Development of Framework for Moving Object Detection and Tracking in Video Sequences

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***Abstract:* -Object detection and tracking is an important and challenging task required in many computer vision applications and is an active research area in computer vision. Object detection involves locating the object in a frame of a video and tracking involves locating the moving object over a period of time. The task of moving object detection and tracking is a difficult because of illumination changes, dynamic background, occlusion, cluttered background, presence of shadows, motion of camera and video noise. The aim of this paper is to propose a framework for moving object detection and tracking in a video sequence. This framework detects and tracks moving object from video sequences and plots its motion trajectories which can be used for many applications like people tracking, vehicle tracking, traffic monitoring, video surveillance, in robotics and many more. We have used correlation based approach to track the moving object from video sequences.**

***Keywords* -Image Processing, Object Detection, Object Tracking, Motion Trajectory**

I. INTRODUCTION

Tracking of moving object is an important step in many applications of computer vision like video surveillance, sports reporting, video annotation, and traffic monitoring system. But, under certain circumstances it is not easy to track a moving object e.g. camera motion as well as object motion change dynamically. The main issues which need to be handled for tracking of moving object are initial segmenting problems, detection, and tracking even in occlusion [3].

Various challenges of moving object detection are discussed in section II. In literature, various techniques are explored for moving object detection and tracking. Section III discusses these techniques. Section IV includes description of our technique for moving object detection and tracking. Experimental results are presented and discussed in section V. We conclude with a discussion on our result in section VI.

II. CHALLENGES IN MOVING OBJECT DETECTION

There are many challenges in detecting a moving object from a video sequence like dynamic background (traffic lights, waving trees), occlusion- partial or full. Presence of shadows caused by foreground object often cause difficulties in background subtraction method. Weather conditions also play an important role in detecting a moving object. Detection of moving object becomes difficult if the video is captured in like fog, snow on the ground, dust etc. Camera motion also plays an important role in detecting a moving object. Compared to fixed cameras if there is camera motion, the object motion gets mixed. Fast-moving objects can be tracked with the use of background construction-based video object segmentation. This is computationally inexpensive and easy to implement but it can give good results only if the camera is fixed, illumination is constant and the background is static. Background subtraction based method would fail for scenes captured by a camera in motion.

III. RELATED WORK

There are mainly three approaches in object tracking: feature , differential method and correlation based. In feature based methods, features (shape, color, texture, motion) are extracted from image sequences and in tracking stage, matching procedure is performed on every frame. The most common feature used for tracking is color [1]. However the drawback of using a single color for detecting the moving object in video is that it can only be used in the target object with unvaryingly spread color. Differential methods are based on the optical flow computation i.e. on the apparent motion of objects, surface and edges in a video sequence, under some constraints. The third class uses the correlation to measure inter image/video frame displacements. Object tracking in a video sequence follows the segmentation step and is similar to the recognition step in the image processing [2].

Camera motion is handled in literature by various techniques as follows: Choi et. al. have used reversible jump Markov chain Monte Carlo particle filtering method for tracking people using mobile camera. Yi et. al. have used single Gaussian model and mixing neighboring model to detect the object using mobile device. ElTantawy et. al have proposed a method which formulates the problem of detecting moving object using active camera as principal component analysis problem and uses inexact augmented Lagrange multiplier to solve the problem.

Occlusion is also a significant hurdle in moving object detection and tracking. Various authors have proposed different techniques for moving object tracking in partial and full occlusion conditions. Liu et. al. used a simultaneous partition and class parameter estimation unsupervised video segmentation method for foreground estimation and n-step search method to identify the location of the moving object. Youssef et. al. have used the method based on discrete wavelet transform. Huang et. al. have used cascaded hierarchical framework for detecting a moving object in occlusion. Dynamic background problem in moving object detection is handled in [23]. Weather conditions like fog and dust have been handled in [24].

Sudden illumination changes result in drastic pixel intensity variations and make it difficult to establish feature correspondences across different frames, detection in the low illumination night scene have been handled in[16][25].

