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Analysis of Multiple Object Detection using Kalman Filter in Sports Video

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ABSTRACT
Object detection and tracking on Broadcast Sports Video (BSV) plays an important role in content analysis and also it‘s a challenging task because of playing track, play court, player‘s size, noises, disturbances and occlusion in a playing court which fails the results of detection. In addition, occlusion of multiple players in matches also causes a failure of tracking. In this paper, an comprehensive study of a robust technique for object detection and player tracking using a Kalman filter(KF) has elaborated. The parameters of the KF are dynamically changed based on the results of player detection or line detection in the video frames. The algorithm is tried on respective case study for the better result.

Keywords
Object Detection, Background Estimation, Kalman Filter Technique

1. INTRODUCTION
Video content Analysis has became an challenging task in the field of computer vision. Among various fields of video applications sports video has grabbed the attention of all kind of viewers. Like cricket, foot ball, Tennis many more attract much more attention. This is due to not only their great popularity, but also the tremendous commercial value. Automatic analysis of sports video data, such as highlights extraction, technical statistics gathering, and tactical analysis, can provide great convenience for both video content service providers and sports game watchers. To accomplish these tasks automatically, locating and tracking multiple players within the playfield region plays a very important role which can provide many fundamental results for them.

Video tracking can be defined as an action which can estimate the trajectory of an object in the image plane as it moves within a scene. There are three key steps in video analysis: detection of interesting still and moving objects, tracking of such objects from frame to frame, and analysis of object tracks to recognize their behavior. This paper elaborates the first two steps using Key frame extraction[1], background subtraction and applying the KF technique for the tracking process.

1.1 Kalman Filter:
The process of tracking any object involves using past and present information to estimate future changes of the object. KF is applied based on two studies Time and measurement updates The **Kalman filter**, also known as **linear quadratic estimation (LQE)**, is an algorithm that uses a series of measurements observed over time, containing noise (random variations) and other inaccuracies, and produces estimates of unknown variables that tend to be more precise than those based on a single measurement alone. More formally, the KF operates recursively on streams of noisy input data to produce a statistically optimal estimate of the underlying system state. The filter is named for Rudolf (Rudy) E. Kálmán, one of the primary developers of its theory. The KF has numerous applications e.g, for guidance, navigation & control of vehicles, particularly aircraft and spacecraft[2]. The process of KF on each frame as stated bellow,

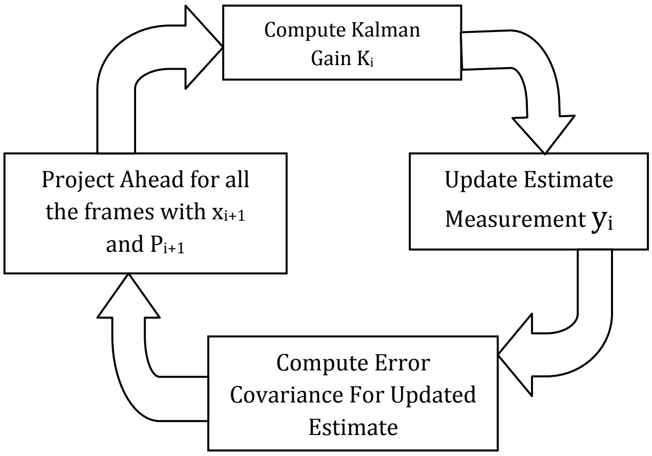


Fig.1 Frame by Frame Working of Kalman Filter

Each player is considered as an moving object and the background (track lines) will be taken as static object[2]. These are individually set as a measurement input. The Kalman tracker then uses this data to effectively correct the system and obtain a probable state vector. The measurement correction equation is given as,

$$\begin{bmatrix} x_t \\ y_t \\ x'_t \\ y'_t \\ W_t \end{bmatrix} = \begin{bmatrix} \hat{x}_t \\ \hat{y}_t \\ \hat{x}'_t \\ \hat{y}'_t \\ \hat{W}_t \end{bmatrix} + K_t \left\{ \begin{bmatrix} mx_t \\ my_t \\ mW_t \end{bmatrix} - \begin{bmatrix} 1 & 0 & \Delta t & 0 & 0 \\ 0 & 1 & 0 & \Delta t & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \hat{x}_t \\ \hat{y}_t \\ \hat{x}'_t \\ \hat{y}'_t \\ \hat{W}_t \end{bmatrix} \right\}$$

Based on the capability of predicating the system state, motion information can be constructed on the KF [3]. The prediction of Kalman gain(KGM) matrix is represented as

