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Particle Filter and CAMShift Approach for Motion Detection: A Comparative Study

Ms. Bedekar K. A.[1] And Dr. Mrs. Patil V.V.[2]

Abstract-Object Detection and Motion Detection are the wide research areas of computer vision. Various methods are available for performing these tasks. Here, two algorithms Particle Filter and CAMShift are used. The parameters such as intensity, elapsed time, track loss rate etc. are examined for both algorithms. Particle filter is a technique for implementing recursive Bayesian filter by Monte Carlo sampling. The posterior density is represented by a set of random particles with associated weights and the estimates are computed based on these samples and weights. CAMShift algorithm is improvement over the MeanShift algorithm. It uses the color histogram model of the target to convert the image into the color probability distribution map, initialize the size and position of a search window, and adaptively adjust the position and the size of the search window according to the results obtained from the last frame, thus locating the center position of the target in the current image.

Keywords – Object Detection, Motion Detection, Particle Filter, CAMShift

I. INTRODUCTION

Visual features (e.g. color, texture, shape etc.) and motion information are two sources of information used for object detection and tracking. Object detection process involves detection and spotting of object in an image. It is a process of scanning an image for an object of interest such as vehicles, robots, computers, people, faces etc. Motion detection is the process of confirming a change in the position of an object related to its surrounding or the change in surrounding relative to an object. The process of the object detection involves locating the objects in the frame of a video sequence. The first requirement of every tracking method is an object detection mechanism in every frame or when the object first appears in the video.[1] Detecting a change in the position of an object relative to its surroundings or change in the surroundings relative to an object is nothing but motion detection. Motion detection is useful in areas such as surveillance/monitoring applications (e.g. security cameras, traffic monitoring, people counting) as well as in control applications (e.g. object avoidance, automatic guidance, head tracking for video conference etc).

[1] *Department of Electronics and Telecommunication Dr. J. J. Magdum College of Engg, Jaysingpur, Maharashtra, India*
[2] *Department of Electronics and Telecommunication Dr. J. J. Magdum College of Engg, Jaysingpur, Maharashtra, India*

II. PARTICLE FILTER ALGORITHM

Particle filter is used for effective object tracking and hence for motion detection in image sequences extracted from video frames. Particle filter uses a color particle that is displayed on the object. For tracking the object using particle filter we concentrate on the color particles in the detected foreground object.

The advantage of particle filter over other types of filters such as Kalman Filter, Extended Kalman Filter, etc. is that it allows for a state space representation of any distribution. The Particle Filter also allows for non-linear, non-Gaussian models and processes. Particle Filter is concerned with the problem of tracking single or multiple objects. [2]

III. CAMSHIFT ALGORITHM

The CAMShift (Continuously Adaptive MeanShift) is an important algorithm for motion detection based on the color histogram. The CAMShift algorithm works by finding the mode of a probability distribution map within a search window and it iteratively updates the position and size of the window until the convergence is met. The algorithm boasts of high performance in a simple environment where the color distribution is constant.

CAMShift algorithm is frequently used for object tracking in video surveillance, which has a good real-time performance. Firstly, the moving object can be obtained by background subtraction and frame differences method, then the location of extracted moving target will be taken as the initial search window for the CAMShift algorithm, and finally the automatic tracking of the moving target can be realized [3].

Steps for CAMShift Algorithm:

The CAMShift algorithm can be summarized in the following steps [3]:

(1) Initialize the search window.

(2) Calculate the color probability distribution of the search window (back projection).

(3) Run Meanshift algorithm, obtain the new size and position of the search window.

(4) Re-initialize the size and position of the search window in the next frame of video image by using the value that calculated in step (3), and jump to step (2) to proceed.

IV. PERFORMANCE EVALUATION

The two algorithms are used and tested for the performance parameters such as track loss rate and elapsed time. Two videos are taken as reference videos and the intensity is varied by 5% each time and results are noted for original video and video with intensity variation. The intensity variation of first video is noted as A_i and that of second as B_i as below:

Table 1- Nomenclature of videos according to intensity variations

Video	Change in intensity
A1, B1	5%
A2, B2	10%
A3, B3	15%
A4, B4	20%
A5, B5	25%

Table2-Performance Evaluation of Two Algorithms based on track loss rate and elapsed time

Video	**Algorithm**	**Track Loss Rate (%)**	**Elapsed Time(seconds)**
Original	Particle Filter	29.13	5.25
	CAMShift	12	55.70
A1	Particle Filter	32.13	5.05
	CAMShift	15	53.70
A2	Particle Filter	35.15	4.82
	CAMShift	16.03	50.35
A3	Particle Filter	37.56	4.30
	CAMShift	18.05	48.78
A4	Particle Filter	39.54	4.28
	CAMShift	20.16	46.07
A5	Particle Filter	40.13	4.10
	CAMShift	25.8	43.65
Original	Particle Filter	29.13	5.25
	CAMShift	12	55.70
B1	Particle Filter	40.67	17.45
	CAMShift	21.26	21.75
B2	Particle Filter	45.65	17.25
	CAMShift	22.03	21.08
B3	Particle Filter	49.53	16.23
	CAMShift	25.05	20.32
B4	Particle Filter	51.25	15.10
	CAMShift	26.16	20.15
B5	Particle Filter	55.14	14.20
	CAMShift	29.8	19.42

IV.CONCLUSION

From the above observations, CAMShift has less track loss rate which is advantageous but its motion detection speed is low (more elapsed time). On the other hand, Particle Filter takes less processing time though its track loss rate is greater. The Particle Filter can be preferred for the applications where track loss is acceptable because of its speed of processing.

For both the videos, as the intensity of original video is changed, elapsed time decreases and track loss rate increases.

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