Object Tracking using Modified Mean Shift Algorithm in A Robust Manner

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Abstract

Object tracking in real time videos is a critical task. So far many algorithms have been proposed to overcome the difficulties which arise from noise, occlusions and changes in the foreground object. But still there is a need for an efficient algorithm that can effectively track the object due to its varying position under various ambient conditions. Among various tracking methods, the mean shift tracking algorithm is a most widely used one due to its efficiency and simplicity. The experimental results show that the method which has been proposed can effectively track an object under the condition of varying illumination and shape deformation. Here the Correlation factor is also used to check the effective working of Mean shift algorithm and to make comparison between RGB and LBP technique.

Keywords: Mean Shift, Local Binary Pattern, Tracking, Correlation, Color Histogram

I. INTRODUCTION

Real-time object tracking is a critical task in and many algorithms have been proposed to overcome the difficulties arising from noise, occlusions, clutters, and changes in the foreground object and/or background environment. Among various tracking methods, the mean shift tracking algorithm is a popular one due to its simplicity and efficiency. The mean shift algorithm was originally developed by Fukunaga and Hostetler for data analysis. Comaniciu and Meer has successfully applied it for object tracking and image segmentation.

The goal of object tracking is to estimate the states of a target object in an image sequence. It plays a critical role in numerous vision applications such as motion analysis, activity recognition, visual surveillance and intelligent user interfaces. While much progress has been made in recent years, still there exist a need to develop a robust algorithm for complex and dynamic scenes due to large appearance changes caused by varying illumination, camera motion, occlusions and shape deformation.

II. MEAN SHIFT TRACKING ALGORITHM

A. Target and Candidate Representation

In object tracking, a target is usually defined as a rectangle or an ellipsoidal region in the image. Currently, a widely used target representation is the color histogram because of its independence of scaling and rotation and its robustness to Partial occlusions. Denote by \( \{ x_n \} \}_{i=1...n} \) the normalized pixels in the target region, which is supposed to be centered at the origin point and have \( n \) pixels. The probability of the feature \( u \) (\( u=1, 2... m \)) in the target model is computed as

\[
\hat{p}_u = \frac{1}{n} \sum_{i=1}^{n} \delta \left( \| x_i - \mu_u \| \right)
\]

where \( \hat{p}_u \) is the target model, \( \hat{q}_{iu} \) is the probability of the \( u \)-th element of \( \hat{q}_u \), \( \delta \) is the Kronecker delta function, \( b(\cdot) \) associates the pixel \( x_i^* \) to the histogram bins and \( k(x) \) is an isotropic kernel profile. Constant \( C \) is a normalization function defined by

\[
c = \int \sum_{u=1}^{m} k(|x|^2)
\]
Similarly, the probability of the feature \( u \) in the target candidate Model from the candidate region centered at position \( y \) is given by Equations II.3 and II.4.

\[
\begin{align*}
\hat{p}(y) &= \{ \hat{p}_x(y) \}_{x \in \mathcal{X}} \\
\hat{p}_x(y) &= C_n \sum_{i=1}^k \frac{1}{\sqrt{2 \pi \hat{\sigma}_n}} e^{-rac{(y-x_i)^2}{2\hat{\sigma}_n^2}}
\end{align*}
\]

\( C_n = \frac{1}{\sqrt{2 \pi \hat{\sigma}_n}} \sum_{i=1}^k e^{-\frac{(y-x_i)^2}{2\hat{\sigma}_n^2}} \)  

In order to calculate the likelihood of the target model and the candidate model, a metric based on the Bhattacharyya coefficient is defined by using the two normalized histograms \( \hat{p}(y) \) and \( \hat{q} \) as follows:

\[
\rho[\hat{p}(y), \hat{q}] = \sum_{u=1}^m \sqrt{\hat{p}_u(y) \hat{q}_u}
\]

The distance between \( \hat{p}(y) \) and \( \hat{q} \) is then defined as

\[
d[\hat{p}(y), \hat{q}] = \sqrt{1 - \rho[\hat{p}(y), \hat{q}]}
\]

### B. Color Histogram:

The second most important thing in object tracking is color feature extraction. This can be done either with the Here color feature is extracted in form of RGB Color space which is divided into equal \( k \)-intervals. This interval is known as a bin. Number of bins feature is given by \( M_c = k^3 \).

Actually the color histogram represent the target region’s discrete probability density function. But the color histogram does not work properly when it is applied alone. But when it is applied alone with the LBP it efficiently tracks the target considering its edge and corner during the motion of an object in a proper manner.

### C. LBP:

It is a very effective technique to describe the texture feature. It has got beneficial qualities such as fast computation and rotation invariance. Thus LBP has wide applications in texture analysis, image retrieval image segmentation etc.

