using background subtraction(BS). It can be done by using background subtraction library like BGSLibrary or Haar Cascades. Only BS algorithm is not sufficient for vehicle tracking, blob tracker algorithm or library like cvBlon or OpenCvBlobLib is needed to use together. The rapid growth of modern road network increases the need of monitoring and managing the road traffic.

Traffic monitoring from real time video is an effective research for detecting and tracking vehicles using stillimages. In typical investigation a simple computer is used to track the parameters of the monitoring objects those seems to be questionable for the transport system. All the processing of these systems is done by manual operator using just a simple computer. Human operator also monitors the video. Normally video analysis can be done in many fashion. The most popular way of video processing is automatic which is done by the smart system. A typical system where manual user collect, process and make decision on processed data for transportation system. Another way of traffic monitoring is the manual user may use the digital system to process the video scene which is the combination of smart devices and human interactions. Human operator completes the task by watching the visual information sent through different cameras. This system is slow and difficult for operator to look at different screens at the same time. Nowadays manual systems are not used due to dense traffic on the road and increase the smart technologies for skilled users. In the combine system the processing is done by the computer vision and human operator so inefficiency may occur in the decision due to human interaction on major classification and activity perceptions. A smart system can automatically track and classify the object. It also intelligently detects the suspicious behavior. On the other hand, a manual system's scope is limited due to low level video scene, human interaction and sometimes for false data acquisitions by the human.

In urban environment to monitor the traffic jam on the road, vehicle detection of the violation of traffic rules are monitor by special ocular smart system [1]. To prevent serious accident video surveillance system plays a significant role with the help of specialized video analytical tools.

All the traffic surveillance system estimates the parameters of vehicle detection and tracking of intended traffic. In case of the vehicle are detected by different still images which due to presume that camera is stable[2,3]. The computer vision algorithm is used to identify and spot a preliminary model in a chain of continuous frames in order to track the object. There are lots of tracking strategy is outlined to track different vehicles. The size, height, color, license number, length are the main parameters those are captured from the video scene to detect the actual object class. All visual surveillance system begins with the detection of moving object ona video stream[4].

The paper is organized as follows. In section I we have discussed the state-of-the-art of vehicle detection and tracking and related work have present in section II. Section III and IV construct the proposed method and design and implementations. Result and discussion are presented in section V. Finally we conclude the paper in section VI.

2. RELATED WORKS

A broad literature exits with regard to detecting moving objects in video streams as well as creating accurate backgrounds from video frames. It is hard to solve the problems mentioned in one background subtraction method, so simulation of different BS methods from the literature and evaluation of their efficiency in many matrices over various video scene is implemented and found many results like as Efficiency of the BS algorithm[4]in Quality(83.71%)

Correctness(98%), Completeness(83.71%), and efficiency of another method from Ref.[12] in Correctness(98%), Completeness(82.33%), Quality(82.33%).

2.1. Vehicle Detection

Computer vision is the major research field for static images' object detection. The cars are used as the common object to study with the static images because of rigid structure, low appearance and presence in daily life [1-6]. Some research were focused more on high accuracy and recall using SVM rather than real time performance, using statistical methods such as SVM[2,5], PCA[3], Bayesian decision making [7] or Neural Networks [4]. A development in statistical learning for the identification of real-time artifacts appeared by the Viola and Jones cascaded classifier [8]. Viola and Jones algorithms follow up work was proposed into [8,9], aiming for automatic cascaded classifier. The classifier trained by the classification accuracy and the average time for classification. They added a time precision optimized cascaded classifier that can work without manual intervention to the original Viola-Jones algorithm. In [10] a different approach is introduced that is inspired by the part based detector success. But this model can run on 1-2 frames per second which is undesirable for the well detection performance.Complex algorithms are implemented for the urban environment to solve the relatively complex and challenging issues [11]. Simple heuristics based detection techniques are projected andutilize shadow cast on the road to identify cars in dark scenario[12]. U-shape curve on the car outer edges are used in [13], some relied on the vehicle symmetry [14,15]. By constraint on road locations to calculate the period of possible vehicle position, are often applied[16]. This method only shows success in real time, while the conclusions of the real world scenes are superficial. In fact, these papers often lack careful perceptible evaluation and comparison on some dataset and other methods which are publicly available. A complete survey of the techniques can be found atarticle [17].A current method on vehicle detection is the use of time multi body visual SLAM or motion parallax [1,18]. The vehicles are detected as oddity on a static scene layout, this allows for scene modeling and identification and monitoring of vehicles or pedestrians. Nonetheless, this method remains tested on a more complex scene where several moving vehicles can not be identified as separate objects easily separating. The WaldBoost based vehicle detector [6,9] are used in these paper to revels the real time performance ability for face detection from still images. It can be trained easily and can also generalize previously unrevealed vehicles. In this analysis, we count on the vehicle detector based on WaldBoost[6,9].

