A Survey on Face Detection and Tracking

R. Jagathishwaran, K.S. Ravichandran and Premaladha Jayaraman

Computer Science and Engineering, School of Computing, India

Abstract: Face detection and Tracking are important research areas in the field of computer vision and image processing. Face detection is a computer technology that helps to determine the locations and size of the human faces. Face detection techniques are used in cameras for auto focus. Face detection and tracking are the two processes done by using various approaches. It is applied mainly in surveillance. The main purpose of these processes are detect and track the face even in poor viewing conditions in surveillance application. In this paper various techniques used for people detection and tracking like adaptive color based particle filter, fuzzy based particle filter algorithm and so on are discussed. Comparisons between the various approaches are illustrated, Performance measures in terms of number of particles used, root mean square error values etc have been reported. Drawbacks for the techniques like tracker facing the problems while detection and tracking has been explained. Reasons why fuzzy based particle filter is best among all the approaches have been produced.

Key words: Face Detection - Face Tracking - Fuzzy based particle filter - Particle filter - Kalman filter

INTRODUCTION

In unconstrained environment, face detection and tracking needs robust tracking and segmentation are needed to provide the normalized face. Two broad approaches are used namely, motion based approach and model based approach. While joining all the motions at a time robust technique are needed for motion based approach. Model based approach needs more semantic knowledge and computationally requires more cost due to scaling, rotation, translation and deformation. Both the model and motion based approaches are combined in a closed loop, motion based tracker reduces the searching space in model based face detection and later it aids the tracking. This has been described in Face tracking and poses representation [1]. Computer vision application requires the task, object tracking. Color based tracking methods are proposed by using mean shift, Anticipation of following reference location is calculated by a kalman filter, described in [2]. To present a target to track video sequences, a particle filter is present. This filter uses simple linear dynamical model and a likelihood model based on color histograms which describes in adaptive color based particle filter [3]. For resolving the stereo vagueness in face detection and tracking a new fuzzy based algorithm is used. More than one fuzzy system is used to remove the unwanted regions detected by the face detector is also described [4].

Related Works: In most of the tracking approaches kalman mean shift [2] has been used for tracking. It will find the target in the next frame which uses the Bhattacharyya coefficient [5]. Lots of processes have been done in stereo vision for finding the distance. Darrell et al [6] system will detect and track more than one person. Whole process has done using skin, face detector and disparity map. Grest and Koch [7] person position has been estimated by using a particle filter and color histogram is created for the face and the real position is computed by using the stereo vision. Moreno et al [8] delivered a system which is capable of detecting and tracking single face using kalman shift and mix the color and stereo information. Harville [9] and Munoz-Salinas et al [10] delivered a system which
detects and tracks multiple people by using the plan-view maps. Soft computing techniques are also applied in the computer vision as described in Kil-jae and Bien [11] and in Bloch [12]. Dealing with uncertainty and vagueness, fuzzy logic [13] is used. Nowadays particle filters are used for tracking algorithms, because they compute the dynamic system through the observation has developed in Gordon and Salmad [14]. Another concept for solving stereo vagueness problem and uncertainty issue is fuzzy logic based particle filter algorithm. In Vermaak et al [15] the number of particles generated are computed by using the Fuzzy System. For Surveillance applications, it may detecting the human face. Kun peng et al [38] used fuzzy classifier and skin color for logic based particle filter algorithm. In Vermaak [36] presents Monte Carlo techniques for many target tracking. Zia khan [37] proposed a particle filter in Gordon and Salmand [14]. Another concept for solving Vermaak [36] presents Monte Carlo techniques for many dynamic system through the observation has developed the convergence and reducing the error rates. Jaco for tracking algorithms, because they compute the author used Bhattacharya distance for measuring fuzzy logic [13] is used. Nowadays particle filters are used demonstrate how to detect 3-d objects. Thomas Kailath in Bloch [12]. Dealing with uncertainty and vagueness, Henry Schneiderman a thesis submitted to detection in various lighting conditions and poses. Papageorgiou et al [27] give a learnable framework for object detection based on the wavelet transform. Francois fleuret [28] escribed about region of interest(ROI) detection course to fine. It accepts all grayscale images and measures the executions in terms of false positives. In [29], shows the work of choosing appropriate features to make use in system learning and delivered in search problem. [30] suggested a algorithm for finding the head of a person by using the ellipse whose positions are updated as per the head movement. Micheal Harville [31] shows the model for foreground segmentation and background subtraction. Model gives more strength without loss of real time performances. In Ming-Hsuan Yang [32] describes various approaches for detecting faces. In [33], the object is detected by using Haar feature extraction and cascade classifier. Henry Schneiderman [34] a thesis submitted to demonstrate how to detect 3-d objects. Thomas Kailath [35] author used Bhattacharya distance for measuring the convergence and reducing the error rates. Iaco Vermaak [36] presents Monte Carlo techniques for many target tracking. Zia khan [37] proposed a particle filter with mcmc filter carries on moving targets. Gayathri a.patil [38] used fuzzy classifier and skin color for detecting the human face. Kun peng et al [39] proposed a algorithm for detecting eye using pattern matching techniques.

