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Research Paper

DETECTION AND TRACKING OF MOVING OBJECTS USING HYBRID MODEL (GMM & HORN-SCHUNCK)

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In many vision based applications moving objects detection and tracking is important and critical task. Because of complicated occlusions and disordered background, identifying moving objects and their tracking is a challenging problem for many computer vision applications. In this paper a new tracking method that uses both Gaussian Mixture Model (GMM) and Optical Flow approach is proposed. Background subtraction is the fast way to detect moving object which subtracts foreground from background. Background subtraction is based on GMM and the tracking of detected object is carried out by Optical Flow model. There are two types of Optical Flow methods i.e., 1) Lucas-Kanade and2) Horn-schunck. In this paper Horn-Schunck model is implemented for tracking a moving object. Both GMM and Optical Flow methods can complement each other and results successful in tracking of objects.

Keywords: Object detection, Object tracking, Gaussian Mixture model, Optical Flow, Horn-Schunck Model

INTRODUCTION

Video signal is basically sequence of time varying images. Video signal is treated as a series of images called frames. Video is obtained by changing the frames in a faster manner which is generally termed as frame rate.

Detection and Tracking of moving objects is an important area of video processing. The essential work to detect and tracking the detected objects is through sequence of frames. Video tracking is the process of locating a moving objects over time using a camera. It has a variety of uses, some of which

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are: human-computer interaction, security and surveillance, traffic control, medical imaging and video editing. The objective of video tracking is to associate target objects in consecutive video frames. The association can be difficult when the objects are moving fast relative to the frame rate.

Zhan *et al*. (2007) proposed an algorithm for moving object detection based on frame difference and edge detection. It gives high recognition rate, high detection speed and noise restraining method. But this method is not suitable for dynamic background detection. To overcome that Soumya Varma and Sreeraj (2013) Proposed background subtraction method for foreground detection which takes the difference between the current image and background image in the given video sequence. Due to change in environment continuously background image change which leads to disturbance in detecting foreground pixels. Stauffer and Grimson proposed an algorithm (1999) using Gaussian distribution to model a multimodal background image sequence. To reduce the disturbances due to environment Dina M Rashed (2013) implemented a new approach, based on adaptive background subtraction to construct background model and compares its pixels with current images to identify foreground/ background pixels and minimize the number of updated pixels in background model to reduce the processing time. The motion detection methods based on optical flow can detect motion accurately but affect badly by environmental and illumination changes (Chauhan Abhishek Kumar and Krishan Prashant, 2013). Fleet and Steven Beauchemin provide number of optical flow techniques which gives accuracy and density measurements (Bue *et al.*, 2002).

RELATED WORK

Object Detection and Tracking Methods

Camera and human visual effects are similar in some functionalities, but not exactly same functions. A camera is the basic visual surveillance system for object detection and tracking process. Manual object detection and tracking is tedious. For this reason, researchers in computer vision research area studied semiautomatic and automatic detection and tracking techniques. This techniques are related to spatial relationship between various featuers.some image features such as color, motion and edge are used to track a moving object in a video. In addition, Video segmentation has two major types: spatial segmentation and temporal segmentation. Spatial segmentation is based on digital image segmentation approach. Automatic video segmentation aims the separation of moving objects from the background and identification of accurate boundaries of the objects. The performance of tracking algorithms usually depends on similarity or dissimilarity between the two subsequent images/video frames. There are different methods for detecting a moving object in a video sequence. The main four methods are stated below:

