OBJECT DETECTION AND TRACKING USING KALMAN FILTER AND GENETIC ALGORITHM

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ABSTRACT:*In computer vision applications such as surveillance and monitoring object detection and tracking is a challenging task. The basic tracking algorithms have weak intensity when the other object occludes the real source image. Automation of the computer object tracking is a difficult task. Motion segmentation can be done using Background subtraction method. Genetic Algorithm is introduced and applied to find the tracked object in a search area. It can efficiently find the global optimal result from the solution space and it is computationally efficient since it avoids exhaustive searches. Kalman filter is applied to estimate the object centre in next time instant and provide more suitable search region.*

Keywords: *Kalman filter algorithm [1], Genetic algorithm [2], Motion segmentation*.

1. INTRODUCTION:

Recently, objects tracking is a considerable topic for researchers, in the area of real-time applications, such as surveillance and monitoring. An efficient tracking algorithm should be able to implement in so many difficult situations. In such a case, various illuminations, background clutter and occlusion could be taken into consideration, as the estimation problems of dynamic system.

A typical surveillance application consists of three building blocks, responsible of: moving object detection, object tracking and higher level motion analysis. Applications include car and pedestrian traffic monitoring, human activity surveillance for unusual activity detection, people counting etc., [3]. Detection of moving objects in video streams is the first relevant step of information extraction in many computer vision applications, including video surveillance, people tracking, traffic monitoring and semantic annotation of videos. In these applications, robust tracking of objects in the scene calls for a reliable and effective moving object detection that should be characterized by some important features: high precision, with the two meanings of accuracy in shape detection and reactivity to changes in time; flexibility in different scenarios (indoor, outdoor) or different light conditions; and efficiency, in order for detection to be provided in real-time [5]. Detecting and tracking moving objects are widely used as low-level tasks of computer vision applications, such as video surveillance, robotics, authentication systems, user interfaces by gestures. Software development of low-level tasks is especially important because it influences the performance of all higher levels of various applications [4].

The Motion analysis is a basis of all intelligent video surveillance technologies. In particular, it provides the fundamentals for automatic detection and tracking of moving objects and automatic detection of new or disappeared objects of observed scene. It is the well-studied area of computer vision including many different techniques[6].Object detection and tracking focuses on detecting the position of a moving object in a video sequence. It is the first step accomplished by an event recognition system that extracts semantic content from video [11]. The purpose of detecting moving objects in video stream is to be able to track the objects over time and derive a set of properties from their trajectory such as their behaviours [9]. A good detection measure should capture the performance in terms of both overall detection (number of objects detected, missed detects and false alarms) and goodness of detection for the detected objects, i.e., spatial accuracy (how much of the ground truth is detected) and spatial fragmentation (object splits and object merges) [6]. In general,there are two types of approaches in Motion detection: (i) the region-based approach and (ii) the boundary-based approach [4]. Other approaches to object detection for

2. PROBLEM DEFINITION:

One of the critical tasks in Computer Vision is Detection and Tracking of objects. But still now, the issues related to this are developing. For the automatic detection of moving objects, some of the monitoring systems cannot able to find the difference, when the difference of brightness between the background and the moving objects is small. The costs are very high in these systems. Most of the previous methods, only concentrated on detecting rough area of targets. The accurate moving target detection cannot be achieved. It makes the result to be shown with noise and healsand the computation time is also increased. Many systems are unableto solve critical solutions such as Partial Occlusions and Cross Targets.Even if the partial occlusions happened, because of other objects or the crossing of other moving objects, the systems cannot have the ability to keep tracking its target.The object tracking can be complex, due to camera motion, loss of information caused by the projection of the 3D world on a 2D image, variations of target scale, partial occlusions, real-time processing requirements, clutter, and so on. Therefore it is difficult to make the efficient tracker and also we cannot track the object accurately.

3. VIDEO TRACKING OF OBJECTS USING GENETIC ALGORITHM:

Video tracking is the process of locating a moving object (or multiple objects) over time using a camera. It has a variety of uses, some of which are: human-computer interaction, security and surveillance, video communication and compression, augmented reality, traffic control, medical imaging and video editing. Video tracking can be a time consuming process due to the amount of data that is contained in video. Adding further to the complexity is the possible need to use object recognition techniques for tracking. Particle filter algorithm is widely used in single object tracking of video sequences in the video surveillance systems. The greatest disadvantage of the particle filter is the particle degradation. In our work multiple object tracking is done. In order to overcome this disadvantage we have proposedKalman filter with the Genetic algorithm [1].

