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3D Real Time Tracking and Recognization of Moving object using Kalman Filter

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Abstract— *Abstract: This paper demonstrate a technique related to video surveillance system improving the Future security systems. The main objective of this paper is to increase efficiency of moving object detection and tracking using 3D model. The method used in this paper is detection in video surveillance system then tracking the object in the scene. Detection of moving object subtly/ accurately is a challenging task especially in 2D tracking. Limitation can be overcome in 3D Tracking. In contrast of 3D tracking it will require high level of application that formulate the location, Shape of every object in every frame having two images producing with two different cameras situated at certain angular distance apart from each other. This paper presents the study on the implementation of Matlab using Kalman tracker in a feedback configuration based on moving object, detection algorithm, image processing technique like filtering, extraction, segmentation, conversion, adding, multiplying etc.*

Index Terms— **3D projection, correlation image processing algorithm, Kalman filter, sensing, tracking.**

I. Introduction

Modern surveillance has been developed in order to formulate best result and to produce more advanced natural systems which have ability to deal with changing environment for instance changing the size of tracking object, changing view point, changing illumination, changing colour, moving either of camera or object etc. Tracking and then categorize the moving object in 3D detection is a critical task which used in a number of computer vision applications such as MRI scanning, Spectrometry, Aircraft motion, Traffic monitoring & redirection, smart video system, effective remote sensing etc.[19]. There are four major steps in 3D video surveillance analysis. Detection of moving object, tracking of interested object from consecutive frames obtained by correlated image of two cameras, identification of these tracked object to analyze behaviour and also demonstrate normal/abnormal events. Edge detection is an image segmentation process is employed with two static cameras. Tracking develops to estimate velocity, distance etc parameters using efficient filtering processes for different estimating and deterministic models. In the feed-forward path, the adaptive background module provides target evidence to the Kalman tracker. In the feedback path, the Kalman tracker adapts the learning parameters of the adaptive background module.[14-15]

II. 3D Vs 2D Tracking

In previous tracking mechanism 2D Tracking was established having information only two co-ordinates x & y. It was not capable of detecting objects depth in real time tracking. Therefore accurate tracking was still a covet question. On the other hand employing 3D tracking which uses three co-ordinates x, y & z for identifying objects is very prominent and advanced. Calibration is the scheme which is uses for tracking of 3D technique. This process attempts to derive the motion of camera by solving the inverse- projection of the 2D paths for position of cameras. A position can be identified in the 2D frames by using 3D projection function. There is a projection function P is treated as a input vector to camera. Projection function is constraint of area of object, points of observation, angular distance between cameras etc.

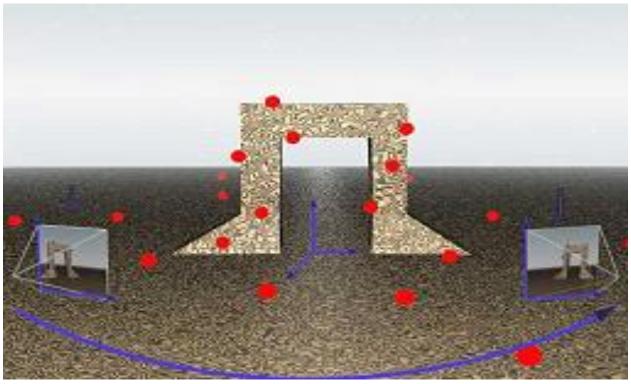

Figure 1: 3D view with Two different cameras

Figure 1 shows the animated image projection of two different cameras from remote points.
There are some set of equation define as follows:

$$XY = P\,(camera, xyz)$$
$$Xyz\ \varepsilon\ P'\,(camera, XY)$$
$$Xyzi = xyzj$$
$$P'(camerai, xyzi)\ \Pi\ P'(cameraj, xyzj) \neq \{\}$$

$$Cij = \{(camerai, cameraj) : P'(camerai, Xyzi)\ \Pi\ P'(cameraj, xyzj) \neq \{\}\}$$

So there is set of cameras vector pairs Cij for which the interaction of the inverse projection of two points XYi and XYj is a non-empty, hopefully small, set centering around a theoretically stationary points xyz.[18]

III. Methodology

Most image processing involves treating the image three dimensional signal and applying standard signal processing technique to it. The video captured by camera is processed by the MATLAB in the form of image processing program that helps in motion detection and color recognition[12]. The result s of this processing can be used in numerous security application such as intrusion detection, spy robot, person finder etc. [16][11].