Video signal is generally superimposed with noise. The speed of moving object is also significant for its detection. If the object is moving very slowly, the temporal differencing method will fail to detect the portions of the object preserving uniform region. If the still object in a video suddenly starts moving then also it creates a challenge. Background

Subtraction algorithm may cause false detection when stationary objects in the scene start to move. This have been handled in [26].

B. Phases In Moving Object Tracking

Moving object tracking in videos requires various phases of processing to be performed on a video. These are detecting motion in frame, segmentation into objects, foreground extraction, feature extraction etc. Once detected, the object needs to be tracked in all further frames. Various techniques are explored in literature for each of these phases. Some of these are discussed and highlighted below.

Segmentation is a method of dividing the parts of an image into different segments so that the image can be easily analyzed. Segmentation consists of different procedures like boundary detection, connected component labeling, thresholding [2]. The objective is to segment the object of users interest and to extract its features [3]. Once the frame is divided into segments or regions, the segments of interest i.e. foreground and back ground can be extracted. One simple method for segmentation of moving object in a video is frame differencing. Once the user selects a moving object as a target, it is segmented by the differences of successive frames t-1, t, and t+1[3].

$$FD(x,y,t) = \begin{cases} 0 & \text{if } |f(x,y,t+1) - f(x,y,t)| \leqslant \text{ threshold}, \\ 1 & \text{otherwise}, \end{cases}$$

If the absolute of the difference is smaller than the threshold, it is the background and FD (x,y,t) = 0. or else, it is the target object and FD (x,y,t) = 1. To detect the part of frames which has been changed consecutive frames difference is used. The frame difference method might generate many segmented moving objects. Region growing method is used for constructing a connected object region of interest for use in further stages.

Frame t Frame t-1

Frame t+1 Detected moving object

Once foreground is extracted the next step is to extract valuable features from the sequence of frames which will help in tracking the object of interest in further frames. In [3] color with highest frequency is extracted for tracking objects. Feature-based approach is simplest for finding image displacements. In this approach features are extracted from consecutive frames and then matching is done. Correct feature extraction is very important and has many advantages like better understanding of the scene, data reduction and removing insignificant parts of the image. The main issue of [5] feature-based object tracking is feature correspondence. When there are similar objects in a frame their feature points are also same and this can create ambiguity while tracking them in the further frames. Algorithms used to overcome this, need to use a large window size to calculate pixel correlations or perform in depth search. In [6][7][8][9][10] feature based approach to track the vehicle is used.

The idea of the correlation is matching the parts of one image with parts of the next and is the base of correlation based approach**.** Kalman filtering uses this approach[11].The drawback of Kalman filtering is that it is computationally expensive as it does not perform data reduction but it is good for tracking occluded objects.

Kalman filter is a mathematical model expressed in terms of state-space concepts. In Kalman filter approach, solution is computed recursively. Generally, the Kalman filter is expressed by state model and measurement model. The working of Kalman filter consists of two phases: prediction step and correction step. In prediction step current state is projected forward, to obtain a priori estimate of the state. And in correction step feedback is given means it includes an actual measurement into the a priori estimate to get an improved a posteriori estimate. Both these steps- prediction step and correction step are executed recursively. In[12] stationary and moving objects are detection is done using

Kalman filtering approach. In[13], the position and speed of each corner of the vehicle is tracked using Kalman filtering. Li et. al. have proposed feature based approach to handle multiple objects tracking method using Kalman filter with the background subtraction technique for object detection. The centroid and area estimation was proposed for occlusion identifications. Drawback of this system is it cannot track object under full occlusion cases. In [15] detection of a moving object is performed by mean shift segmentation algorithm in which the first step is to perform the color based mean shift segmentation and in the second step, smaller regions are filtered out which is done by labeling the connected component and only keeping the component with larger number of pixels and finally, in the third step, if the ratio between the number of the foreground pixels and the total number of pixels in that segment exceeds a predefined threshold then that part will be considered as a foreground object, otherwise, it will be considered as a background object. The segmented objects are then tracked by Bayesian Kalman filter with simplified Gaussian mixture model. Chau et. al present a tracking algorithm for vehicles during the night time. In this work, vehicles are detected and tracked based on their headlight pairs. Assuming that the routes are linear, a Kalman filter is used to predict the movement of the headlights. When a vehicle turns, its Kalman filter is re-initialized.