### D. Correlation:

It is nothing but local averaging. It is a method that uses tracking and image registration techniques for accurate 2D measurements of changes in images. It is somewhat similar to convolution. When the two different signals are correlated it is called as cross correlation while if two similar signal are correlated then it is called as auto correlation.

### III. Literature review

According to [2], it serve the purpose of robust object tracking MAP based algorithm has been proposed. It is based on a sparse collaborative model. This model can exploit both holistic template and local representations to check for drastic appearance changes. It consist of Sparse Discriminative Classifier (SDC) and Sparse Generative model (SGM) for object tracking. It requires online update scheme to update the templates.

According [4], In order to determine the candidate target region, mean shift algorithm was utilized and then a judgment on the tracking effect was made according to the Bhattacharyya coefficient. In case of tracking failure, the candidate area was matched with the target model by SIFT feature. In the next and final step a new track position was determined.

According to [12], video indexing requires the efficient segmentation of video into scenes. Here in this algorithm, Histogram is used to represent a target and then applying it to the mean shift framework. The video is first segmented into shots and a set of key-frames is extracted for each shot. Typical scene detection algorithms incorporate time distance in a shot similarity metric. In the method in order to overcome the difficulty having prior knowledge of the scene duration, the shots are clustered into groups based only on their visual similarity and a label is assigned to each shot according to the group that it belongs to. Then, a sequence alignment algorithm is applied to detect when the pattern of shot labels changes. Apart from the conventional color histogram features, the texture features of the object are also extracted by using the local binary pattern (LBP) technique to represent the object. According to [13], the Mean shift tracking algorithm is applied along with the no parameters estimation method, then evaluation of the tracking performance of Mean shift algorithm has been done on different video sequences.

### IV. Design methodology

In order to start with object tracking, a video file is read using .avi extension. After this the Target window is selected. The first window is taken as reference model while the wholesome of next target windows are considered as candidate model. Finally the target model is compared with the candidate model to estimate whether the object of tracking has been correctly tracked or not. The target model is first built with the initial position of the target in the target window. Based on the position of the target in the
window, during tracking candidate model is built. Both these models are then compared and then the final judgment is made whether the tracking is correctly done or not. The following steps have been followed to serve the purpose: Implementation of calculate the target model with joint color-texture histogram. Image which consider 1st frame of video, the center of target window and the bandwidth of target window and provide quantification scheme of RGB space which in make target model for tracking. Implementation of mean shift tracking with joint color-texture joint histogram which consider current frame of video and track initial location. To design the tracking window which is in the range of image which provide rmin, rmax, cmin, cmax which is window of tracking result and defines height, width the size of image. To design basic means shift tracking algorithm and to compare with modified mean shift tracking which improve in tracking window capture.

V. EXPERIMENTAL SETUP

For experimental purpose “MATLAB 2013a” is used to execute all source codes. Here the search window used is 5. The number iterations taken here is 15 and the distance between the two consecutive frames is 0.3. First a file is converted to .avi file videos in frame. Here the comparison is made between the two techniques RGB and LBP. The conventional mean shift algorithm and modified mean shift algorithm will be compared.

VI. RESULT

The experimental result has been shown in figure 1, 2 3 and 4. The experiments have been performed on various videos using RGB and LBP technique. Along with this, correlation is also used to analyze tracking in inter frame for RGB and LBP techniques.
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Fig. 1: d. Target tracked by RGB

Fig. 1: e. LBP

Fig. 1: f. Histogram of LBP

Fig. 1: g. Target Tracked by LBP

Fig. 2: a. Reference Frame (Video 2)

Fig. 2: b. RGB
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Fig. 2: c. Histogram of RGB

Fig. 2: d. Target Tracked by RGB

Fig. 2: e. LBP

Fig. 2: f. Histogram of LBP

Fig. 2: g. Target Tracked by LBP
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Fig. 3: a. Reference (Demo 1)

Fig. 3: b. RGB

Fig. 3: c. Histogram of RGB

Fig. 3: d. Target Tracked by RGB

Fig. 3: e LBP
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VII. CONCLUSION

In proposed method, tracking is done using target object’s features. Combination of color feature and texture feature makes feature extraction quality better. For extracting texture features LBP technique is used. Color features are insensitive to non-rigid deformation, partial occlusion, target rotation and overlap. Texture features can better extract edges and corner features of the target effectively in the target region and more robustly track the target. The user has to give the location in the first frame. With the help of similarity measure function target object is tracked. Exact object location in frame is determined after several iterations. In all the iterations the target window moves towards the denser region. After number of iterations it converges to most dense area of features and thus this estimates the location of target object in current frame. Correlation is also done to find the inter frame tracking done by RGB and LBP techniques. In the future research can be done for using the true shape of the target, instead of an ellipse or a rectangle window selection, for object tracking in a more robust manner.

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