The block diagram of tracking system is shown in the figure 2. It comprises of Four distinct modules Image Processing module, Adaptive module, Measurement module and Kalman Filter module.

i) Image Processing module: the input as no of frames per second is fetched by two separate cameras to correlator. Correlation is a method of image processing in which pixels of one image is correlated to other. When correlation between two captured image is produced it gets unique information which is different to get within single image. Generally, it reveals the different pixel information of object of third quadrant commonly known as z other than x & y which helps in formulation of object depth giving the knowledge about corners and depth more distinctively. More effective 3D image can be made more than two cameras but same would be increase the cost.

It follows a separate algorithm. Correlation is two type intensity based and feature based. Intensity correlation is a typical relation between pixels of image. Matlab first develop it in intensity matrix string then start it to correlation. Whereas feature based method is more complex but provides more accurate result then intensity. It uses relatively different parameters like length, co-ordinate axis, orientation and average intensity along the line. Intensity method is prominent for illumination sensitive tracking where feature method uses for spare disparity maps.[1-2]

Image Processing involves following steps:

- Object representation: object is represented by multiple set of points. In general point representation is suitable for object tracking that occupy small region in image.
- Feature selection: For tracking object boundaries generate strong changes in image intensities. Edge detection is used to identify these changes. An important property of edge is that they are less sensitive to illumination changes. Because of its simplicity and accuracy it is most popular.
- Object detection : Point detectors are used to find interest points in images which have an expressive texture in their respective localities. Interest points have been long used in the context of motion, stereo and tracking problems. Similarly there is invariance to change in illumination and camera view point.

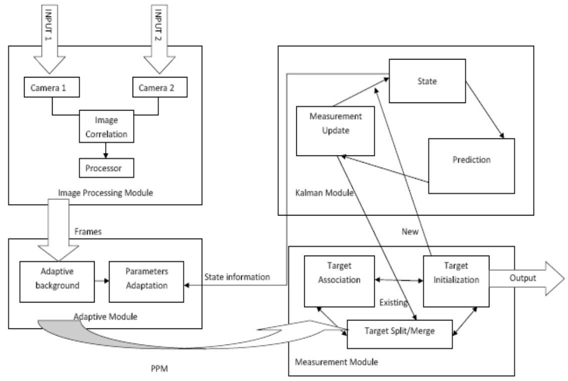

Figure 2: Block Diagram of 3D Tracking

ii) Adaptive module:

The adaptive background module produces the foreground pixels of each video frame. It employs a variation of Stauffer's adaptive background algorithm [11] in the sense that the learning rate and the threshold for the Pixel Persistence Map [10] are adapted based on the Kalman module. These variations, detailed in [7], allow for the system to segment targets from the background even if they remain stationary for some time. The thresholded and Pixel Persistence Map is the evidence passed to the measurement module.

iii) Measurement module:

The module associates the foreground pixels to targets using the Mahalanobis distance of the evidence segments from any of the known targets. Non-associated evidence segments are used to initializes new targets. Finally, existing targets are manipulated by merging or splitting them based on an analysis of the foreground evidence.

iv) Kalman Module :

In order to use the Kalman filter to estimate the internal state of a process given only a sequence of noisy observations, one must model the process in accordance with the framework of the Kalman filter. This means specifying the following matrices: $\mathbf{F}_k$, the state-transition model; $\mathbf{H}_k$, the observation

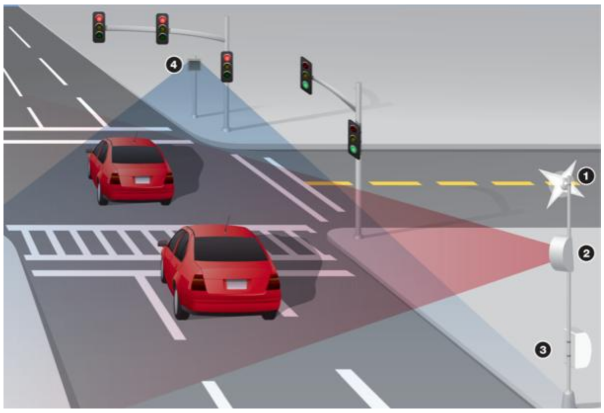

Figure 3 : Animation of Different cameras projection on car

model; $\mathbf{Q}_k$, the covariance of the process noise; $\mathbf{R}_k$, the covariance of the observation noise; and sometimes $\mathbf{B}_k$, the control-input model, for each time-step, k, as described below. The Kalman filter model assumes the true state at time k isevolved from the state at (k−1) according to

$$\mathbf{x}_k = \mathbf{F}_k \mathbf{x}_{k-1} + \mathbf{B}_k \mathbf{u}_{k-1} + \mathbf{w}_k$$

Where

- Fk is the state transition model which is applied to the previous state xk-1.
- Bk is the control-input model which is applied to the control vector uk.

