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Survey on "Motion Based HG Method of On-Road Vehicle Detection"

Mona Saini

Department of Computer Science & Engineering Student of Krishna Institute of Engineering and Technology, Ghaziabad
E-mail: sainimona28@gmail.com

Abstract: *This paper presents a review on the various techniques of On-Road Vehicle detection systems that are based on motion model.The vehicle classification in a traffic video is considered a difficult task due to similarity in appearances among different vehicles. In order to reduce this problem we have adopted a Motion Model based on hypothesis generation. In this paper a Survey of previous and recent works is presented on vision-based vehicle detection using sensors and also gives a detailed discussion on Motion based hypothesis generation method. Detecting the objects in the video and tracking theirmotion to identify 9theircharacteristics 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 and Incident Detection (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: *Vehicle detection, Traffic analysis, Blob tracking, Segmentation, Traffic surveillance.*

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].

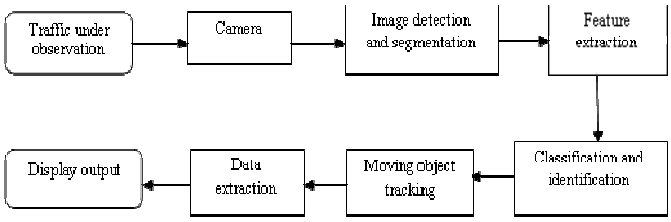


Fig. 1 A vehicle analysis system in typical video.

2. APPLICATIONS

There are various applications that are based on

- **Automated Video surveillance:**Designed to monitor the movement in an area to identify moving object.
- **Robot Vision**: The moving objects obstacles are identified in path to avoid collision in real time object tracking system.
- **Traffic Monitoring**: In case of breaks of traffic rules is monitored using cameras is tracked down easily.
- **Animation:**Using object tracking algorithm can extend to animation.

3. TRAFFIC FLOW MODELLING BASED 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.Traiffic flow becomes a lively subject of research. The traffic flow theory is a new science, which is related to understandingoftraffic processes and to optimize these processes through proper design and control [8]. 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 [5].

The models can be classified according to:

3.1 Scale of the Independent Variables (Continuous, Discrete, Semi-discrete)

- Continuous models describe how the traffic systems state changes continuously over time in response to continuous stimuli.
- Discrete and semi-discrete models assume that state changes occur discontinuously over time at discrete time instants.

3.2 Representation of the Processes (Deterministic, Stochastic)

- Deterministic models have no random variables implying that variables in the model are defined by exact relationships.
- Stochastic models incorporate processes that include random variables.

3.3 Level of detail

(Microscopic with high detail, Mesoscopic with medium detail, Macroscopic with low detail)

- In Microscopic and sub microscopic scale every vehicle is considered as an individual, formulated by an equation, which is usually an ordinary differential equation (ODE).The microscopic scale were started from the 1960's. The dynamic equation can be written as

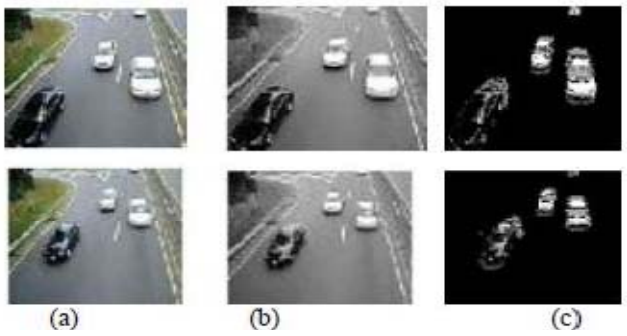
$x_n = f(v_n; \Delta x_n; \Delta v_n)$

Where the function *f* represents the response to the stimulus received by the *n*-th vehicle, $\Delta x_n$is acceleration or deceleration of the *n*-th vehicle. The stimulus may be composed of the velocity *vn* of vehicle, the relative velocity $\Delta v_n = v_{n+1} - v_n$, and the headway $\Delta x_n = x_{n+1} - x_n$.

