Object Detection and Tracking in video using Kalman Filter

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Abstract **-Object tracking in a video is the problem of estimating the positions and other related information regarding moving objects in image sequences of video. Object tracking is a very important task in the field of security automation surveillance systems in the field of security automated surveillance systems. For detecting and tracking the moving objects, Surveillance system are used. First stage of the system is detecting the moving objects in the video. Second stage of the system is tracking the detected object. In this paper, detection of the moving object is done by using a simple background subtraction and tracking of moving objects is done by using Kalman filter. The algorithm is applied successfully on standard video datasets. The videos used here for testing have been taken at indoor as well as outdoor environment having moderate to complex environments. Kalman filter tracks an object by assuming the initial state and estimating noise covariance. It provides an efficient method for calculating the state estimation process. An experimental result which came from different moving object video samples shows a very good result. This filter is intended to be robust without being programmed with all environment specific rules.**

Keywords: **Median filter, Detection, Tracking, Background Subtraction, Kalman Filter.**

I. INTRODUCTION

Object detection and tracking in a video is an active research topic in computer vision that tries to detect, recognize and track objects in a sequence of images in video and also makes an attempt to understand and describe object behavior in video by replacing the old traditional methods of monitoring cameras by human operators. Object detection and tracking in a video is an important and challenging task in many practical applications such as surveillance, vehicle navigation and autonomous robot navigation. Object detection is nothing but locating objects in the frame of a video sequence. The availability of high speed computers, high quality video cameras, and the need for automated video analysis has lead to a great interest in object tracking algorithms. Object tracking is defined as the process of segmenting a desired object from a running video and keeps track of its motion, orientation, occlusion etc. in order to extract the useful information. Difficulties regarding tracking of objects can arise due to abrupt object motion, changing appearance of the object and the environment, non-rigid object structures, object-to-object and object-to-noise occlusions, and camera motion.

The aim of the project is to detect and track the moving object in a video using Kalman filter. In recent times, automatic security surveillance systems are an active research area due to an increasing demand for such systems in public places such as airports, underground stations and mass events. The main objective of this algorithm is to assist human operators in analyzing the bulky video data so that work load becomes less for humans. The goal of the work in this thesis is: 1) To set up a system for automatic detection and tracking of moving objects in a video using stationary camera, which may serve as a foundation for higher level reasoning tasks and applications. 2) To make improvements in commonly used algorithms. At last, the aim of the paper is to show how to perform detection and motion based tracking of moving objects in a video by using video detection algorithm. Therefore, the main objectives are:

1) To analyze segmentation algorithm to detect the objects. 2) To analyze some tracking method for tracking the single objects and multiple objects.

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A simple block diagram representing the object detection and tracking in video is shown in Figure 1.1

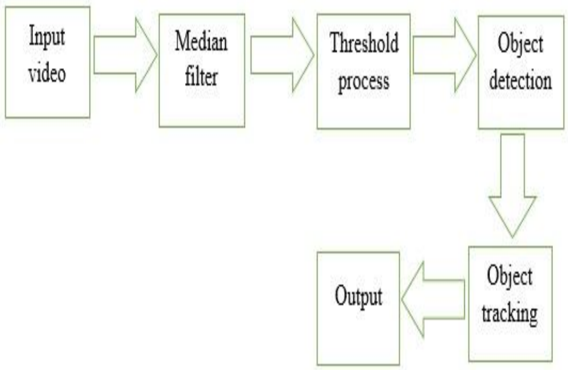

Figure 1.1: Block diagram for object detection & tracking in video

II. MEDIAN FILTER

Median filter is normally used to reduce impulse noise in an image. It is a sliding-window spatial filter which replaces the center value in the respective window with the median obtained by considering all pixel values in window. For calculation of median, at first, all the pixel values of window are sorted in ascending/descending order & then middle value is taken as median. If the neighborhood under consideration contains an even no. of pixels, then the average of the two middle pixel values is calculated and obtained result is fixed as median value. Median filter is preferred to mean filter because it preserves sharp edges while removing noise. The main benefit of using median filter is that it doesn't create new unrealistic values. i.e., median value belongs to one of the pixel value in neighborhood. Here, a 3x3 median filter is used over the frames.