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- Wk is the process noise which is assumed to be drawn from a zero mean multivariante normal distribution with covariance Qk.

Wk ~ N (0,Qk)

At time k an observation (or measurement) zk of the true state xk is made accordingly

Zk = Hkxk+ vk

Where Hk is the observation model which maps the true state space into observation noise which is assumed to be zero mean guassian white noise with covariance Rk.

$$x_{k+1} = \begin{bmatrix} 1 & T \\ 0 & 1 \end{bmatrix} x_k + \begin{bmatrix} T^2/2 \\ T \end{bmatrix} u_k + w_k$$

$$y_k = \begin{bmatrix} 1 & 0 \end{bmatrix} x_k + v_k$$

x_k is a vector that contains vehicle position and velocity at time k, u_k is a scalar that is equal to the acceleration, and y_k is a scalar that is equal to the measured position. w_k is a vector that has process noise due to potholes, uncertainties in our knowledge of u_k, and other unmodeled effects. Finally, v_k is a scalar that's equal to the measurement noise (that is, instrumentation error).

In Figure 3 point 2 & 4 shows camera, 3 is processing unit and point 1 is communicator between two cameras.
The existing or new target information is passed to the Kalman filtering [18] module to update the state of the 2D video tracker, i.e. the position, velocity and size of the targets on the image plane of the particular camera. The output of the tracker is the state information which is also fed back to the adaptive background module to guide the adaptation of the algorithm.

IV. Matlab Simulation Result

As mentioned in the objective we want a system that can track object effectively from two different 2D images captured by two distant cameras. Image using the algorithm which is based on pixel comparison. Incremental method is tested on various sequences of videos acquired on outdoor environments. Surveillance system usually consists of multiple cameras each of which generate correlated data stream. Information from cameras is transmitted to the computer center where the fundamental phase of image processing and analysis take place and also all video data is stored. After interfacing the camera we successfully process the video captured and reconstruct the foreground moving object removing the standard background section. The task of detecting motion is achieved by using MATLAB coding in comparing the reference frame, with every new frame of the video. The detection of motion is achieved by segmentation process of the video. Recognition of object in an image can be performed using edge detection mechanism.

Figure 3 shows tracking of car at different position depending on different pixel values concentrating on the moving car. After that tracking of object is started using Kalman filter which recursively correct the estimation by prediction therefore car is calculated which have relatively less noise than original tracked data.

The input frame sequence of video and output frame sequence that contains moving object detection and tracking using the adjacent frame correlation algorithm method.

Table1 :
Object Tracker Execution Times and Frame Rate:

S.No	Average Time (ms)				Initial	FPS
	Sym	Motion	Refine	Kalman	(ms)	(Hz)
1	37.88	3.25	0.87	0.09	32.20	42.67
2	14.68	3.67	0.75	0.04	12.76	56.78
3	24.87	3.76	0.85	0.03	43.78	77.89
4	42.89	4.56	0.87	0.08	24.78	43.33
5	11.56	3.56	0.79	0.11	30.06	51.25
6	23.57	3.78	0.78	0.13	23.67	45.32

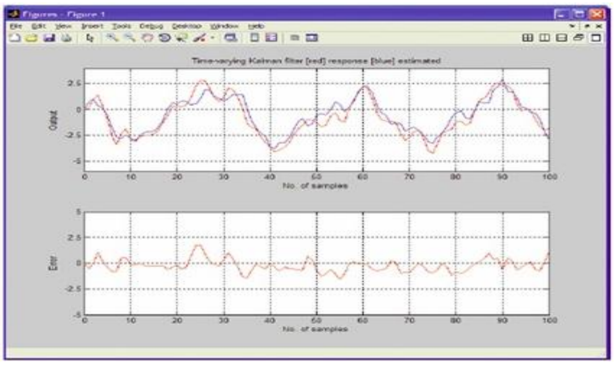

Figure 4: Time varying Kalman Filter Tracking

V. Conclusion

We have presented and implemented of effective moving object detection and tracking with the help of 3D image correlation algorithm in matlab. By experimental result we got nice result compare to other research by using such as image difference and such type of structure element for morphological operation.[4]

We have also estimated velocity as well as acceleration of moving object in particular area. We also graphically presented of velocity and acceleration.

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