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Multiple Target Tracking with the help of Mean Shift Algorithm

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***Abstract*—The multi moving targets tracking are a typical job in the field of visual surveillance. The main difficulties in targets tracking are fast motion of the target, suddenly velocity variations, clutters, complex object shapes and occlusions, etc. Target tracking are basically explain in to three main parts: point tracking, kernel tracking and silhouette tracking. Here we can track multiple targets with the help of mean shift algorithm. For tracking purpose, the mean shift method requires a kernel that mean's a circle or a rectangle or an ellipse region. First with the help of mean shift, we can evaluate the objects locations. In mean shift algorithm the Bhattacharyya coefficient show an important task for tracking. It is a similarity function which can be obtained by target model and target candidate. The experimental results describe that the mean shift algorithm is practical for tracking point of view.**

***Index Terms*—Target Tracking, Mean Shift Method, Target Representation & Localization, Bhattacharyya Coefficient.**

I. INTRODUCTION

Multi target tracking is an interesting but typical task. The main requirement of target tracking is first to detect the target and then track this target. Several methods are available for targets tracking but it is basically explain in to three main parts: point tracking, kernel tracking and silhouette tracking [1]. In point tracking, the targets are denoted with the help of points. For targets tracking the kernel tracking use an ellipse or a rectangle or a circle region[2], [3]. In silhouette tracking, the targets are denoted by the boundary regions [1].

Targets tracking are required in many applications such as traffic monitoring, vehicle navigation, automated surveillance and human computer interaction, etc [1].

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In multi target tacking, the general problem is to change in appearance due to some complex situations such as noises, clutters, occlusions, fast object motions and suddenly changes in velocity, etc. The mean shift algorithm is a kernel region based tracking, in other words it is a type of kernel region tracking [2], [3]. Normally tracking is defined in two parts: detect and track. First part detects means to find the location of the objects and then second part mean's to follow the movement of objects in consecutive video sequences.

In these algorithm we tracks targets region and it is show with the help of histogram. A similarity function that is defined on the detail of target model and target candidate, it is use to obtain the value of Bhattacharyya coefficient and it is also known as Bhattacharyya function [2]. The mean shift algorithm described by using the target representation procedure [5]. On the first side, the mean shift is a simple method which provides normal and reliable results of targets tracking. On the other side mean shift lost the targets when the targets are moving fast or occlusions occurs.

When the objects with small displacement then the performance of mean shift algorithm are good but it is not guaranteed if the objects with large displacement or fast motion or occlusion then its performance are good. So the objective of targets tracking is to tracks target objects position in consecutive frame sequences. The mean shift method is a nonparametric density estimator and it is calculates the nearest mode of a sample distribution [3], [4], [5]. The mean shift method is so popular because of its implementation and real time response.

The whole work is organized as follows. The section II explains the detail of mean shift algorithm. Experimental results detail shows in section III. Conclusions are described in last section IV.

II. DETAILS OF MEAN SHIFT ALGORITHM

A. Mean shift

The mean shift method has an iterative procedure for targets tracking. It is a nonparametric density estimator to finds the nearest mode of a sample distribution. The mean shift algorithm is used to optimize local maxima of the probability density function (pdf) [3], [4], [5]. The main feature of this Algorithm is histogram optimization, by this optimization to find the direction and location of the moving objects. We can compare the histograms of the objects in current frame and next frame of images.

B. Target Representation

The target representation characterize the targets and it is consists by target model and target candidate [2], [5].

Target model: the targets are represented by circular regions in image sequences. Assume that all the targets are initially normalized to a unit circle. This target model is founded by its colour histogram of m bins (pdf). The histogram only considers the pixels inside a rectangle or an ellipse region.

Let $\{x_i^*\}_{i=1...n}$ be the normalized pixel locations in the target model, which is centered at origin (0). So the probability of the feature u=1....m in the target model $\hat{q}$ is obtained as

$$\hat{q}_u = C_q \sum_{i=1}^{n} k(\|X_i^*\|^2)\delta[b(x_i^*) - u] \quad (1)$$

where $\hat{q}$ is the target model, $\hat{q}_u$ is the probability of the u^{th} element, C_q is normalization constant and δ is the Kronecker delta function.

Target Candidate: similarly the target candidate and its pdf is approximated by a colour histogram of m bins.

Let $\{x_i\}_{i=1...n}$ be the normalized pixel locations in the target candidate, which is centered at y location in the next image. So the probability of the feature u=1....m in the target candidate $\hat{p}(y)$ is obtained as

$$\hat{p}_u(y) = C_p \sum_{i=1}^{n} k(\|y - x_i\|^2)\delta[b(x_i) - u] \quad (2)$$

where $\hat{p}(y)$ is the target candidate, $\hat{p}_u(y)$ is the probability of the u^{th} element, C_p is normalization constant.

