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"Moving Object Tracking of Vehicle Detection": A Concise Review

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Abstract

Vehicle detection and tracking applications play an important role for military and civilian applications such as in highway traffic surveillance control management and traffic planning.This paper presents a review on the various techniques of On-Road Vehicle detection systems that are based on motion model. In this paper a literature Survey of previous and recent works is presented on vision-based vehicle detection using sensors. Detecting the objects in the video and tracking their motion to identify their characteristics has been emerging as a demanding research area in the domain of Image Processing and Computer Vision. The traffic image analysis comprises of three parts: (1) Traffic Analysis (2) Motion Vehicle Detection and Segmentation Approaches and (3) Vehicle Tracking Approaches. In this survey, we have classified these methods into various groups, and these groups are providing a detailed description of various representation methods and find out their positive and negative aspects.

Keywords: *Traffic surveillance, Vehicle detection, Traffic analysis, Blob tracking, Segmentation*

1. Introduction

Traffic accidents are the major problem in which millions of people die. To prevent the people from this problem one solution is to increase the significant application of video-based supervision system that is traffic surveillance.

Almost every vehicle detection system includes two basic stages: (1) Hypothesis Generation (HG) which hypothesized the location of possible vehicles in an image and (2) Hypothesis Verification (HV) which verifies the hypotheses [1-2]. This paper introduces a Motion based method of hypothesis generation. Motion based methods calculate the presence of vehicle by employing relative motion between sensor and scene obtained by calculation of optical flow [3]. It is also an effort to design and implement real-time oriented algorithms and systems that are highly adaptive to the road and traffic scenes based on domain-specific knowledge on road, vehicle, and control [4]. Automated motion detection and tracking is a challenging task in traffic surveillance.

Intelligent Transportation System (ITS) to monitor dynamic traffic phenomena becomes more important in various applications. Formulating dynamic traffic phenomenon, which describe traffic situations to adapt the requirements of dynamic traffic assignment models and ITS applications, is a valuable research area [5].

Sensing vehicles ahead and traffic situations during driving are important aspects in safe driving, accident avoidance, and automatic driving and pursuit. It is most challenging task to design a system that is capable of identifying vehicles ahead, moving in the same direction such as car, by tracking them continuously with an in-car video camera. The fundamental problem here is to identify vehicles in changing environment and illumination [6].

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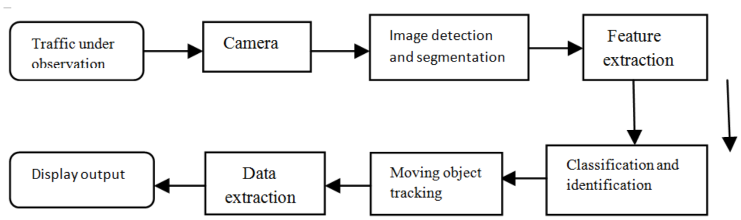

Figure 1. A Vehicle Analysis System in Typical Video

2. Literature Survey

A. Gyaourova, C. Kamath, S. and C. Cheung has studied the block matching technique for object tracking in traffic scenes. A motionless airborne camera is used for video capturing. They have discussed the block matching technique for different resolutions and complexes [7].

Yoav Rosenberg and Michael Werman explain an object tracking algorithm using moving cameras. The algorithm is based on domain knowledge and motion modelling. Displacement of each point is assigned a discreet probability distribution matrix. Based on the model, image registration step is carried out. The registered image is then compared with the background to track the moving object [8].

A. Turolla, L. Marchesotti and C. S. Regazzoni discuss the camera model consisting of multiple cameras. They use object features gathered from two or more cameras situated at different locations. These features are then combined for location estimation in video surveillance systems [9].

One simple feature based object tracking method is explained by Yiwei Wang, John Doherty and Robert Van Dyck. The method first segments the image into foreground are gathered for each object of interest. Then for each consecutive frame the changes in features are calculated for various possible directions of movement. The one that satisfies certain threshold conditions is selected as the position of the object in the next frame [10].

