A Review of Moving Object Detection And Tracking

Mohit Kumar Jindal[1], Er. Deepika Arora[2]
[1, 2] Dept of CSE
[1, 2] RPIIT, KARNAL

Abstract- *Detection of moving object is important in many tasks, such as video surveillance and moving object tracking. The continuing research on object tracking in video sequences has attracted many researchers.*

Detecting the objects within the video and monitoring its movement to establish its characteristics has been rising as a stressful be taught self-discipline within the area of snapshot processing and computer vision. This paper presents a review on phases for video analysis i.e detection of moving objects of interest and tracking of such objects frame to frame. Generally visual surveillance can be classified into three phases of data processing: moving object recognition, object extraction & tracking and to extract temporal information about such objects. This literature presents the techniques available for detection and tracking, their fundamental study and comparative analysis of these techniques in visual surveillance.

Keywords- Moving Object Detection, Object Tracking, Object Representation, And Visual Surveillance.

I. INTRODUCTION

Visual surveillance is highly identified research area including wide area applications in human activity monitoring, public safety in places like banks, shopping malls, private places etc, automated identification of events of interest, people counting, augmented reality, motion based recognition, autonomous robot navigation and other commercial areas. The rapid advancement in availability of high quality and inexpensive video cameras, high powered computers and increasing demand for video analysis has generated great deal of interest and need of video surveillance [1][2]. However detecting moving objects and tracking from a video is a fundamental and critical task since isolating required object from a video scene is necessary for further process of surveillance as well as differentiating the interested object from other background objects becomes a typical problem. Hence it becomes a vital criterion to understand videos and its constituents [1].

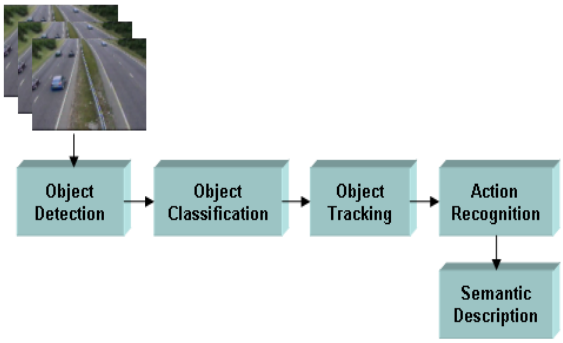

Fig 1: A generic frame work of video surveillance system

The block diagram shown in Fig1 presents a broad framework of video surveillance system. Video frames are given as input to object detection system which is followed by object classification and then tracking of objects in video scenes. Finally actions are performed such as tracking path of a particular object, study behaviour, person identification etc [3]. Further sections elaborate each block and various techniques available for the purpose.

II. OBJECT DETECTION

The detection of an object in video sequence plays a significant role in many applications specifically as video surveillance applications. The different types of object detection are shown in figure 2.

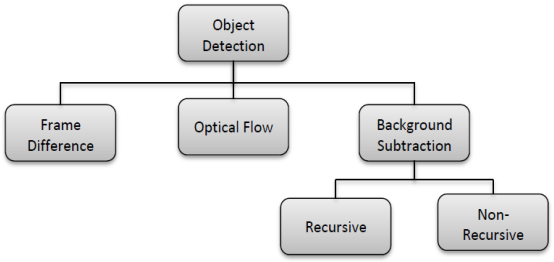

Fig 2: Types of Object Detection Method

Object detection includes detecting objects and recognizing patterns in the frame of a video sequence. An object detection mechanism is needed in any tracking method either in every frame or when the object first appears in the video. Using information in single frame is the most common method for object detection. Although some object detection methods use the temporal information computed from

analyzing a sequence of frames in order to reduce the number of false detections and increase accuracy rate [4] few methods of object detection are described as follows:

A. Frame differencing

The presence of moving objects is determined by calculating the difference between two consecutive images. Its calculation is simple and easy to implement. For a variety of dynamic environments, it has a strong adaptability, but it is generally difficult to obtain complete outline of moving object, responsible to appear the empty phenomenon, as a result the detection of moving object is not accurate [7].

B. Optical Flow

Optical flow method [4] is to calculate the image optical flow field, and do clustering processing according to the optical flow distribution characteristics of image. This method can get the complete movement information and detect the moving object from the background better, however, a large quantity of calculation, sensitivity to noise, poor anti-noise performance, make it not suitable for real-time demanding occasions.