IV. THRESHOLD PROCESS

It is an image processing technique for converting a grayscale or color image to a binary image based upon a threshold value. The type of threshold used here is Global Thresholding. If a pixel in the image has an intensity value lower than the threshold value, then respective pixel in the resultant image is set to black. In case if the pixel intensity value is larger than or equal to the threshold intensity, then the resulting pixel is set to white. Thus, a binary image or an image with only 2 colors, black and white is created.

V. OBJECT DETECTION

Block diagram representation of steps for object detection is shown as,

Figure 5.1: Block diagram for object detection for object detection

Background is a stationary layer located behind all other layers. Anything that is not background is likely foreground i.e., moving objects. Background model is initialized by considering first 'n' frames. Here '10' frames are considered. The background model is developed by averaging these initial '10' frames. For background subtraction, thresholding technique is used.

VI. OBJECT TRACKING USING KALMAN FILTER

Tracking is the process of locating moving objects over time in each frame of videos. A Kalman filter is not a filter. It is an optimal estimator i.e. infers parameters of interest from indirect, inaccurate and uncertain observations. It process the new measurements as they arrive regularly i.e. kalman filter is recursive. The word 'filter' is used because it is the process of finding the 'best estimate' from noisy data for 'filtering out' the noise. It is an estimate obtained through combining both prediction and measurement. The Kalman filter consists of two stages: Time update (prediction) and The measurements update (correction). The time update equations projecting forward (in time) the current state and error co-variance estimates for obtaining the priori estimates for the next time step [2]. The time Update equation is called predictor equation. The measurement update equations incorporates a new measurement into the a priori estimate to obtain an improved a posterior estimate [2]. The measurement update is called corrector equation.

In the proposed algorithm, the same number of the Kalman filter is applied to estimate object's state [1]. Kalman filter estimates the position, (x, y) of object in the frame for tracking that object. Kalman filter is configured as follows:

$X_K^- = AX_{K-1} + W_K$----------3.1

$Z_K = HX_K + V_K$ ----------3.2

A = Transition matrix, which relates the state at time k to the state at time k+1
H = Measurement matrix, which is to relate the state to measurement
X_K = state vector containing the terms of interest for the system at time k i.e. current estimation

X_K^- = Prior estimation value.

W_K = Gaussian noise with zero mean and the error covariance 'Q'

V_K = Gaussian noise with zero mean and the error covariance 'R'

Process of the Kalman filter: There are six step of Kalman filter process which is given below:

1) Time update of the state estimate

$$X_K^- = AX_{K-1} + W_K \quad \text{----------3.3}$$

2) Predicted measurement

$$Z_K = HX_K + V_K \quad \text{----------3.4}$$

3) Time update of the state error covariance

$$P_K^- = AP_{K-1}A^T + Q \quad \text{----------3.5}$$

4) Kalman gain

$$K_K = P_K^- H^T (HP_K^- H^T + R)^{-1} \quad \text{----------3.6}$$

A Kalman gain depends on the accuracy of a measurement. The Kalman gain has high value for high accuracy of the measurement. Otherwise, the Kalman gain has relatively low value.

5) Measurement update of the state error covariance

$$P_K = (1 - K_K H)P_K^- \quad \text{----------3.7}$$

6) Measurement update of the state estimate

$$X_K = X_K^- + K_K(Z_K - HX_K^-) \quad \text{----------3.8}$$

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.

VII. RESULTS

Here, object tracking operation is carried on three sample videos.

Video1:- it consists of 120 frames.

Video2:- it consists of 200 frames.

Video3:- it consists of 283 frames.

The different stages of results in executing the input videos 1 to 3 for different framesare shown in Figures 7.1to 7.6

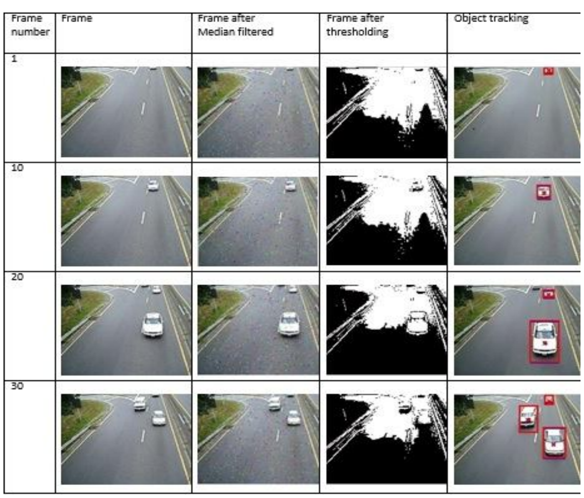

Figure 7.1: Results of video1 for frames 1,10,20,30.