**Approaches Used for Face Detection and Tracking:**

In face tracking and pose estimation, [1] faces are detected by using simple shape model, color and texture. Photometric representations are used to model the internal structure of faces. Eigen faces are used to detect the faces. Tracking process is done by matching the scale and local estimates. Matching faces does not accurately track the face in every new frame. This problem is resolved by motion grouping. In [2], faces are detected by computing the target location and for tracking, kalman filters are used. First, the pixel location x, of the destination is displaced at zero. Let b: r _{1...n} be the measure applied at target pixel. Probability of color u is computed by employing a convex and monotonic function k: [0, 8]→ R. Robustness of the estimation has been improved after the weightage increases. Then target candidate are computed by denoting the pixel location of the target candidate centered at y in the current frame and the probability of color u in the target candidate is computed by

\[
P_u(y) = c_u \sum_{i=1}^{n} K \left( y - \frac{x_i}{h} \right)^{2} \left[ b(x_i) - u \right]
\]

For decreasing the value of distance, Bhattacharyya co-efficient is increased [2]. For tracking there are two shifters, first calculates each x and y co-ordinates and the second for changing velocity. By using the mean shift optimization, tracking process run on every new frame come after by a kalman filters which gives the determined position. In adaptive color based particle filter [3] a method is proposed to track the target in video sequences. It presents a particle filter which uses both the simple linear dynamic model and likelihood model based on colour histogram. Dynamic model predicts the state of target by St, A * S, + W, where A is the
In face tracking and pose estimation [1] head tracker tracks 60 frames from various lighting conditions and twelve people were captured, manually cropped and smoothened to 64*64 pixels. Using kalman filter and temporal zero crossing a real time motion tracker has been implemented. The combination of model based and the motion based representation gives more robustness for the closed loop system. In mean shift detection it uses the fuzzy system confidence is computed by the dezert smarandache theory. In [25], integral image helps the detector to find the region of interest very quickly and adaboost will choose the relevant features for detecting face. Cascade detector will quickly remove the false positives. [26] proposed a fuzzy method for detecting the area of interest and it choose the face based on visual aspect and move it over to the geometric classifier. [27] uses Support Vector Machine for separating the various types of object and it provides very low false positives. [28] got the fast detection while applying the spatial arrangement and testing the shape and performance in course to fine.

**Performance Analysis:** In face tracking and pose estimation [1] head tracker tracks 60 frames from various lighting conditions and twelve people were captured, manually cropped and smoothened to 64*64 pixels. Using kalman filter and temporal zero crossing a real time motion tracker has been implemented. The combination of model based and the motion based representation gives more robustness for the closed loop system. In mean shift and optimal prediction [2] proposed system are applied to multiple video sequences to compute the operational time and cost complexity. Tracker successfully tracks even in the presence of occlusion and the ellipse size $(h_x, h_y) = (55, 39)$ is obtained. System work 30 frames per second at 600MHZ pc which has been implemented in java. In [3] the algorithm is executed in matlab. Performance of the system detection mainly depends on the size of the rectangle and the number of particles used. 100 particles is enough for all experiments which has been proved, filter is capable of detecting face in a cluttered environment and changes in direction. Overall tracker performs well in 211 frames has proved. Algorithm is more robust even if frames having the similar colors. In [4] the performance of the proposed system has been tested in Intel core i5 2.67GHZ processor. At a time, trackers are capable of tracking 4 persons in real time. It has been tested in real time situations where two or more people move freely in the video. After testing the algorithm with various videos it requires 50 particles to finish the process. To measure performance between the various approaches, three measures are taken namely:
Table 1: Performance Measures

<table>
<thead>
<tr>
<th></th>
<th>Fuzzy based particle filter algorithm</th>
<th>Adaptive color based particle filter algorithm</th>
<th>Mean shift and optimal prediction</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMSE position</td>
<td>8.85px</td>
<td>35.99px</td>
<td>58.49px</td>
</tr>
<tr>
<td>RMSE rectangle size</td>
<td>4.88px</td>
<td>61.39px</td>
<td>220.87px</td>
</tr>
<tr>
<td>Processing time per cycle and person</td>
<td>22.64ms</td>
<td>12.62ms</td>
<td>17.65ms</td>
</tr>
</tbody>
</table>

Fig. 1: Performance Analysis

In the above Table 1 px stands for pixels, ms stands for milliseconds. Drawbacks of mean shift and optimal prediction are: It detects only one person at a time. It detects the face based on the skin color. So it loses its target by covering the neck portion which is not the area of interest. Drawbacks of adaptive color based particle algorithm is, it is not capable of differentiating the foreground and the background if both belong to similar colour. Finally, the target is lost due to this reason. But fuzzy based particle filter algorithm works well. It detects more than one people at a time. By using the stereo information, it differentiates the foreground and background. Tracker will not confuse if both objects belongs to similar colour. Hereby, the best algorithm for tracking is fuzzy based particle filter. It performs better than the other approaches as described above. The figure 1 shows the root mean square error position, root mean square rectangular size and processing time per cycle values for various approaches.

In [17] the approaches are tested in various sequences of videos. It takes 20, 26 and 38 ms as the execution time for 320*240, 640*240 and 640*480 frame sizes. [40] After the data set applied, data are portioned in to two halves. First set of data are chosen for training and second set of data have used for testing. The projected approach got the least error in the context of performance measure like mean, median. In [22] getting good accuracy of 24 percentage when testing it in 17 out of 21 trials. In [26] compared to other method, accuracy rates increases up to 70% and false positive rates touches zero.

CONCLUSION

This paper presents the discussion about various face detection and tracking approaches, performance measures and drawbacks. Tracking faces is the main process used in different fields like surveillance application, computer vision and image processing. Particle filter algorithm is frequently used for tracking process even though it performs well it faces some difficulties like, if both objects are very close to each other with similar colour then the tracker fails. So, fuzzy based particle filter algorithm is suggested for solving this type of problem. Fuzzy system is constructed by hierarchical structures. It provides good performance than particle filters and requires more processing time.

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