A Survey on Vehicle Detection Techniques in Aerial Surveillance

Veena Ramakrishnan
M-tech, Department of Computer Science
Karunya University

A. Kethsy Prabhavathy
ME, Department of Computer Science
Karunya University

J. Devishree, PhD.
M.E PhD, Department of Electrical Engineering
Anna University, Chennai

ABSTRACT

Vehicle detection techniques keeps on developing nowadays and existing techniques keeps on improving. This greatly aids in traffic monitoring, speed management and also in military and police. Aerial view has the advantage of providing a better perspective of the area being covered. So in this area experts make use of the aerial videos taken from aerial vehicles. Detection of vehicle can be either from the dynamic aerial imagery, wide area motion imagery or the images can be of low resolution and static in nature. The purpose of this technical report is to provide a survey of research related to the application of vehicle detection techniques for traffic management and other applications.

Keywords

Vehicle detection, aerial surveillance, normalized color, linear svm classification, boosting HOG.

1. INTRODUCTION

The recent growth in the number of vehicles on the roadway network has forced the transport management agencies to rely on advanced technologies to take better decisions. In this perspective aerial surveillance has better place nowadays. Aerial surveillance provides increased monitoring results in case of fast-moving targets because spatial area coverage is greater. Thus aerial surveillance is supplement for ground-plane surveillance systems.

One of the main topics in intelligent aerial surveillance is vehicle detection and tracking. The difficulties involved in the aerial surveillance include the camera motions such as panning, tilting and rotation. Also the different camera heights largely affect the detection results.

Vision based techniques is one of the most common approach to analyze vehicles from images or videos. The view of vehicles will vary according to the camera positions, lighting conditions and background situations. The existing vehicle detection techniques are based on a large variety of techniques. Hierarchical model proposed by Hinz and Baumgartner [22] which describes different levels of details of vehicle features and detection method based on cascade classifiers has the disadvantage of lots of miss detections. Vehicle detection algorithm based on symmetric property [23] of car shapes is prone to false detections. The high computational complexity of mean-shift segmentation algorithm is a major concern in the existing methods.

This technical report provides a survey on the existing methods which to an extent overcomes the disadvantages mentioned earlier. One method utilizes color transformation in case of still images and an approach tends to utilize wide area motion imagery. Another technique seems to provide detection in low resolution strategy and another based on Histogram of Oriented Gradient (HOG) features.

2. DETECTION USING NORMALIZED COLOR AND EDGE MAP

Luo-wei tsai, Jun-wei hsieh, Kuo-chin fan *et al*. [1] proposed a novel detection method using color transform model. The detection procedure is done in different stages. In the first stage a color transformation model is used to easily identify the vehicle pixels from backgrounds .The technique which is adopted for this is dimensionality reduction. Beginning of the technique follows the collection of several thousands of training images. For this all colors of input pixels are projected on the color space. The classification is carried out by means of a Bayesian classifier. The detected pixel corresponds to a vehicle. Different vehicle hypothesis are generated from each detected pixels. The verification of hypothesis is done by edges, coefficients of wavelet transform and corners. An optimal vehicle classifier can be formed by using proper weights from a set of training samples. By using this method the authors insist that vehicles can be very robustly and accurately verified and detected from static images.

3. CONTEXT-DRIVEN MOVING VEHICLE DETECTION IN WIDE AREA MOTION IMAGERY

Detection of moving vehicles in wide area motion imagery has many promising applications nowadays. As the need increases the challenges in this area also keeps on increasing. The authors rely on a novel vehicle detection framework which incorporates the scene context too.

A step wise framework is insisted by the authors who include the motion detection firstly. After the task the detection of vehicles is done by the trained classifier. The second step does the most prominent feature in the work that is the usage of the scene context information. The next step deals with the usage of the shape and gradient distribution.

In the motion detection phase stabilization operation is seemed to be carried out which considerably eliminates the unwanted motions from a dynamic video sequence. Hansen *et al*. [21] defined an affine model for the operation of motion detection. Background subtraction operation follows the operation.

The next phase which comes in detail is binary classification. The actual task performed in the phase is the vehicle detection. Classification is carried out by support vector machine along with considering the features such as HOG and size.HOG features means histogram of oriented gradient which represents the object contours to an extent. Size features are considered for distinguishing the vehicles from the false alarms as vehicles have consistent size and shape representations.

Road context extraction is the final step which the authors rely on. In the categorization multiobject tracking is carried out by exploring the trajectories of objects. Road network has then to be determined from the obtained trajectories. The task of multi-object tracking is carried out by analysis of short tracks and then these tracklets are further associated to form longer tracklets.