1. Spatiotemporal difference
2. Background subtraction.
3. Optical Flow
4. Block matching method.

Spatiotemporal Difference

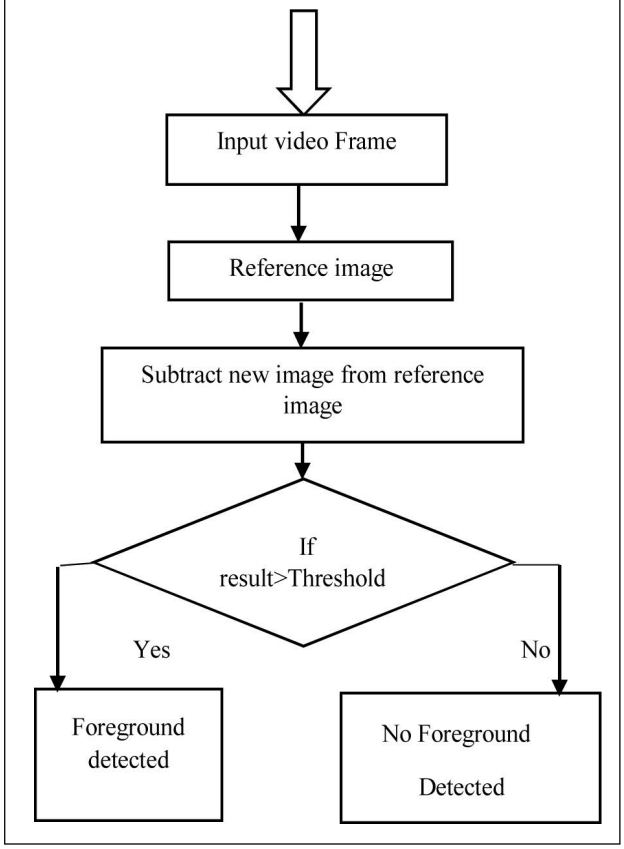
Temporal difference computes the difference between two or three consecutive frames. This

method is based on simple convolution so this method is fast and simple to implement. But besides all this advantages, this method is susceptible to noise and to variations of timings of movement and poor at extracting the feature pixels of certain type resulting holes being generated in the moving object.

Background Subtraction

Background subtraction techniques are mostly used for motion detection in many real-time vision surveillance applications. Background subtraction method can extract the most precise foreground by modelling the background. Background subtraction method uses the current frame minus the reference background image. The pixels where the difference is above a threshold are classified as the moving object. General block diagram of Background subtraction Method is shown in figure1. But it is sensitive to scene changes caused by light and weather etc.

Figure 1: General Block Diagram of Background Subtraction Method



Optical Flow

Optical flow is the pattern of apparent motion of objects, surfaces and edges in a visual scene between an observer and a scene. The concept of optical flow was introduced by the American psychologist James J Gibson in 1940.Optical flow method can detect the moving object. It yields two dimensional vector field i.e., motion field that represents both velocities and directions of each point in an image sequence.it gives all motion information. But it is sensitive noise and requires more time for its computational complexity. There are two different methods for optical flow.

1. Lucas-Kanade.
2. Horn-Schunck.

Block Matching

Block matching method matches blocks from current frame and blocks from a reference frame.

Proposed Work

In this paper the object detection is done using hybrid model for better detection and accurate tracking of a moving object. Here two methods are taken in two consideration for detection and tracking i.e., Background subtraction using Gaussian Mixture Model and Optical flow. As Gaussian Mixture Model is fast and simple it is widely used for background subtraction in

Comparison Table for Object Detection Methods			
Object Detection Method	**Basic Principal**	**Accuracy**	**Comments**
Temporal difference	Pixel wise Subtraction of current and background frame	High	1. Simple and easy to implement. 2. Sensitive to dynamic changes
Background subtraction:			
a) Running Gaussian method	Based on Gaussian Probability density function of pixels	Moderate	1. Suitable for real time applications. 2. Consumes more time.
b) Mixture of Gaussian	Based on Multi modal distribution	Moderate to high	1. Low memory requirement. 2. Cannot cope with objects with noise.
Optical flow	Uses optical flow distribution characteristics of pixels of objects	High	1. Provides complete movement information. 2. Requires large amount of calculation.

detecting a moving object. GMM can detect the object but it cannot track.so, that fortracking purpose we are using optical flow method. Foreground used in optical flow is extracted using Gaussian Mixture model.

Gaussian Mixture Method

The Gaussian Mixture technique is first introduced by Stauffer and Grimson. It takes the difference of the current pixel's intensity value and cumulative average of previous values. If the difference of the current images pixel values and the cumulative pixel value is greater than the product of a constant value and standard deviation then it is classified as foreground. GMM is a single extension Gaussian probability density function. It has a power ability to form smooth approximations to arbitrarily shaped densities.

A GMM can act as hybrid for better modelling capability using discrete set of Gaussian functions each with their own mean and co variance matrix.

In this paper first input video sequence is given to background subtraction model which extracts foreground and updates the background continuously by using Gaussian mixture model. Then median filter is used to remove shadow and morphological operations are done to fill the empty holes to increase the smoothness. Thus foreground is extracted. The extracted foreground is used as a reference frame for optical flow method. Optical flow method calculate the motion between the two image frames and detects the moving objects. To compute Horn-schunck optical flow between two images, the following optical flow constraint equation must be taken into consideration.

$$I_x u + I_y v + I_t = 0$$

- $I_{x,}$ I_y and I_t are the spatiotemporal image brightness derivatives.
- U is the horizontal optical flow.
- V is the vertical optical flow.