In our proposed methodology a sample video is given as input for the purpose of object tracking. The steps to be carried out in our proposed method are given below:

- Motion Segmentation
- Object Tracking

3.1.Motion Segmentation:

For motion segmentation process, Average background model is used. Firstly the background model was generated for the frames. Then the current frame is subtracted from the background model so that the threshold difference can be achieved.

$$bg^k(y,x) = \frac{1}{N} \sum_{j=k-\left(\frac{N}{2}\right)}^{k+\left(\frac{N}{2}\right)} I^j(y,x) \quad (1)$$

Where

$bg^k(y, x)$ = background values of pixels in the frame.

N = total number of frames.

$I^j(y, x)$ = pixel values of frames.

3.2 OBJECT STATE ESTIMATION WITH KALMAN FILTER

Our proposed tracking algorithm is designed inKalman filter framework, in this paper, Kalman filter aims to improve the ability of tracking moving object with a changeable speed, decreasing the search region and coping with temporary occlusion. The transition equation and measure equation of our state system is modeled as:

$$X_k = AX_{k-1} + BU_k + W_k \quad (2)$$
$$Z_k = HX_k + V_k \quad (3)$$

Where

$$X = \{P_x, P_y, a_{ob}\}^T$$

$$A = \begin{matrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{matrix} \qquad B = T, \qquad H = \begin{matrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{matrix}$$

Px, Py,a_{ob} represent the center position of the X-axis, the center position of the Y-Axis and the area of the tracked object. A represents the transition Matrix B is the input Matrix, H is the Measurement Matrix and T is the time interval between two adjacent frames. U_k is the control input, $W_{k,}$ V_k are the Gaussian noise with error covariances, $Q_{k,}$ $R_{k.}$

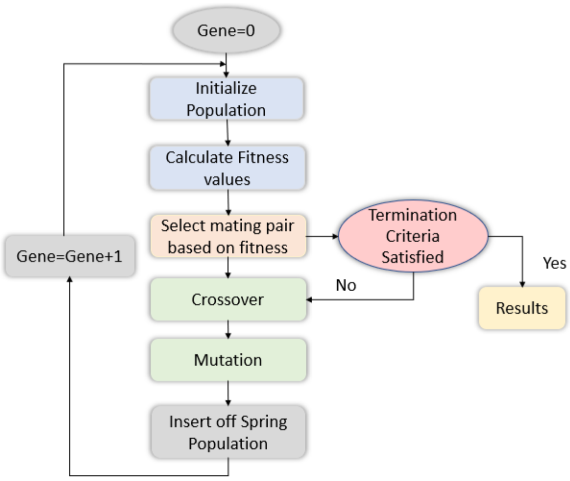


Fig 1: Architecture for Genetic Algorithm process.

3.3 Object search with Genetic algorithm

Genetic algorithm [7] is an efficient optimizationapproach. Inspired by nature, it is designed for finding the optimal solution by repeated selection and crossover operations. Genetic algorithm operates o individuals just like genes in the course of evolution, and each individual represents a possible solution. In each generation, all individuals are evaluated by a fitness function to gain reasonable evolution. Geneticalgorithm is simple, acceptable for parallel processing,and has a high robustness in searching global optimumsolution since it can handle multi-mode distribution.

In this paper, we use genetic algorithm to locate theobject, that is, searching the candidate region which isthe most similar to the target model, the process isdescribe as follows:

1. Individual Coding

We assume that each individual represents apossible object location $X = \{x, y\}$, and it is encodedwith a 16 bits Gray code, where the low 8 bitsrepresents location x, and high 8 bits representslocation y. The reason for selecting Gray Code is dueto the fact that the code values of any two consecutivenumbers have only one bit difference, it outperformsthe Binary Code since it can avoid the case that largecode difference may affect the convergence andmatching precision of GA.

2. Initial individual selection.

The estimation region indicated by Kalman filter isdivided into M X N blocks, M, N is specified as one fourth of the object width and height, two individuals are randomly generated in each block,and their corresponding Bhattacharyya coefficient arecalculated, inthis paper,Bhattacharyyacoefficient is considered the fitness of each individual. For all these $2MN$ individuals, we sort them according to their fitness in decreasing order, and select the top n as the initial individuals, then n is fixed and used for thewhole genetic evolution process, and iteration numberis also specified as c ..