4. ROBUST VEHICLE DETECTION IN LOW RESOLUTION AERIAL IMAGERY

In case of utilizing, Daniel A. lavigne *et al*. [3] makes use of aerial images which has up to an average 11.2cm/pixel resolution. In this methodology authors explore Scale Invariant Feature Transform (SIFT) .This technology effectively generates all the keypoints.SVM is also utilized to classify these key points to an extent.

Scale Invariant Feature Transform (SIFT) is a technique which is invariant to rotation, scaling, illumination changes etc. The task is effective for the natural outdoor images. The advantage which attracts the authors is that the output is affected by noise and distortion to a very low extend.

SVM or Support Vector Machine is a supervised learning algorithm. This algorithm greatly aids in classifying the generated key points in the learned way. Hyper plane concept is used to separate the key points to separate classes. For this purpose the features has to map to a new space and on this space only the hyper plane separation is done.

The next and final stage of the technique is the usage of Affinity Propagation algorithm (AP) on the separated key points. This aids in the unsupervised clustering of the key points generated. The main task in the method of clustering is the finding out of a center for the clusters. Cluster centers have to be developed in such a way that the instances or data should attain stability. Stability in the sense it should not transfer from one cluster to another. This reduces the error rate.

5. LINEAR SVM CLASSIFICATION USING BOOSTING HOG FEATURES FOR VEHICLE DETECTION IN LOW-ALTITUDE AIRBORNE VIDEOS

In this method Xuelong Li et *al.* [4] introduce an extension of the HOG features overcoming the disadvantages. The newly develops technique is known as boosting HOG feature. Adaboost classifier is used for this boosting HOG features. These features are utilized in training a linear SVM classifier. This framework utilizes low-altitude airborne platform. The linear SVM classification is used for the final vehicle classification.

The method is divided into two parts which includes feature description and classifier training. The HOG features have the disadvantage of having high dimensionality. Boosting HOG features overcome the disadvantage by reducing the dimensionality. Hog features are actually considered as a histogram. The bins of the histogram are representatives of the weak classifiers. Adaboost training is required to translate the weak to strong classifiers. These strong classifiers are on the way combined to construct a feature vector. The final stage contributes by training the SVM classifier for the final output of vehicle detection.

6. COMPARISON

The inspection of the four different techniques in vehicle detection are summarized to table I which helps to distinguish between the advantages and disadvantages of the techniques which utilizes different input images and videos taken at different scenarios. To clearly illustrate the differences between the different techniques available the different parameters such as technique, false alarm rate, training samples and conditions of working are taken into consideration. Technique clearly depicts the method used for detection. False alarm rate is the important parameter which indicates the performance of the method. The number of training samples in the ideal method is to be less so the research in that way also should be made in order to train the model with less number of training samples. Working conditions gives the actual platforms in which each of this method works. The false alarm rate and the conditions of working will further contribute to the research in this area. Inspite of the SVM technique the area deals with another technique such as SIFT which considerably reduces the false alarm rate. The actual accuracy rates of all the different techniques are illustrated in table II which greatly aids the inspectors in their relative research works.

The performance measures such as accuracy and false alarm rate are compared for the research purpose. Analysis of the techniques shows that context information contributes most for getting greatest detection results. False rate also seems to reduce to a considerable amount. Authors insist on increasing the accuracy of the vehicle detection. The comparison of the performance matrices in the detection method is compared to ease the researchers work to found out the ideal method in the existing ones and then do further development. This development should actually reduce the distance to the method which gives the actual detection accuracy with considerably less execution time. The graph insists the highest accuracy rate of 95% which relates to the method which incorporates the road network information along with multi-object tracking. The area consists of continue development in the clarity perfection of detected images.

The fig. 1 below clearly depicts the accuracy rates changing according to the methods used during the vehicle detection. New researches relating to this area deals with how to reduce the false alarm rate so proportionally the detection accuracy will increase. Table II clearly depicts that the technique with SVM and HOG features produce high false alarm rate compared to other methods but instead of that if context extraction information is also included then false alarm rate is gradually decreased and accuracy rises proportionally. Table I and Table II also demonstrate that the context information is better than all other three methods.

Table 1.Comparison of four different vehicle detection methods

Topic	Technique	False alarm rate	Training samples	Conditions of working
Using normalized color and edge map	Color transform model	Due to RBF network	Large number required.	Works better in sunny days.
Using low resolution aerial imagery	SIFT with SVM and AP	SIFT reduces FAR	Very less number	Irrespective of appearance
Context driven moving vehicle detection	SVM and HOG and context extraction.	Reduces Context extraction.	Uses the CLIF dataset	Works in low contrast images also.
Using boosting HOG features	Boosting HOG with linear SVM	Has high false alarm rate.	More than 3 hours of video are taken.	For urban video segment.

