A Survey on Moving Object Detection and Tracking Based On Background Subtraction

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Abstract
Detecting Moving object is a task to identify the motion of objects in a specific region/area. Over the last some years, moving object detection has received much attention due to its wide range of applications like human motion analysis, event detection, video surveillance, robot navigation, anomaly detection, traffic analysis and security, video conferencing etc. Video surveillance systems mostly deal with the tracking and classification of moving objects. The most common processing steps of motion detection for video surveillance includes detection of motion, modeling of environment, classification and object detection, behavior understanding and activity recognition. The main aim of this paper is to review recent developments and to analyze the open direction in visual surveillance systems for near future.

Keywords: Background Subtraction Technique, Automatic Video Surveillance, Frame Difference, Object Detection and Tracking, Median Filter.
1 Introduction

The Automated video surveillance is now a wide research area in many different sectors. Now a day’s technology has reached a stage where fixing or place cameras somewhere to capture imagery video is cheaper than finding human resources to sit and watch that imagery is expensive. Cameras surveillance are already installed in commercial establishments, with the facility of recorded tapes of camera output that can be rewritten periodically or stored in video archives. If a crime occurs, example a store is robbed or an expensive car is stolen by the thief, then investigators can go to the video recordings to see what happened, but of course it is too late by then. What we can do for minimize these types of incidence, needed a 24-hour nonstop monitoring as well as analysis of video surveillance data to alert security officers to a robbery which is in progress, or to a doubtful individual hang around in the parking lot, then options are still available to avoided the crime.

The video surveillance system starts with motion and object detection. Motion detection means to segment those regions which contain moving objects from the remaining image. Background modeling and motion segmentation are usually used in the process of motion and object detection. In image sequence, the aim of motion segmentation is to detect the regions or area corresponding to the moving objects such as vehicles, birds, humans, animals etc. When the area/region which involves then motion is detected, then for successive processes such as object tracking and behavior analysis these detected regions need to be investigated. After motion and object detection, the video surveillance system normally tracks moving objects from one frame to another frame in an image sequence. Behavior analysis involves the analysis and recognition of motion patterns, actions description and interactions between the objects.

2 Motion Detection

The survey of motion detection includes motion segmentation, environmental modelling, and object classification, which meet each other during the processing. The process of System surveillance shows in below figure.

Figure 1: General framework of visual surveillance System
2.1. Environment Modeling

Environment Models are representations of the environment that can be used to inform regulation or management decisions. In the images, environmental models are simply a two-dimensional model and in the real world coordinate, environmental models are 3 Dimensional models. If the camera is static, then to automatically get, recover and update the background frames from a dynamic video sequence is the main problem. Some factors sunlight, shaking branches, illumination variance and shadows may bring some kind of obstacles to the capturing and updating of background images.

2.2. Motion Segmentation

Motion segmentation in video sequences aims at identifying only those regions which are related to moving objects like humans and vehicles. Detection of moving areas are required for next processes such as behavior analysis and tracking. Only these detected areas need to be considered for further processes. Currently most of the motion segmentation methods use either spatial or temporal content in the image sequences. There are various methods for motion segmentation may include –

1. Background Subtraction:
2. Temporal Differencing
3. Optical Flow

2.3. Object Classification

Object classification is the categorization of object based on previously classes or types. Object classification is simply used to identify a class of a moving object which is visible in a video as a person or group of persons. In an image, it is considered as a standard pattern recognition task. It is necessary to correctly classify moving objects to track and analyze the behavior of objects. Different moving portions may correspond to different moving targets in real scenes. Two different kinds of approaches exist to classify moving objects –

1. Shape-based classification:
Shape-based classification basically related to the information of moving shape areas like silhouettes, points and boxes. Classifying a moving; object with help of silhouettes features is known as shape based classification

2. Motion-based classification:
Motion-based classification in visual surveillance system for moving objects is classified in terms of periodicity. In motion based classification periodicity and rigidity for moving objects is checked by residual flow.

3. Object Tracking:
After motion detection, object tracking is performed. It follows in two important steps namely, detection of suspicious moving objects, and tracking of these objects frames by frames. By obtaining useful features of a moving object in a sequence of images, the object is detected and its changing parameters, like location, speed, acceleration and orbit are gained. Later, these parameters are analyzed and processed for tracking and behavior understanding of the object.
3 Object Detection

The object detection and object tracking can be done by background subtraction, two frame differencing and three frame differencing as described below.

3.1. Background Subtraction:
In background subtraction, you are creating a model of background. It is also known as foreground detection. In background subtraction an image’s foreground is extracted for further processing. Background subtraction is the most commonly used method to detect moving objects. In background subtraction, difference of the current image and background image is calculated to detect the location of moving object. Firstly, we require to calculate the gray image of the current frame image and the background image:

$$d_t(x,y) = |I_t(x,y) - B_t(x,y)|$$

Second, by setting the threshold $T_h$, we can obtain the binary image.

Third, use mathematical morphology to filter the image difference. Then analyze communicating area. If the area of connected region is larger than a given threshold value, that is a moving object.

