

# An Automated Approach for Video Surveillance Using Kalman Filter

Surbhi Agarwal  
Deptt. Of Computer Science  
Yagyavalkya Institute Of Technology  
YIT Lane, Sitapura, Jaipur, Rajasthan 302022  
Surbhiagarwal2k11@gmail.com

Ankur Goyal  
Deptt. Of Computer Science  
Yagyavalkya Institute Of Technology  
YIT Lane, Sitapura, Jaipur, Rajasthan 302022  
ankur\_gg5781@yahoo.co.in

**Abstract**— Image processing has played a vital role in every aspect of human life. Video surveillance has reached a major out through by the application of advanced image processing and frame modeling techniques. In video surveillance, detection of relocating objects from a video is predominant for object detection, target monitoring, and behavior. Detection of relocating objects in video streams is the first major step of the algorithm, and background subtraction is a pleasant technique for foreground segmentation. In this thesis, automatic actual-time object detection and tracking had been carried out utilizing Kalman filter the place the method output was once monitoring the input and canceling out any variants because of entry and exit noises. This work could be used to boost a surveillance procedure of static digicam and robotic automation visible systems.

**Keywords**— *object detection, tracking, Kalman filter, occlusion, image processing*

\*\*\*\*\*

## I. INTRODUCTION

The real time object detection and tracking has been a great field of research since the emergence of field of Computer Vision and Image processing. Earlier many great contributions had been done by various scholars in this been field. The video surveillance systems can be classified under two broad categories [4]

- a. Static camera systems
- b. Moving camera systems

Static camera systems are characterized by their reference frame that remains constant throughout the process. The work presented here is majorly concentrated on static systems, while the presented concept can be extended to moving camera systems by timely varying their reference frames[2]. Background Subtraction technique has got used a lot in previous works. But as technology develops the processing time of new algorithms continues to shrink, here is too proposed a new method that is fast in processing with fine results[6]. Object detection can be done by two methods:

- a. Automatic systems
- b. Manual systems

The manual system demands of some human interference to locate any geometrical figure on the foreign object[1],[2], while in automated systems once the parameters has got set it can detect new foreign object by itself. In modern systems this technique can be implemented too by using color or texture information [3] of foreign objects in the frame.

After learning the literature, it is observed that detecting the things from the video sequence and likewise monitoring in various articles that, it is a relatively complicated as an undertaking. Object tracking is usually a time drinking procedure due to quantity of knowledge that is contained in the video. From the literature survey it's determined that there are many background subtraction algorithm exits which work efficiently in each indoor and outdoor surveillance system. Julio et al. [5] has proposed a background modeling process and used another algorithm to notice shadowed vicinity.

## II. OBJECT DETECTION AND EXTRACTION

An image is mostly characterized by variety of feature such as frequency domain representation, image edges, corners, texture etc. One of such feature is image histogram. It represents the probability distribution of gray values distributed all over the image, is a probability distribution curve.

### A. Techniques used for Object Detection

1. For generic object detection, the most common approach is to slide image across a window, and with a goal or is classified as the background in each local window [1,2]. This approach has been successful in detecting hard objects such as faces and cars that have been used for detection.
2. Another popular approach generally used is to remove the image points of local interest, and then classify each of the areas around these points, instead of looking at all possible sub windows.
3. Other detection methods fall in the category combining the category of top down and bottom up segmentation with major improvement of Shape-Context.

### B. Object Detection by Histogram Subtraction

The histogram display of subsequent image sequences was subtracted consecutively and averaged out[7]. The resultant peak at a certain region of gray level indicates that the new coming foreign object has gray scale in that particular range. The thresholded image either from RGB plane or single gray plane must first of all be converted into a binary image. Then morphological operations of image labeling [4,9] can be used to detect the number of objects in the image.

### C. Image Thresholding

The concept of image thresholding can be used to extract foreign object in image frames. In relation to current advancement a variety of techniques may be used for object extraction. Various image characteristics such as entropy,

histogram, k-means clustering and watershed development etc are used for image segmentation[8].