- In Mesoscopic (kinetic) scale vehicles and driver behaviour are not distinguished nor described individually, but rather in more aggregate-terms, the behaviour rules are described at an individual level.
- In Macroscopic scale: This is analogy with fluid dynamics models, the rules of fluid dynamics are applied to traffic flow, formulated as a system of partial differential equations (PDE) for some gross quantities of interest, e.g. the density of vehicles or their mean velocity.

4. MOTION VEHICLE DETECTION AND SEGMENTATION APPROACHES

The detection of moving object's region of change in the same image sequence which captured atdifferent intervals is one of interesting field in computer vision [9].In reality, road traffic can be broadly classified into two categories, homogeneous and heterogeneous.A homogeneous trafficcan 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 whichincluded the Moving/Motion Vehicle Detection and Segmentation approaches [10]. Even though variousresearch papers have been showed for moving vehicle detection but still a tough task isto detect and segment thevehicles in the dynamic scenes. It consists of three main approaches to detect and segment thevehicle, as mentioned below (1) Background Subtraction Methods(2) Feature Based Methods (3) Frame Differencing and Motion Based methods.



From the Fig. (a) shows the original video, (b) shows that thevideo is converted to grey scale and (c) shows the segmented outputof the video in performing the frame difference of backgroundsubtraction.

4.1Background Subtraction Methods

The process of extracting moving foreground objects (input image) from stored backgroundimage (static image) or

generated background frame form image series (video) is calledbackground subtraction [11]. It is a 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 changein lighting and the climatic situations [12]. A significant contribution suggested the statistical and parametric based techniques which areused for background subtraction methods; some of these methods used the Gaussian probabilitydistribution model for each pixel in the image [13-17].

The pixel values updated by the Gaussian probability distribution model, these pixel values update new image in the new image series. Then, each pixel (x,y) in the image is categorized either be a part of the foreground (moving object or called blobs) or background according to adequate amount of knowledge accumulated from the model which is mentioned above, using the equation (1) below:

$$I(x, y) - Mean(x, y) < (C \times Std(x, y)) \quad (1)$$

Where I(x, y) is pixel intensity, C is a constant, Mean(x, y) is the mean, Std (x, y) is the standarddeviation.

4.2 Feature Based Methods

Another trend which the researchers investigate and motivate on sub-features like the edges andcornersof vehicles, the moving objects segmented from background image by collecting andanalyzing the set of these features from the movement between the subsequent frames.Furthermore, the feature based method supports the occlusion handling between the overlappingvehicles and compared with background subtraction method represents a less level from thecomputational difficulty view [18]. Several approaches can discriminate the object from the background by using its features, a trainable object detection approach has proposed by [19]. This approach is based on learning and employs a set of labelled training data which are used for labelling the extracted objects feature. In addition, it uses a Haar wavelets technique as a 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.

The authors have suggested a low resolution aerial image used as dataset fordetection vehicles system; this system uses the edges of the car body, the edges of the frontwindshield and the shade as the features for the similarity process. The gathered extractedfeatures knowledge is shaped in the structure of the Bayesian network that will use for integration of all features. In this research, experiments present good results even if tested images were more complicated.

4.3 Frame Differencing and Motion Based Methods

The frame differencing is the process of subtracting two subsequent frames in image sequence tosegment 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 viewwhich 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 [20].

A new method is introduced in Detection of moving vehicles that is based on versatile movement histogram technique[21] which involve two procedures, to segment and detect the vehicles in video sequence. The first step, a novel background changing method will use for changing brightness in video scene. The second step, adaptable movement histogram-basedvehicles detection is used, which is supported and modernized with respect to the dynamic view.

5. VEHICLE TRACKING APPROACHES

Tracking objects in video processing is an important and fast growingstep for tracking the moving objects invisual-based surveillance systems.The object tracking in video sequence of surveillance camera becomesa challenging and demanding task for researchers to improve recognition and tracking performances [22]. To trackthe physical appearance of moving objects such as the vehicles and identify it in dynamic scene, Ithas to locate the position, estimate the motion of these blobs and follow their movementsbetween two of consecutive frames in video scene [23].