Ci gdem Ero glu Erdem and Bulent San have discussed a feedback –based method for object tracking in presence of occlusion. In this method several performance evaluation measures for tracking are placed in a feedback loop to track non rigid contours in a video sequence [11].

By tracking the object in motion, occlusion Alok K.Watve and Shamik Sural explain and compares the result with various algorithms like Kalman Filtering for foreground extraction and camera modelling for Background Subtraction with multiple cameras in both fixed and moving object. Extracting the feature of tracking object in Block matching calculates the frame difference; in exploiting the domain Knowledge the author calculate the motion parameters with the displacement of scale parameters and displacement vector. In compressed domain object tracking method is calculated using bounding rectangle of an object with different frames by using histogram [12].

P. Subashini, M. Krishnaveni,Vijay Singh discuss the object tracking in Frame Rate Display and Color conversion with background subtraction with different techniques like Estimating median overtime, Computing median overtime, Estimating moving objects. With the comparison of various segmentation algorithms like Sobel Operator, Canny operator and Roberts operator the object is segmented through edge detection and its derivate are calculated. Through region filtering in color segmentation color samples for skin is processed and is computed to mean and covariance over color channels. Object tracking for moving

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object through motion vector is calculated through optical flow algorithm and Blob analysis for binary feature of an image is calculated. Tracking of object is measures by the position done by tracking in region filtering and the information of the object is created an estimation of new object [13].

Background subtraction and motion estimation for tracking an object. DCT domain background subtraction in Y plane is used to locate candidate objects in subsequent I-frames after a user has marked an object of interest in the given frame. DCT domain histogram matching using Cb and Cr planes and motion vectors are used to select the target object from the set of candidate objects [14].

A tracking and detecting algorithm that predicts the object by predicting the object boundary using block motion vectors followed by updating the contour using occlusions/disclosing detection. Another group of algorithms deals with object tracking using adaptive particle filter [15-16], kalman filter [17-19].

The efficiency by reducing the number is computations for object tracking in video frames is tracked with the adaptive particle filter, kalman filter and for color frames the image is captured into transform to YCbCr space with the wavelets coefficient transform for detecting moving objects [20].

A weighted adaptive scalable hierarchical (WASH) tree based video coding algorithm is proposed with low-memory usage. The standard coding uses three separate lists to store and organize tree data structures and their significance, which can grow large at high rate and consume large amounts of memory. In the proposed algorithm, value added adaptive scale down operator discards unnecessary lists and the process length of the sorting phase is shortened to reduce coding time and memory usage. Spatial and temporal scalability can be easily incorporated into the system to meet various types of display parameter requirements and self-adapting rate allocations are automatically achieved. Results show that the proposed method reduces memory usage, run time and improves PSNR [21].

A novel approach for car detection and classification is presented, to a whole new level, by devising a system that takes the video of a vehicle as input, detects and classifies the vehicle based on its make and model. It takes into consideration four prominent features namely Logo of vehicle, its number plate, color and shape. Logo detector and recognizer algorithms are implemented to find the manufacturer of the vehicle. The detection process is based on the Adaboost algorithm, which is a cascade of binary features to rapidly locate and detect logos. The number plate region is localized and extracted using blob extraction method. Then color of the vehicle is retrieved by applying Haar cascade classifier to first localize on the vehicle region and then applying a novel algorithm to find color. Shape of the vehicle is also extracted using blob extraction method. The classification is done by a very efficient algorithm called Support vector machines. Experimental results show that our system is a viable approach and achieves good feature extraction and classification rates across a range of videos with vehicles under different conditions. Edge matching, Divide-and-Conquer search, Gradient matching, Histograms of receptive field responses, Pose clustering, SIFT; SURF etc are some of the approaches applied. All these methods are either Appearance based methods or Feature based methods. They lag in one or the other way when it comes to real time applications. So there has been a need for creating a new system that could combine positive aspects of both the methods and increase the efficiency in tracking objects, when it comes to real life scenario. [22].