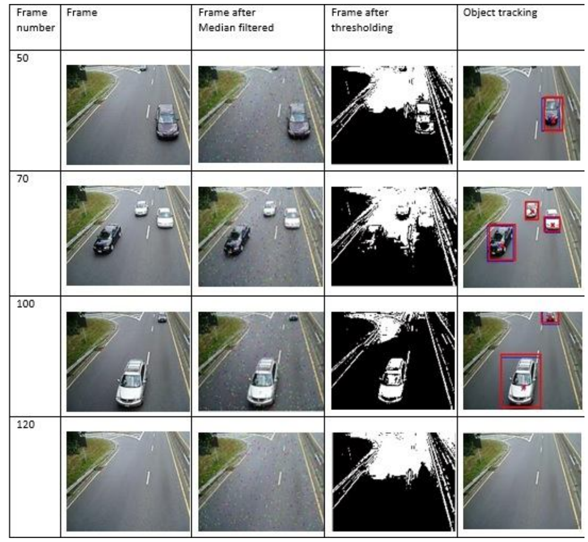

Figure7.2: Results of video1 for frames 50, 70,100,120.

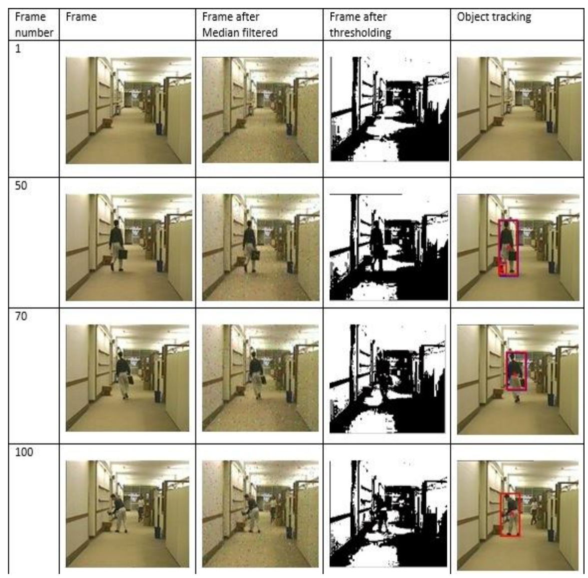

Figure 7.3: Results of video2 for frames 1, 50, 70, 100.

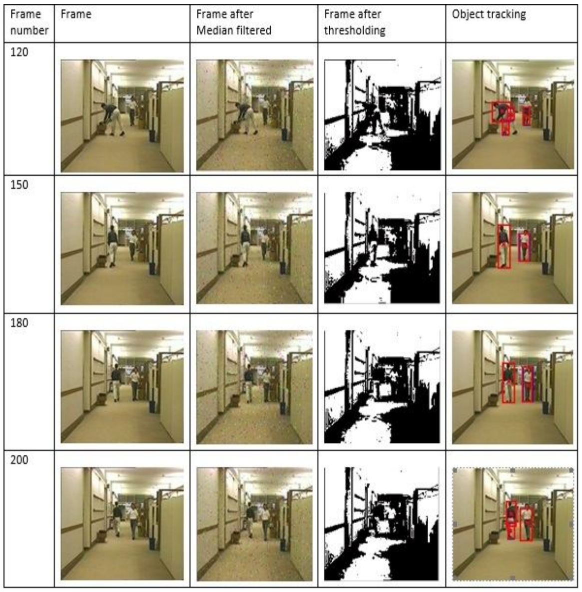

Figure 7.4: Results of video2 for frames 120,150,180,200.