To solve U and V using Horn-Schunck method:

- Compute I_x and I_y using sobel convolution Kernel

  [-1 -1 -2; 0 0 0; 1 2 1], and its transposed form, for each pixel in the first image.
- Compute I_t between images 1 and 2 using [-1 1] kernel.
- Assume the previous velocity to be 0, and compute the average velocity for each pixel using [0 1 0; 1 0 1; 0 1 0] as convolution kernel.
- Iteratively solve for u and v.

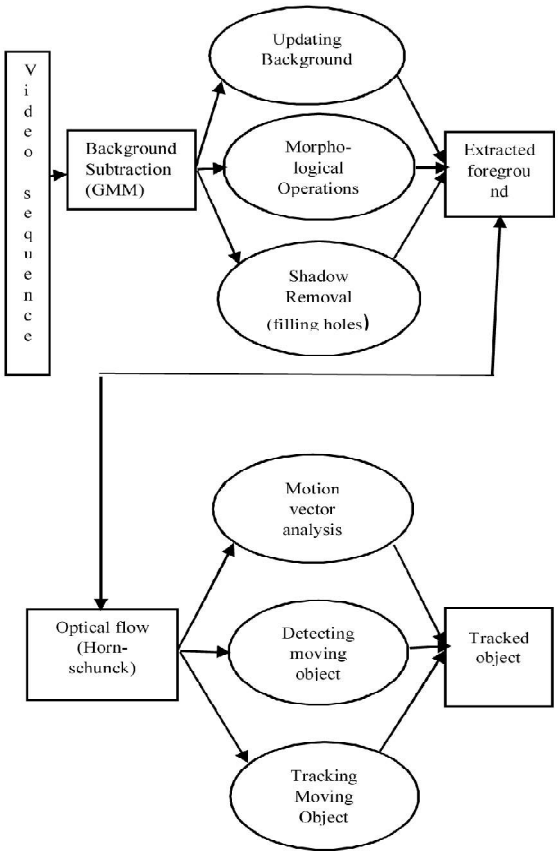
As the optical flow is smooth over the entire image, it computes an estimate of the velocity field, $[u\ v]^T$ that minimizes the equation

$$E = \int\int \left(I_x u + I_y v + I_t\right)^2 dxdy$$

$$+\infty \int\int \left\{ \left(\frac{\partial u}{\partial x}\right)^2 + \left(\frac{\partial u}{\partial y}\right)^2 + \left(\frac{\partial v}{\partial x}\right)^2 + \left(\frac{\partial v}{\partial y}\right)\text{^}2 \right\} dxdy$$

Here Horn-schunck optical model is used to track moving object in the given video sequence. Horn-Schunck algorithm assumes more smoothness over the whole image. It yields a high density of flow vectors, i.e. the flow information missing in inner parts of homogenous objects is filled from motion boundaries. But it is more sensitive to noise.

Figure 2: Block Diagram of Proposed Model



EXPERIMENTAL RESULTS

Figure 3: Snapshot for Proposed Method First Screen For Original Video, Second For Foreground, Third For Motion Vector, Fourth For Threshold, Fifth For Tracking

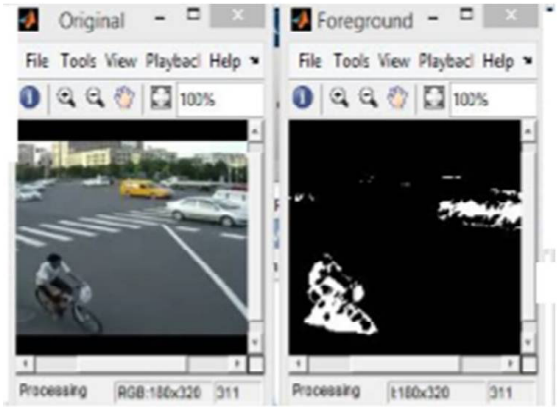


Figure 3 (Cont.)

CONCULSION

As there are many existing methods for moving object detection and tracking, but they have their own advantages and disadvantages. To overcome this disadvantages due to poor resolution and environmental changes here hybrid model was proposed using Gaussian mixture modelling and optical flow to get better accuracy and low computational cost. Advance study can open door by using efficient algorithms to reduce the computational time for detecting and tracking moving objects using GMM and optical flow.

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