C. Bhattacharyya Coefficient

Bhattacharyya coefficient is a similarity function that is used to calculate the similarity between the target model and target candidate [2]. The Bhattacharyya coefficient varies with locations within images.

$$d(y) = \sqrt{1 - \rho[\hat{p}(y), \hat{q}]} \quad (3)$$

where

$$\rho[\hat{p}(y), \hat{q}] = \sum_{u=1}^{m} \sqrt{\hat{p}_u(y)\hat{q}_u} \quad (4)$$

D. Target Localization

If you want to track the location of object exactly in the image, the distance d(y) should be minimized and it is equivalent to maximize the Bhattacharyya coefficient. Apply linear Taylor expansion in equation (4).

$$\rho[p(\hat{y}), \hat{q}] \approx \frac{1}{2}\sum_{u=1}^{m} \sqrt{\hat{p}_u(\hat{y}_0)\hat{q}_u} + \frac{C_p}{2}\sum_{u=1}^{n} w_i k(\|y - x_i\|^2) \quad (5)$$

where

$$w_i = \sum_{u=1}^{m} \sqrt{\frac{\hat{q}_u}{\hat{p}_u(\hat{y}_0)}}\,\delta[b(x_i) - u] \quad (6)$$

Let in the current frame the new target location starts at the y_0 point location. At every step of the iterative mean shift algorithm the obtained target shifts from y_0 to y_1 and it is defined as

$$\hat{y}_1 = \frac{\sum_{i=1}^{n} x_i w_i g\left(\left\|\hat{y}_0 - x_i\right\|^2\right)}{\sum_{i=1}^{n} w_i g\left(\left\|\hat{y}_0 - x_i\right\|^2\right)} \quad (7)$$

where g(x) = $-k'(x)$ and k(x) is kernel function. The whole mean shift algorithm is in short as follows.

1: Basic Algorithm for Mean Shift

For multi target tracking, generate the target models $\hat{q}_1$ and $\hat{q}_2$ by equation (1) and its positions $\hat{y}_{01}$ and $\hat{y}_{02}$ from the previous frame.

1. Initialize the centers of the ellipses in the current frame at $\hat{y}_{01}$ and $\hat{y}_{02}$, then calculate the target candidates $\hat{p}(y_{01})$ and $\hat{p}(y_{02})$ by equation (2) and evaluate Bhattacharyya coefficients ρ_1 and ρ_2 by equation (4) .

2. Drive the weights w_1 and w_2 i.e. $\{w_i\}_{i=1...n}$ by equation (6).
3. Calculate the next positions of the target candidates by equation (7).
4. Calculate the target candidates $\hat{p}(y_{11})$ and $\hat{p}(y_{12})$ by equation (2) and evaluate Bhattacharyya coefficient by equation (4) at next positions,
5. If $\|\hat{y}_{11} - \hat{y}_{01}\| < \xi 1$ and $\|\hat{y}_{12} - \hat{y}_{02}\| < \xi 2$ Stop.

   Else set $\hat{y}_{01} \Leftarrow \hat{y}_{11}$ & $\hat{y}_{02} \Leftarrow \hat{y}_{12}$ and repeat from step 2.

III. RESULTS AND DISCUSSION

Here we performed an example and computes the results by the mean shift method. This example tested on Matlab software. The detail of this image sequences are jpg images with 320x240 resolutions per frame. The ability of the mean shift method is shows by this example. The image sequences "MULTIPLE" has total number of frames are 91 frames for tracking.

Frames 8, 12, 30 and 42 shows the results at the normal condition means without large displacement or fast motion or occlusions and it is show in figure1.

Frame 8

Frame 34

Frame 66

Frame 91

Figure 1: multiple object tracking by mean shift

Figure 2 shows the Bhattacharyya coefficient of object1 and object2.

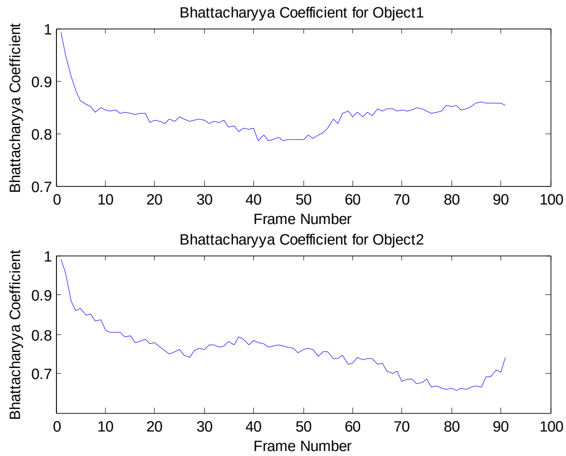

Figure 2: Bhattacharyya coefficient of object1 and object2

Figure 3 shows the horizontal and vertical positions of object1 and object2.Means here we seen that the movement of object1 & object 2 in graphically.

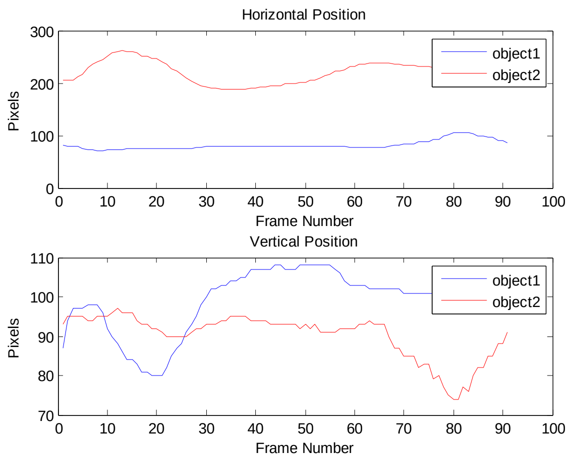

Figure 3: horizontal and vertical positions of object1 and object2

So the finally results show that the mean shift algorithm is better for small displacement.

IV. CONCLUSIONS

Here we proposed a mean shift method for multi tracking. The mean shift algorithm is a kernel based tracking. In this method the mean shift tracks targets region. By these target regions we can calculate histograms and it is a graphical representation of image. Tracking is completed by estimating the similarity function using the iteration of mean shift algorithm. When the objects with small displacement then the performance of mean shift algorithm are good but it is not guaranteed if the objects with large displacement or fast motion or occlusion then its performance are good.

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