Multiple Object Detection and Tracking using Kalman Filter in an Indoor and Outdoor Scene

Manisha Chahande, Vinaya Gohokar

Abstract*: *Tracking target through sequences of images is fundamental problems in vision. In this paper we converse the motion based kalman filter procedure to track the multiple objects for indoor and outdoor scenes. This is of utmost importance for high-performance real -time applications. The mentioned approach is appropriate for indoor & outdoors scenes with static background & overcomes the problem of non-moving objectives fading into the background. The tracking in proposed turned into solely based totally on movement with the belief that each one items move in a immediately line with continuous speed. The motion primarily based Kaman filter monitoring for more than one objects works correctly but requires the camera to be stationary.

Index Terms*: *Kalman filter, Multi-Object tracking, vehicle tracking, measurement update

I. INTRODUCTION

Detection of multiple objects and tracking based on motion are important works of many computer vision applications . Tracking of objects contains tracing a single moving object or multiple moving objects in a sequence of images. It has previously been useful in various computer vision application, like biological application, surveillance system, robot navigation, artificial intelligence, safety detection, military guidance etc. [1].

There are number of single-object tracking systems implemented in recent years. But with difficulties of presence of many objects, the problem is one of several item tracking where targets and examinations should be matching from frame to frame in a video sequence. Deciding the correct methodology for detecting objects of interest depends on what object you want to track and whether the camera is moving or non-moving . Background subtraction algorithm can be used for detection of objects which requires camera to be stationary. Tracking an object over time requires predicting its location in the next frame, that means, the preceding detection serves as the following prediction. This method serves the purpose for high frame rates. A more state-of-the-art technique of prediction is to apply the previously discovered movement of the object. The Kalman filter able to predicts the subsequent position of an object, supposing that it travels with constant speed or constant acceleration.

II. SCENE CLASSIFICATION

Classifying scene is a great interesting problem in the field video processing. Scene may be indoor or outdoor. This happens because of the great unpredictability of the scene content and the difficulty in explicitly modeling scenes with indoor- outdoor content. Scene can be Indoor or outdoor depending on the environment we are observing. A Indoor scene can be a library or an office, where the background is generally static, the light is artificial. and the 3D structure of the environment is known. An outdoor scene example police team moving with dog on road of a nearly static background is a motor on road and all the cars travel in different lanes.

III. TRACKING OF OBJECT

Multi-Target Tracking (MTT) involves determining resemblance between a set of observations (or measurements) separated over time. Generally multi target tracking problem involves multiple targets and multiple measurements, [3] accordingly every target requires to be proved and managed to one measurement in a data association procedure [8][9]. The Multi target tracking process can be divided into 2 integral steps:

1. The first step is association – It means assignment of every observation received for a specific target path;
2. The second step is estimate – It means the attained reflection is used to give a state approximation of the associated path.

On receiving a new observation each time, it must be related to the valid path among the set of the existing paths, or, if it denotes a different object, a different track must be created. Accordingly, the tracking system needs some mechanisms of statistics affiliation and tracks management [8]. In a single speculation approach, an information is always related to most effective one of the existing tracks and the track management module must cope up with track initialization, track update (consisting of prediction and information association), and track deletion.

The system cannot recuperate from a mistaken association (i.e., an observation is associated to a wrong track). This is biggest limitation of this method. As in a crowded environment it is not forthright to allot an observation to a particular track, it is appropriate to use a multi-hypothesis tracking system (see Fig. 1).Every time there is an observation that could be assigned to more than one path the system divides every object tracks into two new ones (one revised with the observation, one not revised). Such a method (called track split) pointers to a conceivable proliferation of the number of pathways, thus the system needs to detect and delete unwanted ones (track merging).

Track initializarion	If any new observation is obtained, a new track is created, in case it is not correlated with any existing track
update of Track	Once observations are associated to track in a one-to-one fashion,standard updates of the Filters are performed and the filters evolve

Revised Manuscript Received on January 15, 2020

Manisha Chahande, Amity school of Engineering and Technology, Amity University, India,

Vinaya Gohokar, Maharashtra Institute of Technology, Pune, India

split of Track	When an target is highly interrelated with more than one track,new association hypotheses are created
Track merge	If the probability association between two tracks exceeds a threshold, keep only the most significant hypothesis &one of the two tracks is deleted,
deletion of track	In case track is not maintained by observations,the inaccuracy in the estimated state increases. If the uncertainty reaches threshold,the track is deleted.

Figure 1: Tracks management.