Table 2.Detection accuracy and false alarm rate using four different detection methods

Vehicle detection method	Accuracy	False alarm rate
Normalized color and edge map	94.9%	8.5%
Low resolution aerial imagery	92.16%	7.26%
Context driven detection	95%	7.17%
Linear SVM and boosting HOG	90%	10%

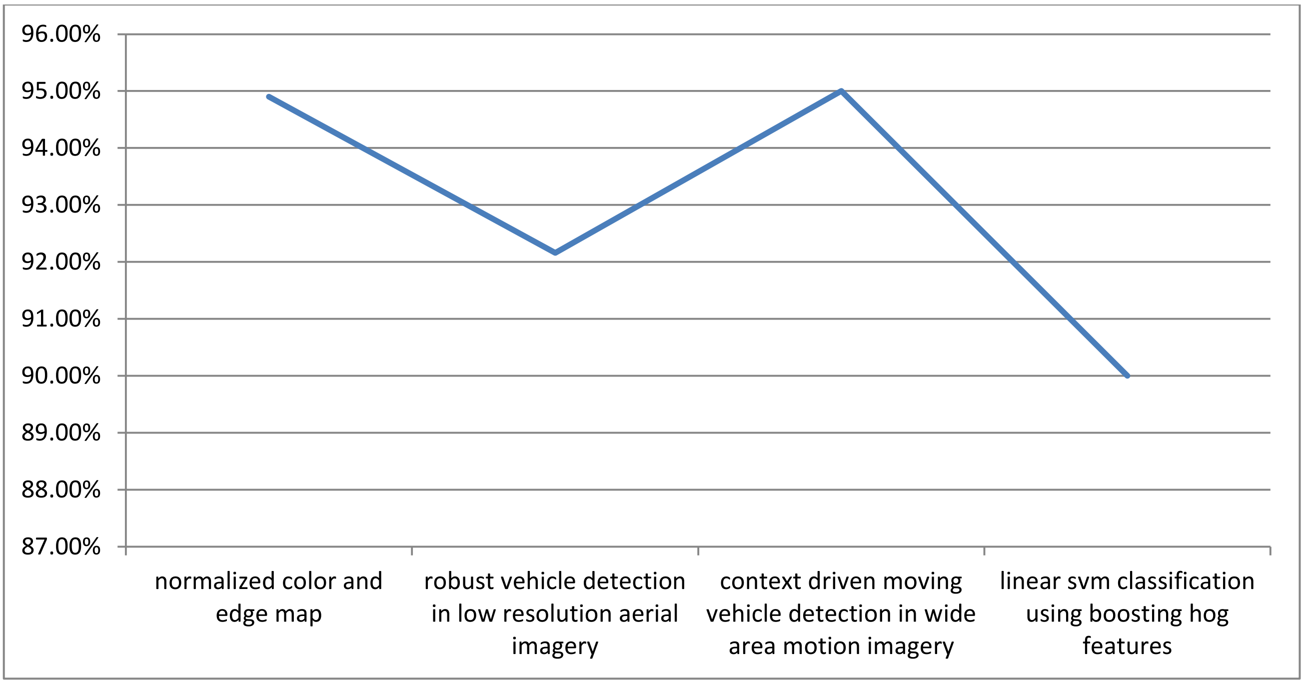

Fig 1: Detection Accuracy

7. CONCLUSION

The paper discusses about four vehicle detection techniques each one having advantages and disadvantages. The main aim of this inspection is to explore an ideal approach of nearly no false alarms and high detection accuracy. For an ideal method number of training samples should also be considerably low. The method using normalized color and edge map requires a large number of training samples and it is observed that the method using the SIFT and AF considerably reduces it. The other two methods mainly make use of HOG features for the detection and SVM for classification but the simple HOG has the disadvantage of high dimensionality which reduces the detection speed and accuracy. These methods specifically rely on the CLIF dataset and also on the urban traffic videos which constricts its usage. The survey points to the fact that vehicle detection using dynamic Bayesian networks can be applied on a broader extent and the false detections is considerably reduced and it works well by taking only a small training dataset which is a great advantage. It is observed that using background removal and enhanced edge and corner detection has increased the detection accuracy which is appreciatable. The experimental results demonstrate the flexibility and good generalization abilities of proposed method on a challenging data set with aerial surveillance images taken at different heights and under different camera angles.

8. REFERENCES

[1] Luo-wei tsai, Jun-wei hsieh, member, IEEE, and Kuo-chin fan, member, IEEE, "Vehicle detection using normalized color and edge map", IEEE Transactions On Image Processing, vol. 16, no. 3, March 2007.