Daniel Marcus Jang proposed the Car-Rec search framework is made up of four stages: feature extraction, word quantization, image database search, and structural matching [23]. Car-Rec differs from other car identification systems in that it focuses on efficiently searching

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a large database of car imagery, using quantized feature descriptors to find a short list of likely matches. This list is then re-ranked with a structural verification algorithm [22].

The merits of this method is that it uses SIFT in place of SURF feature extraction or Lucerne search and the structural verification algorithm may be swapped out for alternative choices. Its modular framework can be applied to general image recognition tasks, particularly with similar image search in large image databases. The demerit of this method is handling imagery with background noise information.

3. Traffic Analysis and Incident Detection

Traffic flow is the study of interactions between vehicles, drivers, and background obstacles such as road signals, trees and weather conditions with the goal of understanding and developing an optimal road network with efficient movement of traffic and minimal traffic congestion problems. Traffic flow becomes a lively subject of research. The traffic flow theory is a new science, which is related to understanding of traffic processes and to optimize these processes through proper design and control [24]. The first attempt to give a mathematical theory of traffic flow dated back to the 1950s. Vehicle classification in a traffic flow is considered a difficult task due to similarity in appearances among different vehicles. During the past 50 years, a wide range of traffic flow models and theories have been developed [25].

The models can be classified according to:

1. Scale of the Independent Variables (Continuous, Discrete, Semi-discrete)
2. Representation of the Processes (Deterministic, Stochastic)
3. Level of detail (Microscopic with high detail, Mesoscopic with medium detail, Macroscopic with low detail)

4. Motion Vehicle Detection and Segmentation Approaches

The detection of moving object's region of change in the same image sequence which captured at different intervals is one of interesting field in computer vision [26]. In reality, road traffic can be broadly classified into two categories, homogeneous and heterogeneous. A homogeneous traffic can be described as a hypothetical synchronized flow of traffic of identical vehicles in which all vehicles move with the same time-independent speed and a heterogeneous traffic condition is unsynchronized and unregulated. One of the video surveillance branches is the traffic image analysis which included the Moving/Motion Vehicle Detection and Segmentation approaches [27]. Even though various research papers have been showed for moving vehicle detection but still a tough task is to detect and segment the vehicles in the dynamic scenes. It consists of three main approaches to detect and segment the vehicle, as mentioned below (1) Background Subtraction Methods (2) Feature Based Methods (3) Frame Differencing and Motion Based methods.

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From the figure (a) shows the original video, (b) shows that the video is converted to grey scale and (c) shows the segmented output of the video in performing the frame difference of background subtraction.

4.1 Background Subtraction Methods

The process of extracting moving foreground objects (input image) from stored background image (static image) or generated background frame form image series (video) is called background subtraction [28]. It is an advanced background subtraction technique used to detect and extract features for vehicles in complex road scenes in traffic surveillance. The non-adaptively is a drawback which is raised due to the change in lighting and the climatic situations [29]. A significant contribution suggested the statistical and parametric based techniques which are used for background subtraction methods; some of these methods used the Gaussian probability distribution model for each pixel in the image [30].

4.2 Feature Based Methods

Another trend which the researchers investigate and motivate on sub-features like the edges and corners of vehicles, the moving objects segmented from background image by collecting and analyzing the set of these features from the movement between the subsequent frames. Furthermore, the feature based method supports the occlusion handling between the overlapping vehicles and compared with background subtraction method represents a less level from the computational difficulty view [31]. Several approaches can discriminate the object from the background by using its features, a trainable object detection approach has proposed by [32]. This approach is based on learning and employs a set of labelled training data which used for labelling the extracted objects features. In addition, it uses a Haar wavelets technique as feature extraction method and also uses support vector machine classifier for classification process. Moreover, face, people and cars static images datasets have tested on this approach.

4.3 Frame Differencing and Motion Based Methods

The frame differencing is the process of subtracting two subsequent frames in image sequence to segment the moving object (foreground object) from the background frame image. The motion segmentation process is an important and fundamental step in detecting vehicle in dynamic view which is done by isolating the blobs (moving objects).Blobs can be created through analyzed and assignment sets of pixels to different classes of objects which is based on orientations and speed of their movements from the background of the motion scene [33].