For $i = 1, \ldots c$ repeat Step 3

3. Evolution

3.3.1. Selection process:

Selection is the first stage in genetic algorithm. In the selection process the MMSE estimated output is given as input. In the selection process the fitness function is calculated. The fitness function was calculated using the given formula:

$$F(i) = \frac{1}{e_i} \quad (4)$$

Here the fitness function is the inverse of the root mean square error between the state estimate and the true state.

$$e_k = \left| X_k - \hat{X}_k \right| \quad (5)$$

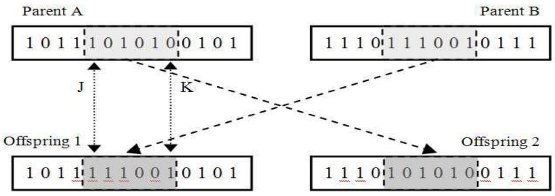
3.3.2. Crossover:

It is a genetic operator used to vary the
programming of a chromosome or chromosomes from one generation to the next. It is analogous to reproduction and biological crossover, upon which genetic algorithms are based. Cross over is a process of taking more than one parent solutions and producing a child solution from them. The best solutions were selected using the fitness function calculation. Crossover is calculated by using the following formula:

$$\begin{cases} x_1' = rx_1 + (1-r)x_2 \\ x_2' = (1-r)x_1 + rx_2 \end{cases} \quad (6)$$

Where

r = random number generated from interval [0, 1].



3.3.3. Mutation:

Mutation is the final stage in genetic algorithm. Mutation is a genetic operator which is used to maintain genetic diversity from one generation of a population of algorithm chromosomes to the next. A genetic operator is an operator used in genetic algorithms to maintain genetic diversity. In mutation the chromosome value remains the same.Mutation is calculated by using the following formula:

$$x' = \begin{cases} x+\Delta\left[g_c, r(k)-x\right], & sign = 0 \\ x+\Delta\left[g_c, x-l(k)\right], & sign=1 \end{cases} \qquad \textbf{(7)}$$

1	1	0	1	0	1	1

1	1	0	1	1	1	1

In this paper Gaussiuan mutation is taken as the mutation. Mutation in binary string. An offspring generation is obtained after 3.1 and3.3, for gaining a more optimal individuals, we sort its father generation by their fitness with a decreasing order, and sort the offspring generation with an increasing order, then the half part of individuals in offspring generation with lower Bhattacharyya coefficient is replaced by the higher half parts in father generation, then the obtained generation is considered as the father generation in the next iteration.

4. RESULTS. Frames 15to42 object is tracked.Due to occlusions object has disappeared in almost 70 frames.Insuch case,the Red box show that the Kalman filter is running for object tracking.

frame 15

frame 42

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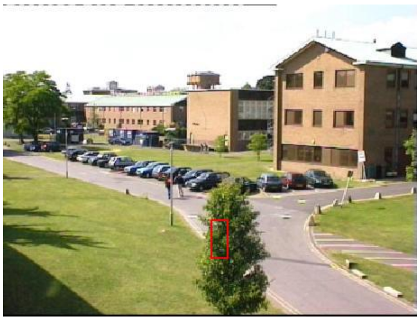

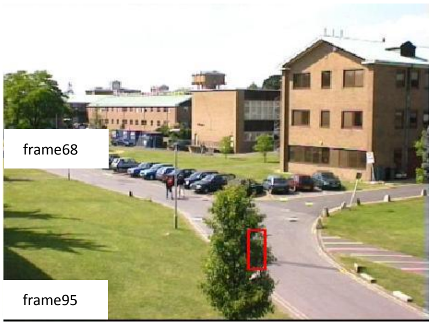

5. CONCLUSION:

In this paper, we propose a new evolutionary Kalman Filter with Genetic Algorithm for video tracking. The input video is motion segmented to track the motion of the object.Genetic algorithm improves the fitness value so that objects can be tracked with high efficiency. In future from multiple videos multiple objects can be tracked as a development.Genetic algorithm can be efficiently used for this purpose.

REFERENCES:

[1] Jong-Min Jeong, Tae-Sung Yoon2, and Jin-Bae Park "The Specific Object Tracking Algorithm Based on Kalman Filter in an Environment Where Similar Objects Are Existing" 13th International Conference on Control ,Automation and Systems (ICCAS 2013) pp..641-773, 2013

[2] HuanWang, Ming-wuRen, Jing-yu Yang "Object Tracking based on Genetic Algorithm and Kalman filter"2008 International Conference on Computational Intelligence and Security, pp 81-85 ,2008

[3] Codrut Ianasi, Vasile Gui, Corneliu I. Toma, and Dan Pescaru, "A Fast Algorithm for Background Tracking in Video Surveillance, Using Nonparametric Kernel Density Estimation", Electronics and Energetics, Vol. 18, No. 1, pp. 127-144, 2005.