Several vehicle tracking methods havebeen 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, andvehicle level.The region based object model is also based on the color distribution of

the tracked object [24]. It represents the object based on the color. Hence, it is computationallyefficient. However, its efficiency is degraded when several objects move together in the imagesequences. It is not possible to achieve accurate tracking when multiple objects move due toocclusion. The object tracking is largely dependent on the background model used in the extraction of the object outlines in the absence of any object shape information.

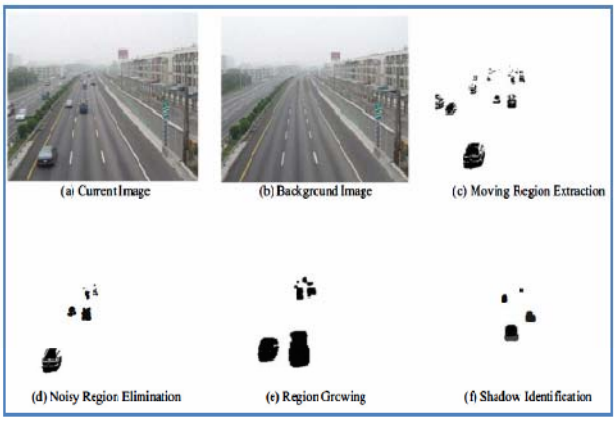


Fig. (4) Detection and tracking of moving regions

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 [25].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. A few traffic criterions (lane change recognition, vehicle numbering and vehicle classification) on highway are extracted by a real-time vehicles tracking and classification technique. These methods used the Kalman filter, background differencing methods and morphological operations for extraction and recognition of vehicle's contour.

The authors have proposed a novel real time traffic supervision approach which employs optical movement and uncalibrated camera parameter knowledge to detect a vehicle pose in the 3D world. This approach uses two new techniques: **1**. color contour based matching **2**. Gradient based matching, and it showed well results when it is tested for tracking, foreground object detection, vehicle recognition and vehicle speed assessment methods.

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 [27].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 usedin similarity process, these features represents a large region of set of featuresforms a strong depiction for object classes. This proposed framework showed a good performancefor vehicle classification in surveillance videos [28].A linearity feature technique is a proposed line-based shade method which uses line groups toremove all undesirable shades and properly undertakes the occlusion resulting fromshades. Finally, this method represents an automatic vehicle tracking and classification trafficobservation system [29]. To clearly distinguish the objects in the feature space we have to need find various features like Color, Gradient, Edges, Texture, OpticalFlow, and Biological etc.

5.5 Color and Pattern-Based Tracking Methods

This technique is used to analyze color of image series of traffic supervision views [30]. Throughthe 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-time traffic supervision forcontinuousvisual tracing andclassification of vehicles for busy multi-lane highway scene [31]. In thisproposed work, the authors use the orthographic approximations for matching process. Thissystem consists of three improved main levels: (1) using 1-D patterns of shape and posture theory(2) theory tracking (3) using 2-D patterns of theory verification.

6. CRITIQUE OF MOTION-BASED HG METHODS

Motion-based Methods can detect objects based on relative motion information but it cannot used to detect static obstacles, which can represent a big threat. Generating a displacement vector for each pixel is time-consuming and impractical for a real-time system. In contrast, discrete methods based on image features such as color blobs [32] or local intensity minima and maxima [33] have shown good performance while being faster. Several factors affect the computation ofmotion information [34] including:

- Displacement between consecutive frames.

- Lack of textures.
- Shocks and vibrations

Among these factors, camera movement is the main reason that traditional differential methods fail. If we can counter balance camera movements, then these methods could become very useful. This is the objective of another research direction, called “image stabilization”. This method would fail when an image contains close scenesa common scenario when driving a vehicle in downtown or during vehicle turns.

7. CONCLUSION AND FUTURE WORK

This paper provides a short and snappy study on the proposed techniques which have used in trafficvideo. It focuses in these areas, namely Traffic Analysis and Incident Detection, Segmentation Approaches and Vehicle Tracking Approaches. These types showsthe detailed information about how the traffic surveillance systems useImage ProcessingMethods 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.

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