*Techniques used for image segmentation:-*

Various well known threshold selection techniques mostly used are

1. Basic Global Thresholding.
2. Clustering methods
3. Histogram-based method

*D. Otsu's image thresholding technique.*

In this method the procedure followed in such a way that, for every possible value of threshold, histogram was subdivided into classes. Then total image variance, within the class variance and between the class variance was used to evaluate the most exact value of threshold. Fig.1 depicts the Otsu algorithm for segmentation[7].

$$(1) p_i \leftarrow \frac{n_i}{n}, \text{ where } n = \sum_{i=1}^G n_i$$

$$(2) u_r = \sum_{i=1}^G i p_i$$

(3) Do for  $k=1$  to  $G$

$$w(k) \leftarrow \sum_{i=1}^k p_i$$

$$u(k) \leftarrow \sum_{i=1}^k i p_i$$

$$\sigma_B^2(k) \leftarrow \frac{[u_r w(k) - u(k)]^2}{w(k)[1-w(k)]}$$

(4) Select  $k^*$  such that  $\sigma_B^2(k)$  is maximized

Note that,

$$w_0 = w(k), u_0 = \sum_{i=1}^k i P(i / C_0) = \frac{u(k)}{w(k)}$$

$$w_1 = 1 - w(k), u_1 = \sum_{i=k+1}^G i P(i / C_0) = \frac{[u_r - u(k)]}{[1 - w(k)]}$$

$$\sigma_w^2 = w_0 \sigma_0^2 + w_1 \sigma_1^2$$

$$\sigma_B^2 = w_0 (u_0 - u_r)^2 + w_1 (u_1 - u_r)^2$$

$$\sigma_r^2 = \sum_{i=1}^G (i - u_r)^2 p_i$$

$$\sigma_w^2 + \sigma_B^2 = \sigma_r^2$$

$$\epsilon = \frac{\sigma_B^2}{\sigma_r^2}, k = \frac{\sigma_r^2}{\sigma_w^2}, \lambda = \frac{\sigma_B^2}{\sigma_w^2}$$

Fig.1: Otsu segmentation Algorithm

III. OBJECT TRACKING

In an order to track the moving objects, discrete version of Kalman filter was used. Kalman filter [3] is basically an estimator to perfectly follow system response irrespective of input or output and any other inherent system noises. The filter predicted the next movement of object depending upon parameters of previous and present state. Then it measures variation of the observed value from predicted one.

**Understanding the Kalman filter**

Thus Kalman Filter can be understood to work in following two steps:

- a) Predictive Stage
- b) Measurement or Correction Stage

As this work is mostly concentrated on objective of motion analysis. The work should based on two types of error estimates, priory state estimate and posteriori state estimates. Priory estimate is the prediction of next state parameters using the information of previous state, before the actual process is going to be occurred. Posteriori estimate refers to state estimation once the actual process or measurement has got completed.

Now switch up to understanding the working of a Kalman Filter, for this first of all it should pass through the derivation of a Kalman filter, where the input is a scalar quantity. Fig.2 depicts the structural block diagram of Kalman filter.

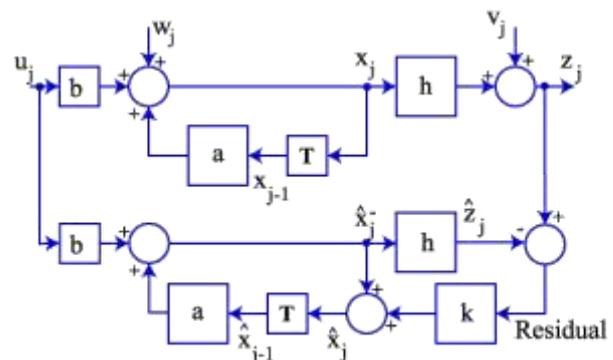


Figure (2): Kalman Filter Structure

IV. EXPERIMENTAL TOOL & RESULTS

Matrix laboratory is abbreviated as MATLAB and it is developed by EISPACK and LINPACK projects provided easy access to matrix and vectors. It is an interactive language in which basic data elements are array and they don't require dimensioning. The language features are organized into six directories in the MATLAB Toolbox:

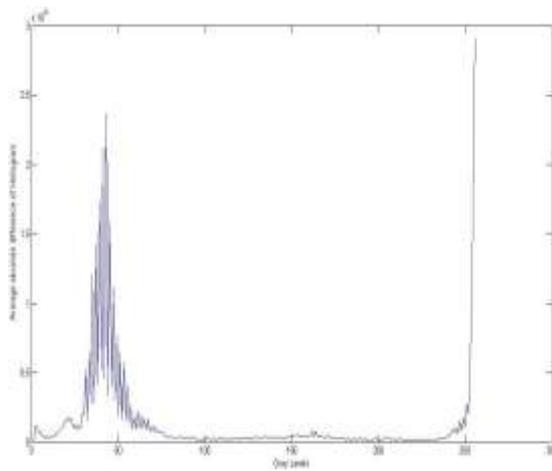
ops	Operators and special characters.
Lang	Programming language constructs.
Strfun	Character strings.
Iofun	File input/output.
Timefun	Time and dates.
datatypes	Data types and structures.