$K(k) = P–(k)\ HT(k)\ [H(k)\ P–(k)\ HT(k) + R(k)]–1$ Eq:1

A KGM depends on the accuracy of a measurement. The KGM has high value for high accuracy of the measurement[9]. Based on the KF prediction state and the measurement state, we define the Measurement update of the state error covariance as follows

$$P_K = (1 - K_K H) P_K^- \quad \text{Eq: 2}$$

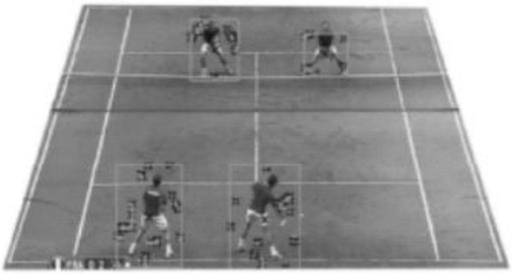
And Measurement update of the state estimate

$$X_K = X_K^- + K_K(Z_K - H X_K^-) \quad \text{Eq: 3}$$

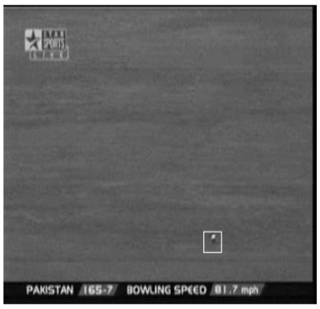
After each time and measurement update pair, the process is continuously repeated with the previous posterior estimates for projecting or predicting the new priori estimate values [1] for the tracking purpose. For example, in the Kabaddi game we can estimate the location where the object appearance on the image, either near to middle tracks lin or middle of the game point. This is applied on different sports application to find the accuracy of the tracking status.

The result of KF on BSV tennis

Fig.2(a): Tennis court detection



(b) player detection



(a) at frame 26

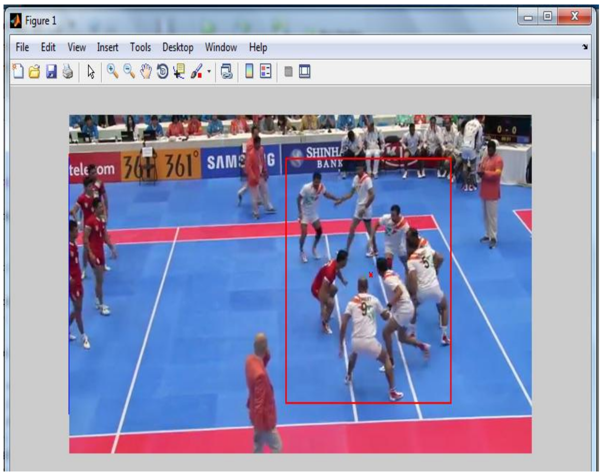
Fig.3 (a)Ball Trackig in cricket video frame [4]

(b) ball position detection

(c) Volly Ball detection[8]

2. PROPOSED CASE STUDY

The algorithm is tested on Kabaddi game by concentrating the half of the kabaddi court. The algorithm starts with reading the first 30 frames for the background estimation [14]. Initialize the centroid and prediction for actual point of recognition. Then we initialize the Kalman parameters for measurement matrix as measurement noise, transformation from measure to state, system noise, status covariance matrix, transform matrix . Based on these Kalman values fix the threshold th point at 30 and calculate the difference image to extract pixel more than 40(threshold) change. Then apply the bubble sort large to small. Get the upper left conrner, measurement centroid and bounding window size. Which will detects the multiple player occurance in the field and the actual background image with ploting of blue rectangle. Affter the KF the new state on prediction and velocity will be pointed by red rectangular box. This algorithm will be tested for resulting more accuracy on the self developed video more than the broadcasted video shots.



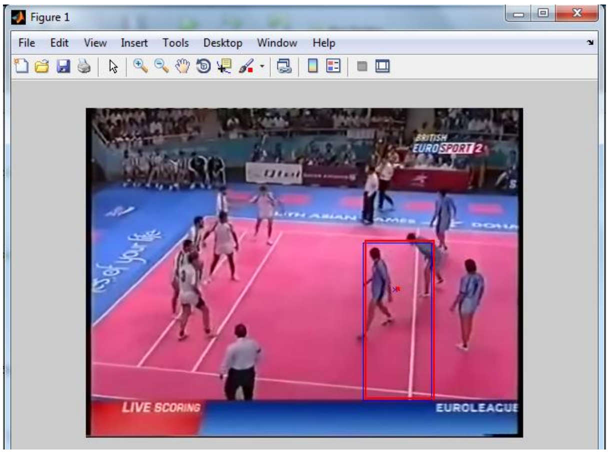


Fig.4 KF testing on Kabaddi court for half court observation.

The above experimental result shows the background detection near the teaser and the chaser. The second frame shows the multiple player moment inside the court chaser team.

3. CONCLUSION

Object detection and tracking process has made its effective role in wide areas with different techniques. This paper elaborated on KF technique on different applications which resulted in detecting the multiple players inside the play court. This was previously used on many games like tennis cricket soccer and many other. The proposed case study applied the KF technique on Kabddi video which is the new experiment in the Video image processing(VIP) field using MATLAB. The results shows the multiple object tracking of dincgle team with two bonded box accurately.

In future we can improve the efficiency by concentrating on sub-region under the predicted location. In reality more than prediction we often find the non-linear, non-Gaussian noise and multi modal distribution. The quality of the camera will also affect the detection accuracy of the KF. In future, these all observations will be tested on self developed videos for more accuracy.

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