5. Vehicle Tracking Approaches

Tracking objects in video processing is an important and fast growing step for tracking the moving objects in visual-based surveillance systems. The object tracking in video sequence of surveillance camera becomes a challenging and demanding task for researchers to improve recognition and tracking performances [34]. To track the physical appearance of moving objects such as the vehicles and identify it in dynamic scene, It has to locate the position, estimate the motion of these blobs and follow their movements between two of consecutive frames in video scene [35].

Several vehicle tracking methods have been illustrated and proposed by several researchers for different issues, it consists of:

1. Region-Based Tracking Methods
2. Contour Tracking Methods
3. 3D Model-Based Tracking Methods
4. Feature-Based Tracking Methods
5. Color and Pattern-Based Methods

5.1 Region-Based Tracking Methods

In these methods, the region of the moving objects are tracked and used for tracking the vehicles. These regions are segmented using the subtracting process between the input frame image and prior stored background image. This model worked on series of traffic scenes recorded by a stable camera for automobiles monocular images and provided position and speed knowledge for each vehicle as long as it is visible. The processing algorithms of this model represented by three levels: raw images, region level, and vehicle level.

5.2 Contour Tracking Methods

These methods depend on contours (the boundaries of vehicle) which are updated dynamically in successive images of vehicle in Tracking Vehicle Process [36]. These methods provide more efficient descriptions of objects than Region-Based Methods and have been successfully applied to practice. But objects occlusion and automatic initialization of tracking are difficult to handle and tracking precision is limited by a lack of precision in the location of the contour.

5.3 3D Model-Based Tracking Methods

A vehicle anisotropic distance measurement achieved through the 3D geometric shape of vehicles. A new 3D model-based vehicle detection and depiction framework is based on a probabilistic boundary feature grouping, which is used for vehicle detection and tracking process [37].In this paper, the occlusion of vehicles detection process uses a 3D solid cuboid form with up to six vertices, and this cuboid is used to fit any different types and sizes of vehicle images by changing the vertices for a best fit. Therefore, vehicle detection, segmentation and tracking can be achieved efficiently due to changes in the region proportion, prototype width and height with consideration to previous images.

5.4 Feature-Based Tracking Methods

The particular vehicles are detected, segmented and tracked in image sequence by assembling, bunching and approximating the 3D world coordinates of vehicle's feature points. An iterative and distinguishable framework based on edge points as features is used in similarity process, these features represents a large region of set of features forms a strong depiction for object classes. This proposed framework showed a good performance for vehicle classification in surveillance videos [38]. A linearity feature technique is a proposed line-based shade method which uses line groups to remove all undesirable shades and properly undertakes the occlusion resulting from shades.

5.5 Color and Pattern-Based Tracking Methods

This technique is used to analyze color of image series of traffic supervision views [39]. Through the practical experiments, this system proven to work well under several weather situations, and it is insensitive to light variations. This model-based system is used for real-

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time traffic supervision for continuous visual tracing and classification of vehicles for busy multi-lane highway scene [40].

7. Conclusion and Future Work

This paper provides a short and snappy study on the proposed techniques which have used in traffic video. It focuses in these areas, namely Traffic Analysis and Incident Detection, Segmentation Approaches and Vehicle Tracking Approaches. These types shows the detailed information about how the traffic surveillance systems use Image Processing Methods and analysis tools to detect, segment, and track the vehicles. More specifically, this review gives better understanding and highlights the issues and their solutions for traffic surveillance. We rely on temporal information of features and their motion behaviors for vehicle identification, which compensates for the complexity in recognizing vehicle shapes, colors, and types. The paper work can be extended using the optical flow method and Background Subtraction technique which helps to find out the speed of the vehicle from the video sequence. In optical flow method the distance travelled by the vehicle is calculated using the movement of the centroid over the frames.