The MATLAB working environment provides us the set of tools and facilities to work as the MATLAB user or programmer. It includes facilities for managing the variables in workspace and importing and exporting data. It also includes tools for developing, managing, debugging, and profiling M-files, MATLAB's applications. The working environment features are located in a single directory.

**RESULTS:-**

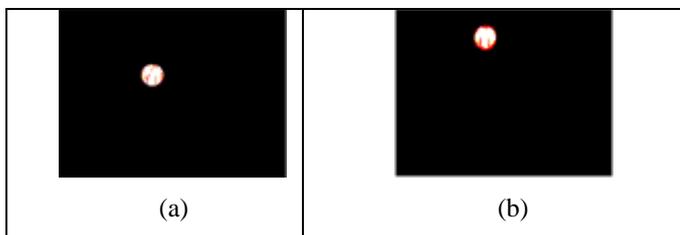
The object detection result taken for the video file "ball.avi" represented in Fig(3) , here the peak represent the detection of

foreign body and the gray value at which this peak occurs gave an inference of gray properties of foreign object.



Figure(3): The peaks in absolute histogram difference curve show the detection of object in given gray level range.

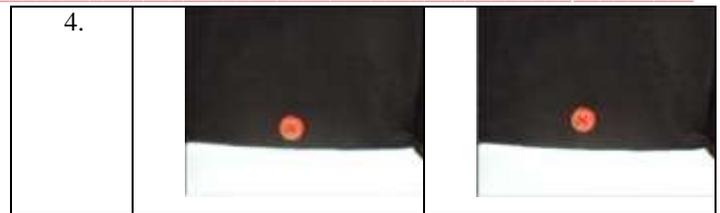
Subtract consecutive frames and extract the external object using Otsu’s thresholding technique as shown in Fig (4):-



Figure(4): Otsu’s thresholded moving object in selected frames (a) and (b)

The sequence of images taken by static camera when passed through Kalman Filtering structure as in Fig(5) gave out following sequences of images.

Image Sequence	Frame occurrence rate $dt = 1$	Frame occurrence rate $dt = 100$
1.		
2.		
3.		



Figure(5):Kalman Filtered image sequences for different values of frame occurrence rate  $dt$ , the object motion, tracked by green square.

## V. CONCLUSION

In this thesis work Kalman Filtering based methodology for Real Time Object Detection and Tracking was studied. The system model was developed using the kinematics equations related to velocity and accelerations. It was shown that the suitable techniques for object detection were successive histogram subtraction, for object extraction done by Otsu’s method of image thresholding and for object tracking Kalman filter was used with optimized frame rate. This article provides a significant outline for any scholar researching in this sector.

## REFERENCES

- [1] Gregory F. Welch, “History: The Use of the Kalman Filter for Human Motion Tracking in Virtual Reality,” *Presence*, Massachusetts Institute of Technology, vol.18,pp 72–91, February 2009.
- [2] G.L. Smith; S.F. Schmidt and L.A. McGee, “Application of statistical filter theory to the optimal estimation of position and velocity on board a circumlunar vehicle,” *National Aeronautics and Space Administration.*, 1962.
- [3] C. Harris and M.J. Stephens, “A combined corner and edge detector,” In *Alvey Vision Conference*, pages 147–152, 1988.
- [4] C. Schmid, R. Mohr and C. Bauckhage, “Evaluation of interest point detectors,” *International Journal of Computer Vision*, vol. 37, pp.151–172, June 2000.
- [5] Frank Y. Shih, Shouxian Cheng, “Automatic seeded region growing for color image segmentation,” *Image and Vision Computing*, vol. 23, pp.877-886, 2005.
- [6] Li de-yi, Du yi, “Uncertainty artificial intelligence,” *National Defence Industrial Press*, Beijing, 2005.
- [7] Madhur Mehta, Chandni Goyal, “ Real Time Object Detection and Tracking: Histogram Matching and Kalman Filter Approach,” *IEEE Conference*, vol.5, pp 796-801, 2010.
- [8] Carsten Rother, Vladimir Kolmogrov, Andrew Blake, “GrabCut-Interactive Foreground Extraction using Iterated Graph Cuts,” *In Proceedings SIGGRAPH 2004*.
- [9] Kar-Han Tan, Narendra Ahuja, “Selecting Objects With Freehand Sketches,” *In Proceedings IEEE Computer Society Conference on Computer Vision and Pattern Recognition*, 2001.