IV. PROPOSED METHODOLOGY

In our approach, graph of the moving object which is being tracked is plotted and their trajectories are drawn using Kalman filtering. Detection results of an object in an image sequence are sensitive to occlusions.The following Fig.1 explains how an object can be detected and tracked.

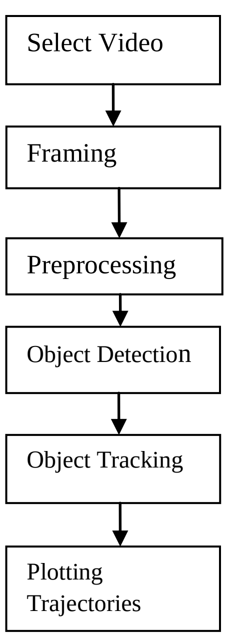

Fig 1: Methodology used in our approach

Step 1: SELECT VIDEO: It allows the user to choose a particular video clip from various categories. Here we have divided the video into different categories depending on the type of motion trajectory. The categories signify the type of trajectories which will be formed. Motion trajectories are divided into four types- Straight line, Zig Zag , Sinusoidal and Random. When the user clicks on this option, a pop up window will appear which will allow the user to choose the video from the above mentioned categories.

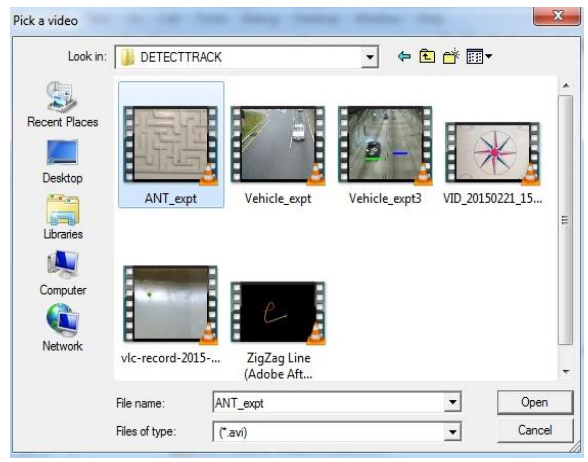

Fig2: Different Categories of Video

Step 2: Video Framing: In this step, the selected video will be divided into number of frames/images and total number of frames/images in a video will be calculated using a function.

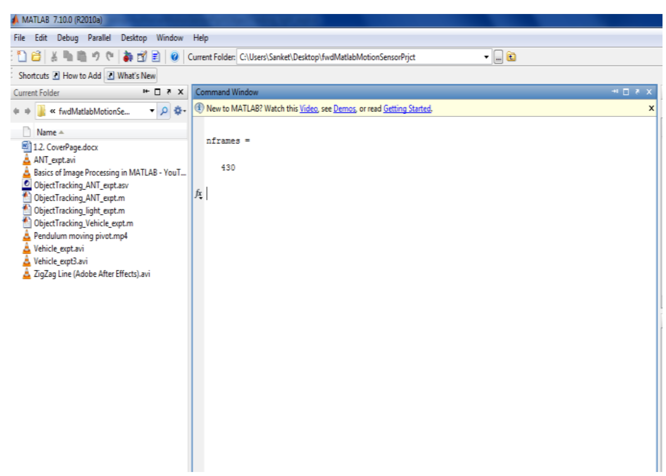

Fig 3: Total Number of frames extracted

Step 3: Pre-processing: Pre-processing of video frames were done by applying Gaussian blur.

Step 4: Object Detection: Using differencing moving object is detected, framed and labelled. Labelling is done using bwlabel function of Matlab and measurement is done using regionprops function. The output of this phase is shown below.

Fig 4: Detected Object in a video

Step 5: Tracking a detected Object: We have used a Kalman filtering approach for tracking a moving

object. First step in the Kalman filtering is the prediction of state of moving object. Correction is predicted by using newly detected object in the second step. In the final step, if occlusion occurs it uses the previous predicted state to predict the future state.

For tracking we have used area, cetroid , xcorner, ycorner, xwidth, ywidth features of a moving object.Bounding box was drawn around moving object. Bounding box mesurment includes xcorner, ycorner, xwidth, ywidth of a moving object.