References

[1] Z. Sun, R. Miller, G. Bebis and D. DiMeo, "A Real-Time Precrash Vehicle Detection System," Proc. IEEE Int'l Workshop Application of Computer Vision, (**2002**) December.
[2] Vehicle Detection by Independent Parts for Urban Driver Assistance "IEEE transactions on intelligent transportation systems, vol. 14, no. 4, (**2013**) December.
[3] IEEE transactions on intelligent transportation systems, vol. 12, no. 2, (**2011),** June.
[4] FLEXYS: Motion-based Traffic Analysis and Incident Detection (IBBT/VUB-ETRO)
[5] IOSR Journal of Engineering (IOSRJEN) www.iosrjen.org ISSN (e): 2250-3021, ISSN (p): 2278-8719 Vol. 04, Issue 07 (July. 2014), ||V4|| PP 39-43
[6] Y. Rosenberg and M. Weman, "Real Time Object Tracking from a Moving Video Camera: A software approach on PC-Applications of Computer Vision", (**1998**), WACV '98.Proceedings.
[7] A. Turolla, L. Marchesotti and C. S. Regazzoni, "Multicamera Object tracking in video surveillance applications".
[8] Ci gdem Ero glu Erdem and Bulent San-Video Object Tracking With Feedback of Performance Measures-IEEE Transactions on circuits and systems for video technology, vol. 13,no. 4, (**2003**), April.
[9] A. K. Watve and S. Sural, "A Seminar on Object tracking in Video Scenes".
[10] P. Subashini, M. Krishnaveni, V. Singh, "Implementation of Object Tracking System Using Region Filtering Algorithm based on Simulink Blocksets", International Journal of Engineering Science and Technology (IJEST),vol. 3, no. 8, (**2011),** August, pp. 6744-6750, ISSN:0975-5462.
[11] A. Aggarwal, S. Biswas, S. Singh, S. Sural and A. K. Majundar, "Object tracking using background subtraction and motion estimation in MPEG videos", Springer-Verlag Berlin Heidelberg, ACCV 2006, LNCS vol. 3852, pp.121-130.
[12] Z. Duan, Z. Cain and J. Yu, "Occlusion detection and recovery in video object tracking based on adaptive particle filters," IEEE trans.China, pp. 466-469, [Chinese Control and Decision Conference CCDC2009].
[13] T. Xi, S. Zhang and S. Yan, "A robust visual tracking approach with adaptive particle filtering," IEEE Second Intl. Conf. On Communication Software and Networks, (**2010**), pp. 549-553.
[14] X. Zhang, W. Hu, Z. Zhao, Y.-G. Wang, X. Li and Q. Wei, "SVD based kalman particle filter for robust visual tracking", IEEE (**2008**), 978-1-4244-2175-6.
[15] Y.-h. Li, Y.-g. Pang, Z.-x. Li and Y.-l. Liu, "An intelligent tracking technology based on kalman and mean shift algorithm", IEEE Second Intl.Conf. on Computer Modelling and Simulation, (**2010**).
[16] M. Mehta, C. Goyal, M. C. Srivastava and R. C. Jain, "Real time object detection and tracking: Histogram matching and kalman filter approach", IEEE (**2010**), 978-1-4244-5586-7.
[17] A. Purushothaman, K. R. S. Kumar, R. Rangarajan and A. Kandasawamy, "Compressed Novel Way of Tracking Moving Objects in Image and Video Scenes", European Journal of Scientific Research, vol. 64, no. 3, (**2011**), pp. 353- 360, ISSN 1450-216X.
[18] G. Suresh, P. Epsiba, M. Rajaram and S. N. Sivanandam, "Image and Video Coding with a New Wash Tree Algorithm for Multimedia Services", Journal of Theoretical and Applied Information Technology, (**2005–2009**), pp.53- 59.