IV. KALMAN FILTER

The Kalman filter is basically a set of mathematical equations that device a predictor-corrector type estimator that is optimal in the sense that it minimizes the estimated error covariance—when some presumed conditions are met.[1][3]. It is a predictive filter that is based on the use of state space method and recursive algorithm

Usually it is 2 -step process

First is Prediction and second is Correction.

In first stage the state is predicted with the dynamic model then it is corrected with the observation model so that the error co-variance is minimized. The procedure is repeated each time with the step as the prior step as initial value.

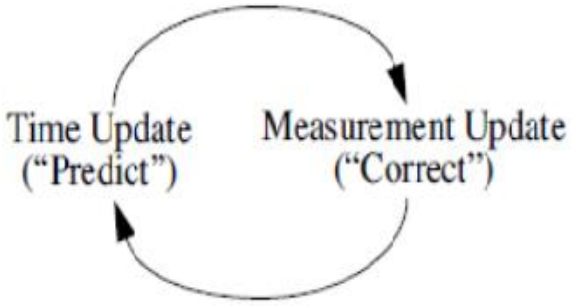

Figure-2 The complete algorithm of kalman filter

The Kalman filter best described with mathematical equations & it's recursive filter. It means that only the estimated state from the prior time step and the current measurement are needed to calculate the estimate for the current state.

V. TRACKING WITH KALMAN FILTER

Kalman filer is an estimator that calculates and corrects the states of vast variety of linear techniques . In this filter, we regard a tracking system in which xk is the state vector which represents the dynamic behaviour of the object, where subscript k suggest the discrete time. The objective is to estimate xk from the measurement zk. Next is the mathematical description of Kalman filer, which for consideration we have sectioned into four phases.

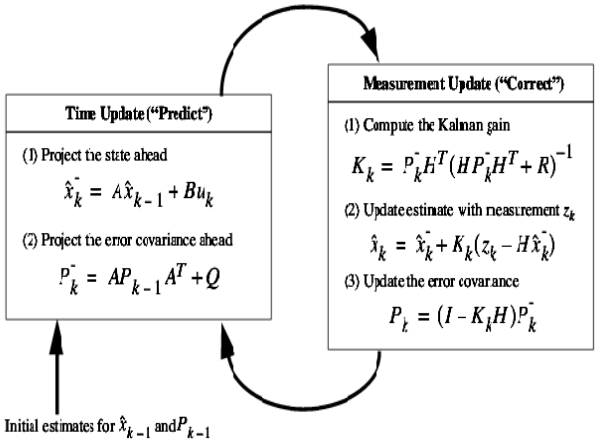

Figure-3 Kalman Filter operation

VI. EXPERIMENTAL RESULTS AND ANALYSIS

To validate the kalman filter method, we have considered slandered databases. All these sequences include multiple objects, and background lighting is unstable and non-uniform. Database is comprise of video data from indoor scenes of persons walk by and around each other and outdoor scenes with multiple object consist of persons and moving vehicles traffic in which several occlusions occur.

A. Multiple object tracking in Indoor scene

The tracking results displays in Figure 4 for a video of moving human in an indoor scene. It is not easy to track moving people because their silhouette change is difficult to track and their motion is difficult to learn and predict. Selection of the right approach is important for detecting objects of interest and it is depends on what you want to track and whether the camera is stationary. To detect objects in motion with a stable camera, we perform background subtraction. [5][6][7]

B. Multiple object tracking in Outdoor scene

We use real time traffic video to verify the tracking method based on Kalman filter, shown in Figure 4, It is observed that the method has a good tracking speed and it can track fast moving object such as vehicles. The results of tracking with Kalman filter show the tracking method is able to correctly handle the fresh entry and exit moving objects in the outdoor traffic scenes. For figure 4 and figure 5 camera is stationary and background is static.

Results has been taken for moving humans and vehicles are shown in figure 6. It is assumed that all objects move in straight line with uniform speed .Tracking is completely based on motion. This tracking method produce error when object are moving with non-uniform speed. This methods then fails for this scene as objects are moving with varying speed and camera is not stationary.[9]

C . Multiple object tracking in case of occlusion

Occlusion is one of the imperative problems in multiple objects tracking.