2.2. Vehicle Tracking

The algorithm for Particle Filter (PF) is referenced in [2] which is a famous methodology for vehicle following. It has been upheld on both to single item following [1,10] and on an all-encompassing structure that can track unknown objects [8,18]. The PF approach has an advantage that it can show entangled article elements by non-parametric, molecule based movement dispersion estimation. Multi-Hypothesis Tracking (MHT) is applied on [11] rather than PF. In MHT just a little arrangement of the pertinent movement clarification remains. The issue of the techniques referenced above is that, their reactivity drifts from the true object location, generally for long successions. They don't offer remedying techniques, in the end could not recognize when there are changes in object appearance, lighting conditions. As of late, discriminative strategies are getting famous in following as a forefront foundation classification [3,19]. The issue of composite movement displaying is refrained by looking through the area of the foreseen position through these methodologies. One valuable method for reducing the drifts is co-training. Incredible outcomes have been indicated utilizing these methodologies for distinguishing the adjustments in the item appearance.

3. PROPOSED METHOD

The proposed system comprised of a real time static traffic camera network that captured real time traffic video, processes traffic video site and then transmits the obtained parameters in real time. The focus of this study is to analyze the algorithmic part of such system. We represent vehicle detection and tracking system to work on video data. The system consists of two modules: video acquisition, video detection and tracking. The proposed system is mapped for the real tome videos where camera is used for recording. A threshold is represented as the connected component area and a vehicle will be detected and tracked if the detected area is over the threshold value. Distance between vehicle and camera is determined, so when the vehicle is in that range the connected component area for the vehicle will be maximum. The proposed system is represented in Fig. 1.

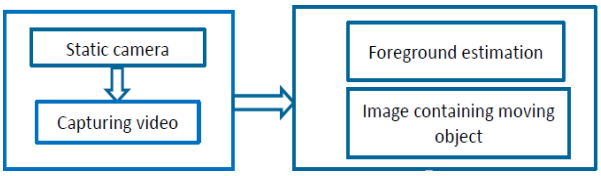

Figure 1.Block diagram of the proposed system.

For video acquisition, videos are captured using static camera. The camera network transmitted images to the central operation area in real time. The transmission process should be done onsite to save network bandwidth as it will only transfer the outcome evaluation. The whole process should also be carried out for real time video streaming for the purpose of bandwidth savings. The overall flow chart for the system is shown in Fig. 2.

For video detection and tracking, various background subtraction methods are simulated. This technique should solve the illumination condition, shadow, camouflage and background cutter problems. It is complicated to solve the motion segmentation problem by only one background subtraction technique, so simulation and performance evaluation is done on several video data of different situations. All the module of the system follows the following Constraint.

- System identification time should be lesser
- Must detect every type of vehicle
- Remain untouched by any kind of disturbances in images

Quality of tracking also depends on the following factors.

- The image captured should be in high quality, so that every feature of the image is clear.
- The camera should be fit at an angle that the images or videos do not suffer because of the bad angle and rotation.

4. DESIGN AND IMPLEMENTATION

Background Subtraction (BS) is a popular method for vehicle detection that can be done using a BS library like BGSLibrary. Another way for vehicle detection is Haar Cascades, based on Cascade Classifier for object detection. But this method is not a best choice because it has high false positive rate. That is why using BS algorithm with blob tracker algorithm or cvBlob library or OpenCvBlobLib is a good choice for vehicle detection.