C. Background subtraction

First step for background subtraction is background modelling. It is the core of background subtraction algorithm. Background Modelling must sensitive enough to recognize moving objects [6]. Background modeling is to yield reference model. This reference model is used in background subtraction in which each video sequence is compared against the reference model to determine possible Variation. The variations between current video frames to that of the reference frame in terms of pixels signify existence of moving objects [8]. Currently, mean filter and median filter [5] are widely used to realize background modeling. The background subtraction method is to use the difference method of the current image and background image to detect moving objects, with simple algorithm, but very sensitive to the changes in the external environment and has poor anti-interference ability. However, it can provide the most complete object information in the case background is known. As describe in [6], background subtraction has mainly two approaches:

1. Recursive Algorithm

Recursive techniques [6] do not maintain a buffer for background estimation. Instead, they recursively update a single background model based on each input frame. As a result, input frames from distant past could have an effect on the current background model. Compared with non-recursive techniques, recursive techniques require less storage, but any error in the background model can linger for a much longer period of time. This technique includes various methods such as approximate median, adaptive background, Gaussian of mixture

2. Non-Recursive Algorithm

A non-recursive technique [9] uses a sliding-window approach for background estimation. It stores a buffer of the previous L video frames, and estimates the background image based on the temporal variation of each pixel within the buffer. Non-recursive techniques are highly adaptive as they do not depend on the history beyond those frames stored in the buffer. On the other hand, the storage requirement can be significant if a large buffer is needed to cope with slow-moving traffic.

III. OBJECT CLASSIFICATION

Different moving regions may correspond to different moving targets in natural scenes. To further track objects and analyze their behaviors, it is essential to correctly classify moving objects. The classification of objects [10] can be done under humans, vehicles, trees, birds, etc. For analyzing behavior of objects in the frame classifications among several objects is particular frame is needed. Classification approaches are based on shape, motion, color and texture.

A. Shape based classification

Different descriptions of shape information of motion regions such as points, boxes, silhouettes and blobs is available for classifying moving objects. Input features to the system of object classification is mixture of image-based and scene-based object parameters such as image blob area, apparent aspect ratio of blob bounding box and camera zoom. Classification is performed on each blob at every frame and results are kept in histogram [11]. These histograms sometimes become the basis for classification of objects for further processing.

B. Motion based classification

In general, non-rigid articulated human motion shows a periodic property, hence this has been used as a strong cue for classification of moving objects. Residual flow is used to analyze rigidity and periodicity of moving objects [11]. It is expected that rigid objects present little residual flow, whereas a non-rigid moving object such as a human being has a higher

average residual flow and even display a periodic component. Based on this useful cue, human motion is distinguished from motion of other objects, such as vehicles, pedestrians or herds.

C. Color based classification

Unlike many other image features, color is relatively constant under viewpoint changes and it is easy to be acquired. Although color is not always appropriate as the solo means of detecting and tracking objects, but the low computational cost of the algorithms proposed makes color a desirable feature to exploit when appropriate. To detect and track vehicles or pedestrians in real-time, color histogram based technique is used. Color histograms have become extremely popular to describe a large image region [11]. Since it does not vary much to target translation, rotation, or the target scale variation, it has been used in many tracking applications. Color histogram describes the color distribution in a given region, which is robust against partial occlusions.

D. Texture based classification

Texture based technique counts the occurrences of gradient orientation in localized portions of an image, which is computed on a dense grid of uniformly spaced cells and uses overlapping local contrast normalization for improved accuracy. The texture-based approaches also work similar to motion-based approaches but with the help of texture pattern recognition. It provides better accuracy, but may require more time, which can be improved using some fast techniques.
An average or normal trend of the techniques has been discussed to give an overall understanding of each category.
However Table 2 below describes about comparative study made among different techniques used for classification of moving objects in visual surveillance

Object Classification Method	Computational Time	Accuracy	Comments
Shape Based	Low	Moderate to high	Simple pattern-matching approach can be applied with appropriate templates. It does not work well in dynamic situations and is unable to determine internal movements well [12]
Motion Based	High	Moderate	Does not require predefined pattern templates but struggles to identify a non-moving human [12]
Color based	High	High	Provides improved quality with the expense of additional computation time [14]
Texture Based	High	High	It creates a Gaussian Mixture Model to describe the color distribution within the sequence of images & to segment the image into background and objects [14]

IV. OBJECT TRACKING

The object tracking is the term which used to identify the moving object position as well as tracking them from video sequences (Balasubramanian et al., 2014). The tracking method is classified into three types such as kernel, point and silhouette based tracking (Yilmaz et al., 2006). Compared to silhouette method, existing most of them have focused on kernel-based method due to high accuracy with less computational cost. However, the point tracking method has less computational cost with reduce in accuracy (Weng et al., 2013). The various types of object tracking techniques are shown in figure 3.