Step 6: Plotting the Trajectories :In this step we first plot the bounding rectangle and then using the function plot we have made the trajectory of the moving object

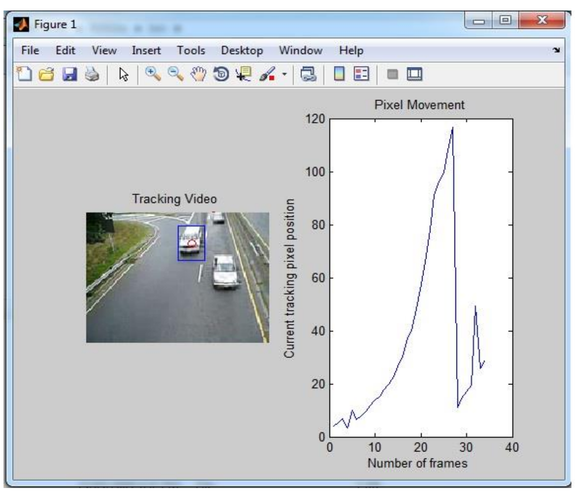

Fig 5: Moving car video with trajectory

V. EXPERIMENTS AND RESULTS WITH OTHER VIDEOS

We have also done the testing of our methodology with different types of videos containig different sizes of objets.Sample results are given below.

Fig 6: Detected Ant in a Video

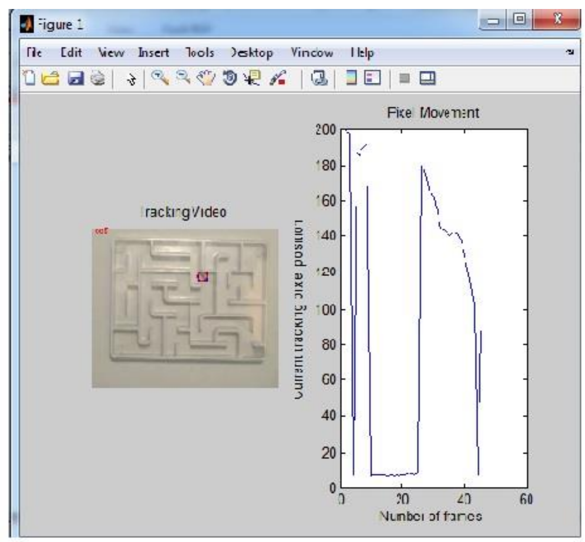

Fig 7:Moving Ant with Trajectories

Fig 8:Ball Detected

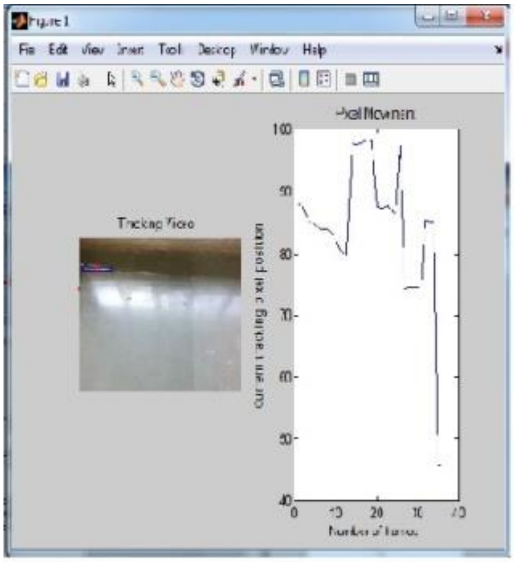

Fig 9:Moving Ball with Trajectories

VI. CONCLUSIONS AND FUTURE SCOPE

There have been several efforts made earlier by using different algorithms to detect and track moving object in a video sequence. Here we have proposed an approach, based on Correlation using Kalman filtering, that is simple and easy to use. We have observed that our approach was successful to detect and track a moving object of any size like ant, ball and car in a video clip. The trajectory of tracked object is made and graph is plotted.

As for future concerns, we think that this approach could be extended to find the velocity of the moving object, for motion based video retrieval by giving motion trajectory as input which can be further extended to semantic based video retrieval and also for indoor navigation of Blind and visually impaired people.

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