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[19] T. S. Kumar, and S. N. Sivanandam, “A Modified Approach for Detecting Car in video using Feature Extraction Techniques”, European Journal of Scientific Research, ISSN 1450- 216X, vol. 77, no. 1, (**2012**), pp. 134-144.
[20] D. M. Jang and M. Turk, “CarRec: A Real Time Car Recognition System”, WACV '11 Proceedings of the 2011 IEEE Workshop on Applications of Computer Vision.
[21] L. Juan and O. Gwun, “A Comparison of SIFT, PCA-SIFT and SURF”, International Journal of Image Processing (IJIP), (**2008**) September 10.
[22] M. Chaple and S. S. Paygude, “Vehicle Detection and Tracking from Video frame Sequence”, International Journal of Scientific & Engineering Research, vol. 4, no. 3, (**2013**), March, ISSN 2229-5518.
[23] S. P. Hoogendoorn and P. H. L. Bovy, “State-of-the-art of vehicular traffic flow modeling”, Journal of Systems and Control Engineering, vol. 215, no. 4, (**2001**), pp. 283, 303.
[24] Video based Vehicle Detection and Classification in Heterogeneous Traffic Conditions using a Novel Kernel Classifier (IETE JOURNAL OF RESEARCH | VOL 59 | ISSUE 5 | SEP-OCT 2013)
[25] Signal & Image Processing: An International Journal (SIPIJ), vol. 5, no. 1, (**2014**) February.
[26] L. Vasu, “An effective step to real-time implementation of accident detection system using image processing”, Master of Science, Oklahoma State University, USA, (**2010).**
[27] T. E. Boult, “Frame-rate Omni directional surveillance and tracking of camouflaged and occluded targets”, in Visual Surveillance, (**1999**), Second IEEE Workshop on, (VS'99), 1999, pp. 48-55.
[28] G. Xiang, “Error analysis of background adaption”, in Computer Vision and Pattern Recognition, (**2000**), Proceedings, IEEE Conference on, 2000, vol. 1, pp. 503-510.
[29] I. Haritaoglu, “W4: Real-Time Surveillance of People and Their Activities”, Pattern Analysis and Machine Intelligence, IEEE Transactions on, vol. 22, (**2000**), pp. 809-830.
[30] G. C. De Silva, “Automation of Traffic Flow Measurement Using Video Images”, Master of Engineering, University of Moratuwa, Sri Lanka, (**2001**).
[31] D. Koller, “Towards robust automatic traffic scene analysis in real-time”, in Decision and Control, Proceedings of the 33rd IEEE Conference on, vol. 4, (**1994**), pp. 3776-3781.
[32] W. Zhang, “Moving vehicles detection based on adaptive motion histogram”, Digit. Signal Process, vol. 20, (**2010**), pp. 793-805.
[33] F. Porikli and A. Yilmaz, “Object Detection and Tracking”, in Video Analytics for Business Intelligence. vol. 409, C. Shan, Eds., ed: Springer Berlin Heidelberg, (**2012**), pp. 3-41.
[34] S. Rhee, “Vehicle Tracking Using Image Processing Techniques”, in Rough Sets and Current Trends in Computing. vol. 3066, S. Tsumoto, et al., Eds., Ed: Springer Berlin Heidelberg, (**2004**), pp. 671-678.
[35] L. Li, S. Ranganath, H. Weimin and K. Sengupta, “Framework for Real-Time Behavior Interpretation from Traffic Video”, IEEE Tran. On Intelligent Transportation Systems, vol. 6, no. 1, (**2005**) pp. 43-53.
[36] K. H. Lim, “Lane-Vehicle Detection and Tracking”, Proceedings of the International Multi-Conference of Engineers and Computer Scientists (IMECS 2009), vol. 2, (**2009**), pp. 5–10.
[37] D. Koller, N. Heinze and H. Nagel, “Algorithmic Characterization of Vehicle Trajectories from Image Sequence by Motion Verbs”, Proc. IEEE Int’l Conf. Computer Vision and Pattern Recognition, (**1991**), pp. 90-95.
[38] A. Giachetti, M. Campani, and V. Torre, “The Use of Optical Flow for Road Navigation,” IEEE Trans. Robotics and Automation, vol. 14, no. 1, (**1998**), pp. 34-48.

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