[4] Masayuki Yokoyama, and, "A Contour-Based Moving Object Detection and Tracking", In proceedings of Visual Surveillance and Performance Evaluation of Tracking and Surveillance, 2005.

[5] A. H. Mazinan A. Amir-Latifi M. F. Kazemi "A Knowledge-Based Objects Tracking Algorithm in Color Video Using Kalman Filter Approach" 978-1-4673-1090-1/12/$31.00 ©2012 IEEE pp..50-53, 2012.

[6] Vasant Manohar, Padmanabhan Soundararajan,HarishRaju, Dmitry Goldgof, Rangachar Kasturi, and John Garofolo, "Performance Evaluation of Object Detection and Tracking in Video", In Proceedings of 7th Asian Conference on Computer Vision, Hyderabad, pp. 151–161, 2006.

[7] KaiqiHuanga, LiangshengWanga, Tieniu Tana, and Steve Maybank, "A real-time object detecting and tracking system for outdoor night surveillance", ELSEVIER Pattern Recognition, Vol. 41, pp. 432-444, 2008.

[8] ThiThi Zin, Pyke Tin, Takashi Toriu and Hiromitsu Hama, "A Probability-based Model for Detecting Abandoned Objects in Video Surveillance Systems", In Proceedings of theWorld Congress on Engineering 2012, London, U.K., Vol 2, 2012.

[9] Isaac Cohen, and Gerard Medioni, "Detecting and Tracking Moving Objects for Video Surveillance", In IEEE Proceedings of Computer Vision and Pattern Recognition, pp. 2319-2325, 1999.

[10] C. Kamath, A. Gezahegne, S. Newsam, and G. M.Roberts ,"Salient Points for Tracking Moving Objects in Video", Image and Video Communications and Processing, 2005.

[11] Boris Vishnyakov, YuryVizilter, and Vladimir Knyaz, "Spectrum-Based Object Detection And Tracking Technique For Digital Video Surveillance", International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, pp. 579-583, 2012.

[12] Jie Hu, 1Huaxiong Zhang, 1Hai Huang , 1Jie Feng, 1Gang Wang "An Improved Kalman Filter Algorithm Base on Quaternion Correlation In Object Tracking" 9th International Conference on Fuzzy Systems and Knowledge Discovery (FSKD 2012) pp..1725-1729,2012.

[13] SA. Vigus, D.R.Bul1," OBJECT TRACKING USING REGION SPLIT AND MERGE AND A KALMAN FILTER TRACKING ALGORITHM"pp 650-652,2001

[14] Garima Sharma, "Video Surveillance System: A Review", International Journal of Research in Engineering and Applied Sciences, Vol. 2, pp. 75-85, February 2012.

[15] Approachtoward Automatic object Detection and Tracking in Surveillance Systems", International Journal of Soft Computing and Engineering, Vol. 2, pp. 82-87, March 2012.

[16] Kinjal A Joshi, and Darshak G. Thakore, "A Survey on Moving Object Detection and Tracking in Video Surveillance System", International Journal of Soft Computing and Engineering, Vol. 2, pp. 44-48, July 2012.

[17] Chih-Hsien Hsia, and Jen-Shiun Chiang, "Real-Time multiple moving objects detection and tracking with direct LL-Mask Band Scheme", International Journal of Innovative Computing, Information and Control, Vol. 8, No. 7(A), pp. 4451-4468, July 2012.

[18] Ritika, and Gianetan Singh Sekhon, "Path Estimation and Motion Detection of Moving Object in Videos", IOSR Journal of Computer Engineering, Vol. 2, pp. 01-04, July-Aug. 2012.

[19] Sang Won Hwang, Eun*Yikim***, Se** *Hyun* ***park',*** *and Hang Joon* ***Kim***"Object Extraction and tracking Using Genetic Algorithms " pp..383-386 **0-7803-6725-1/01/$10.00** 02001 **IEEE**

[20] Yuping Lin, Qian Yu, and Gérard Medioni, "Efficient detection and tracking of moving objects in geo-coordinates", Machine Vision and Applications, Vol. 22, pp. 505–520, 2011.

[21] A. H. Mazinan,A. Amir-Latifi,M. F. Kazemi "A Knowledge-Based Objects Tracking Algorithm in Color Video Using Kalman Filter Approach"pp..51-53,978-1-4673-1090-1/12/$31.00 ©2012 IEEE