It includes merge and split problems. Conjoining two or more objects into one is referred as merge. needed to be established for every object, also the judgement
Whereas , split problem is separating from merging objects. Occlusion is one of the imperative problems in multiple objects tracking.. In figure 7, Kalman motion models are
is needed whether any of these objects fused together or split from a muti-person object. The info is sent to their associated trackers to maintain correct ID for tracking after multi-person object separated. The results for tracking with Kalman filter based tracker does a great job of tracking the human bodies when they get partially or completely occluded [2][4]

VI . CONCLUSION

We researched Kalman filter for multiple target detection and tracking for an indoor and outdoor scene. Using this method, every object is tracked in indoor and outdoor scene, using Kalman filter in normal condition. The moving object guarantee a 100% chance of correct tracking for multiple object when the objects are moving with constant speed and camera is stationary. However, by this Kalman filter prediction technique, it can fail when objects move with non –uniform speeds, and camera is moving.
The experimental results have validated the effectiveness of kalman filter for multi-object tracking in indoor and outdoor scene.

Figure 4 Indoor scene with multiple objects

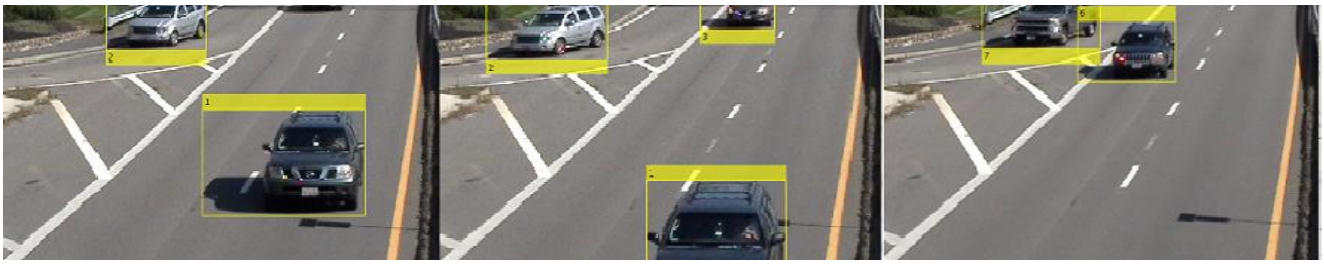

Figure 5 outdoor scene with stationary camera

Figure 6 outdoor scene with moving camera

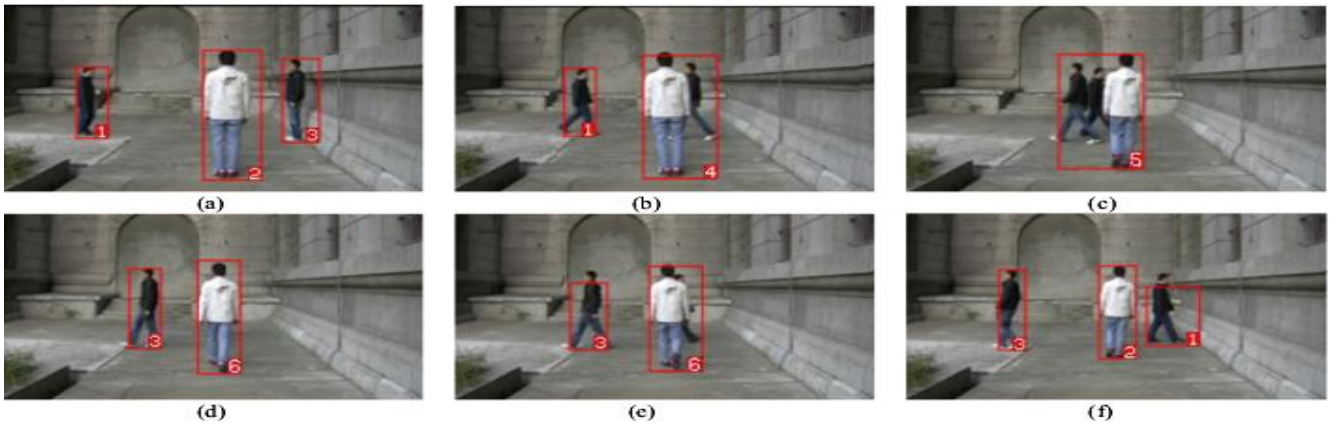

Figure 7 Tracking result in an outdoor scene with occlusion

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AUTHORS PROFILE

Manisha Chahande is an Assistant Professor, at Amity University in the college - Amity school of Engineering and Technology, Noida. She has a teaching experience of more than 12 years. Her area of interest includes Image and video processing, Engineering in microwave domain. She has many Publications in Journals and National /International Conferences.

Vinaya Gohokar is a Professor in Electronics & Telecommunication department, Maharashtra Institute of Technology, Pune. She has been teaching for more than 25 years. Area of Interest includes Image and video processing, Microwaves and IoT. She is PhD Guide in Amaravati and Nagpur University. She has many Publications in Journals and National /International Conferences.