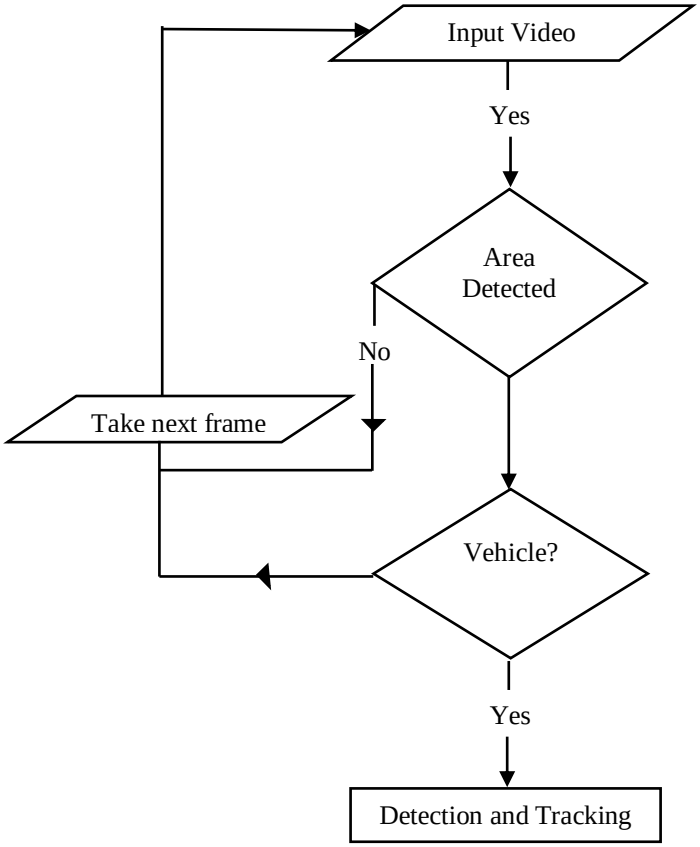

Figure 2. Flow chart of the proposed system.

BGSLibrary is a background subtraction library, latest version is 1.9.2. It was developed by Andrews Sobral. It provides a C++ framework based on OpenCV to work on videos, complies under Windows, Linux, Mac OS X. The library provides large number of algorithms by several authors. The library is free and the source code found under GNU GPL v3 license. The blob tracking system with five modules are presented in Fig.3.

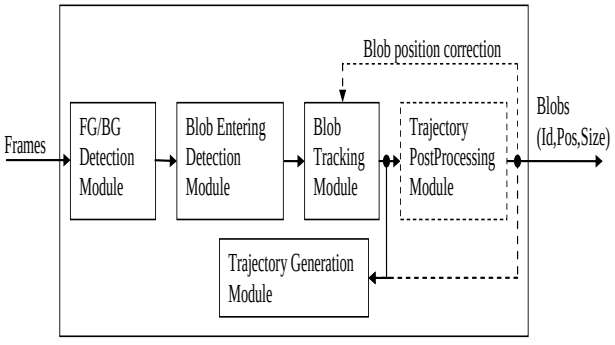

Figure 3. Blob tracking system.

The foreground and background segmentation for every pixel are performed by FG/BG Detection module of the blob tracker system. The new blob object which is appeared on the scene on each frame during captured is performed by Blob Entering Detection module. The Blob

Entering Detection module uses the result of FG or BG detection module to find the proper object.

The previous module results and locations of each new blob that entered loaded by Blob Tracking, module Trajectory Generation, and module that works as a saving function. It collects the positions of all blobs and save blob trajectory into hard disk as its final task.

Trajectory Post Processing is an optional modules and smoothing functions that are not included in any specific pipeline. At first we need to perform background subtraction and send the foreground mask to the OpenCvBlobLib or cvBlob library. Then the library will provide some procedures to get the basic, track and Id of the stirring objects. We can also track the angle of the object to detect the object perfectly.

5. RESULTS AND DISCUSSION

The system is tested on a laptop powered by Intel Core Duo CPU with clock speed 1.83 GHZ and RAM of 2GB, which is also tested on image sequences from highway scenes. The proposed system could detect and track most vehicles well.