Figure7.5: Results of video3 for frames 1, 50, 100, 150

Figure7.6: Results of video3 for frames 170, 200, 250, 283

VII. CONCLUSION

In this paper, a visual surveillance system which is used for detection and tracking of objects in a video has been presented. Object tracking of any moving object has been successfully implemented on standard surveillance datasets using Kalman filter. This algorithm works on video taken at indoor and also outdoor environment using static camera under medium as well as complex background condition. This implemented module can be applied to any computer vision application for moving object detection and tracking. There are various applications in surveillance system such as Intelligent Transportation System, Traffic Monitoring surveillance System, understanding of human activity, observation of people and vehicles within a busy environment, Security in Shopping Centre or Offices etc. There are different algorithms for Object Detection. This project presents the Background Subtraction method for object detection. This method consists Background Modelling and Local threshold based Background Subtraction and it gave the better result and high accuracy rate in tracking object compared to other existing method due to the usage of kalman filter for tracking purpose.

REFERENCES

[1] Shao-Fan Lien, Kuo-Hsien Hsia and Juhng-Perng Su, “Moving Target Tracking based on CamShift Approach and Kalman Filter”, An International Journal of Applied Mathematics & Information Sciences, Januray 2015

[2] Sumit Kumar Pal and Sohan Ghorai, “Moving Object Tracking System In Video With Kalman Filter”, International Journal of Engineering Research & Technology (IJERT), June 2013

[3] R. E. Kalman, “A new approach to linear filtering and prediction problems,” *J. Basic Eng.*, vol. 82, no.1, pp. 35–45, Mar. 1960.

[4] P. D. Groves, *Principles of GNSS, Inertial, and Multisensor Integrated Navigation Systems*.Norwood, MA: Artech House, 2008.

[5] S. J. Julier and J. K. Uhlmann, “Unscented filtering and nonlinear estimation,” *Proc. IEEE*, vol. 92, no. 3, pp. 401–422, 2004.

[6] J. Bibby and H. Toutenburg, *Prediction and mproved Estimation in Linear Models*. New York:Wiley, 1977.

[7] Greg Welch, Gary Bishop, "An Introduction to the Kalman Filter", University of North Carolina at Chapel Hill Department of Computer Science, 2001

[8] M.S.Grewal, A.P. Andrews, "Kalman Filtering - Theory and Practice Using MATLAB", Wiley, 2001

[9] Jazwinski, A. H..Stochastic Processes and Filtering Theory. New York, Academic Press, 1970.

[10] Bozic, S M, Digital and Kalman Filtering, Edward Arnold, London 1979.Maybeck, P. S. "The Kalman filter: An introduction to concepts." Autonomous Robot Vehicles. I. J. Cox and G. T. Wilfong. New York, Springer-Verlag: 194-204, 1990.

[11] Saied bagheri-golzar et al., A New Method for Video Object Tracking , The Journal of Mathematics and Computer Science TJMCS Vol. 4 No.2 (2012) 122-128.

[12] Jianbo Shi and Carlo Tomasi, ―Good Features to Track‖, IEEE Conference on Computer Vision and Pattern Recognition , 1994,pp. 593-600.

[13] Sheldon Xu and Anthony Chang, Robust Object Tracking Using Kalman Filter with Dynamic Covariance, Cornell University.

[14] Dorin Comaniciu, Peter Meer. ―Mean Shift: A Robust Approach Toward Feature Space Analysis, ‖IEEE Transaction on Pattern Analysis and Machine Intelligence, Vol 24(5),2002, pp:603-619.

[15] Zhang Hongzhi, Zhang Jinhuan, Yue Hui,Huang Shilin, ―Object tracking algorithm based on camshift‖, Computer Engineering and design,Vol27(11), 2006, pp:2012-2014.

[16] Youssef ZINBI, Youssef CHAHIR, S.―Moving object segmentation using optical flow with active contour model‖. IEEE Conference on ICTTA, 2008,pp. 1-5.

[17] Rachel Kleinbauer, Kalman Filtering Implementation with Matlab, University of Stuttgart, Helsinki, Nov 2004.

[18] G. Welch and G. Bishop, An Introduction toKalman Filter, proceedings of SIGGRAPH 2001,pp19-24.

[19] J.G Allen et al., Object Tracking Using Camshift Algorithm Multiple Quantized Feature spaces, Conferences in Research and practice in Information Technology, vol. 36 ,204 pp 1-4

[20] Rupesh Kumar Rout, Department of Computer Science and Engineering, Master of Technology, Thesis "A Survey on Object Detection and Tracking Algorithms", National Institute of Technology Rourkela Rourkela , 2013