3.2. Two Frame Differencing:
In two frame differencing, the previous frame is subtracted from the current image. We got a subtracted value, which gives a difference image. In this method, by subtracting two consecutive frames, we get the moving object.
3.3. Three Frame Differencing:
Three frame differencing is an improved method of two-frame difference. This method takes three consecutive frame images from the video stream. Then calculate the difference of 1st frame and second frame then second frame and 3rd frame and then multiply the two differences to get the moving object area. Finally apply the AND operation to get the final result.

4 Related Work for Object Detection and Tracking

In the recent years, many surveys about object detection, classification, tracking and activity analysis have been carried out. Recently, automatic humanoid recognition as gained abundant attention within the field of video analysis technologies because of its satisfying performance in an exceedingly vast selection of applications like intelligent supervision, human computer interaction, robot visual and military navigation guidance, health care systems etc. In this chapter, we are going to present an overview of some of the previous research works which are inherited for this thesis.

In the year 2017, Pulli Harsha Samhitha proposed a new approach for Vehicle detection, tracking and speed measurement. They proposed a novel background subtraction model for running vehicle detection. To make the system more robust and exact, they use enhance thinning and dilation process after subtracting background. For vehicle they use region props inbuilt function to give more accuracy. For vehicle tracking, estimate the difference between the vehicle feature and the extracted feature extracted from the previous frame.

In the year 2015, Jaya S. Kulchandani reviewed various methods related to object detection and also analyze the growth in the field of detection for a moving object. In this paper, they found that there are few drawbacks occurred during background subtraction and frame differencing i.e. shadow, lightning effect. According to their research, they discovered the fact that plenty of work has been done which gives better result compare to conventional methods. In future, various methods can be developed to get better performance.

In the year 2014, Nishu Singla proposed a novel approach for detecting a moving object with the motionless camera. He used frame differencing method with a static background to identify motion of an object. In this paper, he applied frame differencing to detect an object and after that use morphological operations for filtering. The experiment shows efficient results and better performance. In future, by sending an email or multimedia messages can be used this approach.

In the year 2012, Kinjal A. Joshi represented review on different methods which is related to video surveillance system for the purpose of enhancing the security. Contribution of this paper is to review of various moving object detection and object tracking techniques for video surveillance systems and tracking. The paper described various methods which used in video surveillance system in which Temporal Differencing method fails to extract all significant pixels of a foreground object especially when the object has uniform texture or moves slowly. It concludes the temporal differencing method fails in detecting a change between consecutive frames and loses the track of the target when a foreground object stops moving.

In the year 2012, Yanzhu Zhang have analyzed that it is hard to detect moving object and track in uncertain route and variable speed of an object in mobility because features of moving object are not stable due. Three frame subtraction approaches are used to detect moving an object and extract image using the method of mathematical morphology. In this process, noise is eliminated also using noise filter. Their experimental results show that this method has less calculation amount with high real-time performance and higher accuracy for moving target detection. The benefit of proposed technique is it has no constraints on the background environment and complexity of calculation is also less with higher real-time performance.

In the year 2012, C.SrinivasRao compared two methods, named as Kalman filter and Frame difference for detecting a moving object. In this paper, a video sequence is applied as an input for Kalman filter and Frame difference method to detect the moving vehicles in video surveillance system. According to the experimental
results, Kalman filter shows better accuracy with low resource requirements for a given video. In the future, techniques, objects can be detected using other filters.

In the year 2012, N. Prabhakar have proposed a scheme to develop a robust and reliable object tracking system in an efficient way to improve security services. The proposed technique used concepts of frame differencing and template matching method. The patterns used for matching purpose are created dynamically which assures that the change in orientation and position of the object does not delay the tracking system. It can be used in many applications as a surveillance tool. Thus motion detection using frame differencing method provides a better result for the object tracking and which can be easily applied to a number of fields. Furthermore, the study also represents a method to keep the track of movement of the object which can be accessed later to analyze the motion.

A novel approach which combines three-frame differencing and background subtraction for motion detection of a fish in a video was proposed in the year 2014, by Lan Yongtian et al. [12]. In this methodology, the video is applied as an input which is collected by robotic fish platform and then identifies the appropriate threshold. At last, to get a correct image 4-neighbour topology applied. The experimental result shows the better result to detect a fish and identify the correct moving situation.

In the year 2014, Habib Mohammed Hussien et al. [15] proposed a technique that combines Frame Differencing, simple adaptive Background Subtraction, and Gaussian Solution to detect and track a moving target to monitor security areas such as surveillance system. In this paper, he used Matlab as a tool to implement the proposed technique. This system has implemented using static cameras and it is able to adapt dynamic scene, removing shadow both in indoor and outdoor. In this methodology, video sequences applied as inputs which were captured via static camera. Each frame placed into the filtering process and applies an appropriate threshold for the moving object. In this research work, they implemented and tested algorithms for detection of a moving object and compare the results. The proposed technique has a promising future in shadow removal and sudden illumination changes with more robust and efficient detection algorithms.

5 Conclusion

Motion detection is an efficient research area in the area of visual computing. This paper describes the moving object detection process in video surveillance. The paper explains the different methods for motion detection including background subtraction, frame differencing and optical flow methods. In this paper, we have presented an overview of recent developments in human motion analysis. We addressed four techniques for motion segmentation: background subtraction, temporal differencing, optical flow and statistical methods. The statistical methods may be a better choice in more unconstrained situations. The ample amount of work has been done in that research area. But there is a need of more computation time to get better results.

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