Approximate results are discussed with the experiments done above, also performance analysis of the proposed model along with other current models are presented. To perform the evaluation, a numerical accuracy is measured using the parameters. We have found out the number of vehicles using the proposed techniques. The parameters used for the evaluation are defined as follows:

$$\text{Correctness} = TP/(TP+FP)*100$$
$$\text{Completeness} = TP/(TP+FN)*100$$
$$\text{Quality} = TP/(TP+FP+FN)*100$$

Here, True Positive(TP) represents the correctly pulled true vehicle' number; False Positive(FP) represents the incorrectly pulled false vehicles' number, False Negative(FN), represents the erased vehicles' number. The parameters mentioned above gives the effectiveness of the suggested techniques also other systems in the consideration is computed.

Table 1, 2 and 3 shows the efficiency of the proposed method in comparison to that of the BS algorithm and the method used in Ref. [11] in terms of three parameters which are correctness, completeness and overall quality.

Table 1.Efficiency of the BS algorithm.

InputVideo	TP	FP	FN	Correctness (%)	Completeness (%)	Quality (%)
Scene1	6	0	1	100	85.71	85.71
Scene2	3	0	6	100	50.00	50.00
Scene3	4	1	1	80	80.00	66.70

Table 2 Efficiency of the Method used inRef. [12].

InputVideo	TP	FP	FN	Correctness (%)	Completeness (%)	Quality (%)
Scene1	5	0	1	100	83.33	83.33
Scene2	3	0	6	100	50.00	50.00
Scene3	4	1	1	80	80.00	66.60

Table3.Efficiency of the ProposedMethod.

InputVideo	TP	FP	FN	Correctness (%)	Completeness (%)	Quality (%)
Scene1	6	0	1	100	85.71	85.71
Scene2	5	0	4	100	55.56	55.56
Scene3	6	1	1	100	85.71	75.00

It is observed from the Tables 1, 2 and 3 that the percentage of correctness, completeness and quality are better for the proposed method as compared to those of the other two methods under consideration. These results implied that the proposed method shows better performance than the BS algorithm and the method used in Ref. [11].

Fig. 5, 6, and 7 shows the graphical representation of the results presented in Tables 1, 2, and 3 respectively for the BS algorithm, the method proposed in Ref. [11] and our proposed method. From these bar graphs the idea become clear that in terms of the parameters like correctness, completeness and quality, the proposed method gives better scores than BS algorithm and method proposed in Ref. [11].

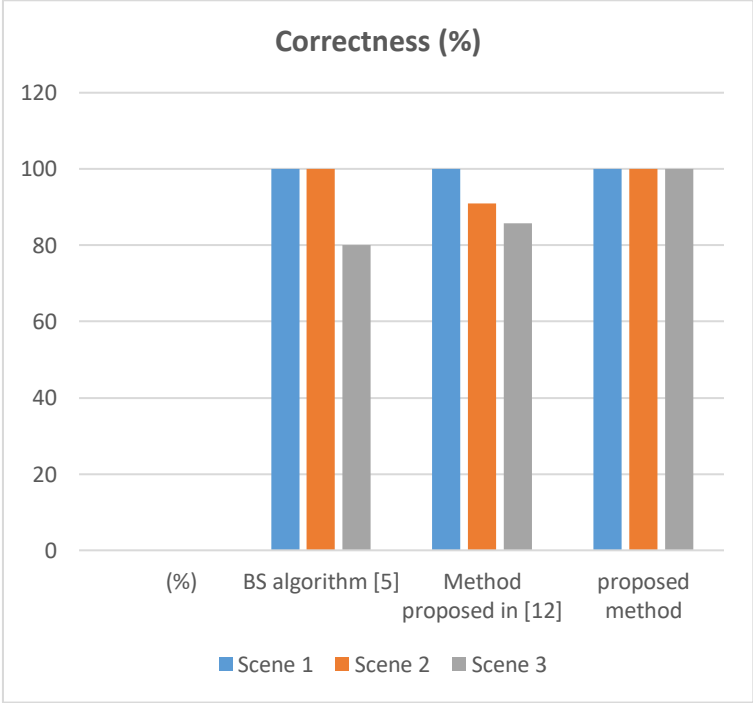

Figure 4. Correctness comparison.