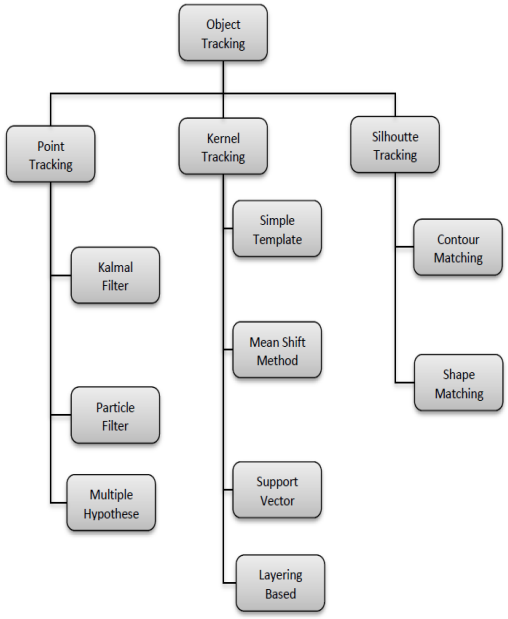

Figure 3 Types of object tracking approach

Table 2 Comparative Study of Object Tracking Methods

Object tracking method	Algorithm used	Computational time	Accuracy	Comments
Point Tracking	Kalman Filter	Kalman filtering algorithm	Low to Moderate	Moderate	This approach applicable to track point even in noisy images (Javed and Shah, 2002)
				Distributed State variables (Gaussian) (Ali and Zafar, 2009; Javed and Shah, 2002)
	Particle Filter	Recursive Bayes filtering	Moderate to High	High	Good results for occultation and complex background (Hu et al., 2004)
				Not advisable for real-time applications due to big calculations (Athanesious and Suresh, 2012; Hu et al., 2004)
	Multiple Hypothesis tracking	MHT algorithm	Low	Low to moderate	Adapt new object as well as exists existing object(Blackman, 2004)
				High computation in memory and time(Blackman, 2004)
Kernel Tracking	Simple template matching	Matching region of interest in video	Low to moderate	Low	Capable of dealing with partial occlusion (Cucchiara et al., 2003)
				Require equivalent model for each region of interest for each image (Cucchiara et al., 2003)
	Mean shift method	Expression & location of object; optimal gradient decline	Low	Moderate	Can be used for real-time applications due to less calculations (Tao Zhang et al., 2010)
				Iterations get into local maximum easily (Tao Zhang et al., 2010)
	Support vector	Positive & negative training	Moderate	Moderate	Can handle single image and partial occlusions (Avidan, 2004)

	machine	values			Need physical initialization and training (Avidan, 2004)
	Layering based tracking	Shape representation using intensity	Moderate	Moderate to high	Track multiple objects and full occlusion (Wei and Qin, 2007)
					Require parametric models of each pixel (Wei and Qin, 2007)
Silhouette tracking	Contour matching	Gradient Descent Algorithm	Moderate	Moderate to high	Object Shape is Implicitly modeled (Karasulu, 2010)
					Requires time for state space estimation (Karasulu, 2010)
	Shape matching	Hough Transform	High	High	Less sensitive towards variance of appearance
					Need to enhance the performance (Karasulu, 2010)

V. CONCLUSION AND FUTURE WORK

This paper presents a widespread review of visual surveillance systems describing its phases of object detection, object representations, object tracking and semantic decision. Various approaches of detection, representation and tracking proposed have been explained and compared. Object detection techniques like temporal differencing, background subtraction and optical flow are briefly described . More research, however, is needed to improve the robustness against the effects of the environment such as noise, illumination changes, occlusions and etc. We require to question about the weaknesses of particular algorithm against specific conditions. The aim of this paper is to provide a better understanding performances of video surveillance systems in the literature via published measures, computational and environmental details.

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