[2] Xinchu Shi1, Haibin Ling, Erik Blasch, Weiming Hu1 "Context-Driven Moving Vehicle Detection in Wide Area Motion Imagery" National Laboratory of Pattern Recognition, Institute of Automation, Beijing, China Department of Computer and Information Science, Temple University, Philadelphia, USA Air Force Research Lab, USA.

[3] Samir Sahli, Yueh Ouyang , Yunlong Sheng , Daniel A. lavigne "Robust vehicle detection in low-resolution aerial imagery" aImage Science group.

[4] Xianbin Cao, Changxia Wu, Pingkun Yan, Xuelong Li3 " Linear svm classification using boosting hog features for vehicle detection in low-altitude airborne videos" University of Science and Technology of China.

[5] S. Hinz and A. Baumgartner, "Vehicle detection in aerial images using generic features, grouping, and context," in Proc. DAGM-Symp., Sep.2001, vol. 2191, Lecture Notes in Computer Science, pp. 45–52.

[6] S.Tuermer,j.Leitloff ,P.Reinartz ,U.Stilla "Automatic vehicle detection in aerial image sequences of urban areas using 3d hog features" paparoditis n., pierrot-deseilligny m., mallet c., tournaire o. (eds), iaprs, vol. xxxviii, part 3b – saint-mandé, France, September 1-3, 2010.

[7] Birgi Tamersoy and J.K. Aggarwal "Robust vehicle detection for tracking in highway surveillance videos using unsupervised learning" advanced video and signal based surveillance 2009.

[8] Jie Zhou, senior member, IEEE, Dashan Gao, and David Zhang, senior member, IEEE "Moving vehicle detection for automatic traffic monitoring" IEEE Transactions On Vehicular Technology, vol. 56, no. 1, January 2007.

[9] Line Eikvil, Lars Aurdal and Hans Koren "Classification-based vehicle detection in high resolution satellite images" Norwegian Computing Center.

[10] Saad m. al-garni, and Adel a. Abdennour "Moving vehicle detection for automatic traffic monitoring" world academy of science engineering and technology 24, 2006.

[11] Toby P. Breckon, Stuart E. Barnes, Marcin L. Eichner and Ken Wahren, "Autonomous Real-time Vehicle Detection from a Medium-Level UAV".

[12] Karsten Kozempel and Ralf Reulke "Fast vehicle detection and tracking in aerial image bursts", Iaprs, vol. xxxviii, part 3/w4 --- Paris, France, 3-4, September, 2009.

[13] Joshua Gleason, Ara V. Nefian, Xavier Bouyssounousse, Terry Fong and George Bebis, "Vehicle Detection from Aerial Imagery".

[14] Hulya Yalcin, Robert Collins, Michael J. Black, Martial Hebert, "A Flow-Based Approach to Vehicle Detection and Background Mosaicking in Airborne Video".

[15] Lloyd L. Coulter, Douglas A. Stow, Yu Hsin Tsai, Christopher M. Chavis, Christopher D. Lippitt,Grant W. Fraley, Richard W. McCreight " Automated detection of people and vehicles in natural environments using high temporal resolution airborne remote sensing"

[16] Lowe, D., "Distinctive Image features from Scale-Invariant Key points," International Journal of Computer Vision. Papers 60(2), 91-110 (2004).

[17] J. Canny. A computational approach to edge detection.IEEE Trans. on Pattern Analysis and Machine Intelligence, 8(6):679–698, 1986.

[18] D. A. Forsyth and J. Ponce. Computer Vision: A Modern Approach. Prentice Hall, 2003.

[19] G. Jun, J. K. Aggarwal, and M. Gokmen. "Tracking and segmentation of highway vehicles in cluttered and crowded scenes", IEEE Workshops on Applications of Computer Vision, 2008.

[20] C. Stauffer and W. E. L. Grimson, "Adaptive background mixture models for real-time tracking", IEEE Conf. on Computer Vision and Pattern Recognition, 1999.

[21] M. Hansen, P. Anadan, K. Dana, G. van de Wal, P. Burt, "Real-timescene stabilization and Mosaic Construction", Proc of IEEE CVPR,1994, 54-62) .

[22] S. Hinz and A. Baumgartner, "Vehicle detection in aerial images using generic features, grouping, and context," in Proc. DAGM-Symp., Sep.2001, vol. 2191, Lecture Notes in Computer Science, pp. 45–52.

[23] J. Y. Choi and Y. K. Yang, "Vehicle detection from aerial images using local shape information," Adv. Image Video Technol., vol. 5414, Lectures Notes in Computer Science, pp. 227–236, Jan. 2009.