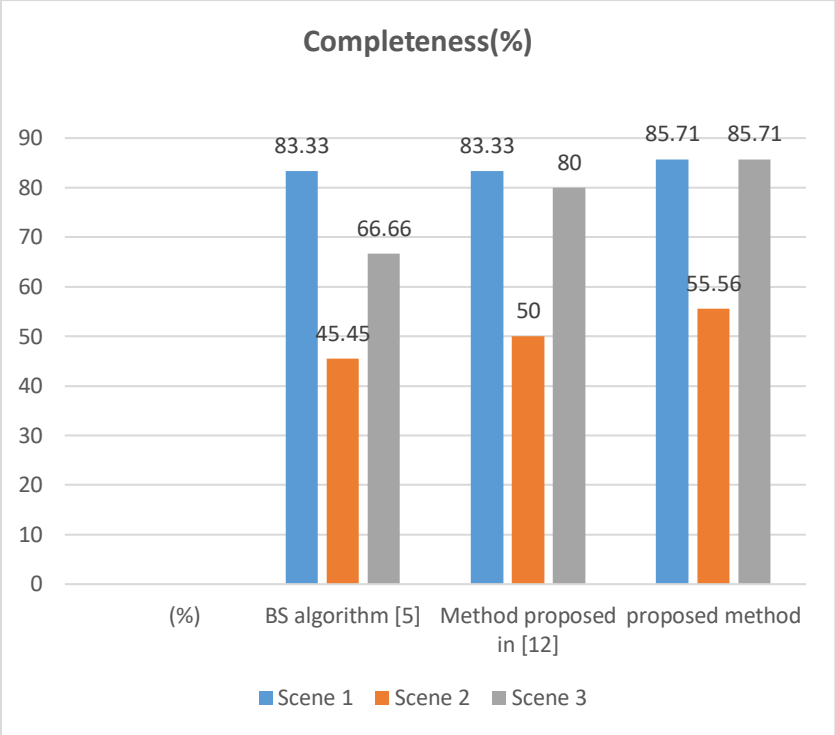

Figure 5. Completeness comparison.

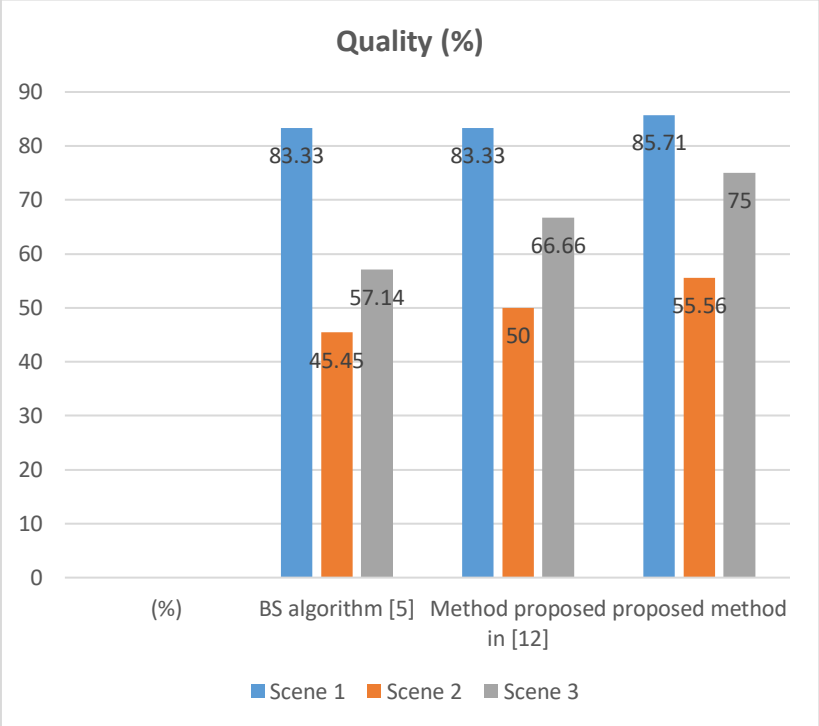

Figure 6. Quality comparison.

6. CONCLUSIONS

In this study a method of tracking and detecting the vehicles from the real time video steaming using background subtraction(BS) process with blob tracker algorithm has been proposed. The system's operation is performed on huge number of captured still images of vehicles and multiple video scenes and its efficiency is evaluated considering various performance parameters. Based on the experimental results it can be concluded that the proposed method performs better either in real time mode or in already stored video in terms of completeness, correctness and overall quality compared with other considered existing methods.

REFERENCES

[1] A. Elgammal, D. Harwood, and L. Davis, "Non-parametric model for background subtraction,'' In Computer Vision—ECCV 2000, Springer Berlin Heidelberg, pp. 751-767 (2000).

[2] Deepak Kumar Panda, "Motion detection, object classification and tracking for visual surveillance application," PhD diss. (2012).

[3] I. Haritaoglu, D. Harwood, and L.S. Davis, "W4: real-time surveillance of people and their activities," Pattern Analysis and Machine Intelligence, IEEE Transactions on 22, no. 8, pp. 809-830 (2000).

[4] A. Ajmal and I. Hussain, "Vehicle detection using morphological image processing technique," in Proc.IEEE International Conference on Multimedia Computing and Information Technology (MCIT2010), pp. 65–68, 2010.

[5] K. Toyama, J. Krumm, B. Brumitt, and B. Meyers, "Wallflower: Principles and practice of background maintenance," In Computer Vision, 1999; The Proceedings of the Seventh IEEE International Conference on, vol. 1, pp. 255-261(1999).

[6] M. Everingham, L. V. Gool, C. K. I. Williams, J. Winn and A. Zisserman, "The Pascal Visual Object Classes (VOC) Challenge," International Journal of Computer Vision, no. 2, vol. 88, Jun. 2010.

[7] Z. Sun, G. Bebis, and R. Miller , " "On-road Vehicle Detection using Gabor Filters and Support Vector Machines," in 14th Intern. Conf. on Digital Signal Processing (DSP), vol. 2, pp. 1019–1022 (2002).

[8] C. Papageorgiouand T.Poggio, "A Trainable System for Object Detection," Int. J. Comp. Vision, no. 1, vol. 38, pp. 15–33(2000).

[9] N.D.Matthews, P.E.An, D.Charnley, and C.J.Harris, "Vehicle Detection and Recognition in Grayscale Imagery," Control Engineering Practice, Vol. 4, no. 4 , pp. 473–479, (1996).

[10] P. Viola and M. Jones, "Rapid Object Detection using a Boosted Cascade of Simple Features," in Computer Vision and Pattern Recognition, 2001. CVPR 2001; Proceedings of the 2001 IEEE Computer Society Conference on, vol. 1, , pp. I511–I518 (2001).

[11] M. Daigavane, and P. R. Bajaj, "Real Time Vehicle Detection and Counting Method for Unsupervised Traffic Video on Highways," International Journal of Computer Science and Network Security, vol. 10, no. 8, pp. 112-117, (2014).

[12] J. Sochman and J. Matas, "WaldBoost - Learning for Time Constrained Sequential Detection," in CVPR, vol. 2, pp. 150–157(2005).

[13] L. Bourdev and J. Brandt, "Robust Object Detection via Soft Cascade," CVPR, pp. 236–243(2005).

[14] J. Wu and X. Zhang, "A PCA Classifier and its Application in Vehicle Detection,"IJCNN '01. International Joint Conference on Neural Networks, Proceedings vol. 1, pp. 600–604, (2001).

[15] L. Bourdev and J. Brandt, "Robust Object Detection via Soft Cascade," in CVPR, pp. 236–243(2005).

[16] E. Richter, R. Schubertand and G. Wanielik, " "Radar and Vision-based Data Fusion - Advanced Filtering Techniques for a Multi-object Vehicle Tracking System," in Intelligent Vehicles Symposium, 2008 IEEE, pp. 120–125 (2008).

[17] T. Kowsari, S.S. Bea uchemin, J. Cho, "Real-time Vehicle Detection and Tracking using Stereo Vision and Multi-view AdaBoost," 14th International IEEE Conference on Intelligent Transportation Systems (ITSC), 2011, pp. 1255–1260 (2011).

[18] Jon Arr´ospide, L. Salgado and M. Nieto, “Vehicle Detection and Tracking using Homography-based Plane Rectification and Particle Filtering,”in Intelligent Vehicles Symposium (IV), 2010 IEEE, pp. 150–155 (2010).

[19] A. Manzanera and J. Richefeu, "A new motion detection algorithm based on [Sigma]-[Delta] background estimation," Pattern Recognition Letters, vol. 28, no. 3, pp. 320–328, (2007).