



# Movable Object tracking by using Mean Shift method with Adjusted Background Histogram

Mahesh Kumar Chouhan<sup>\*</sup>, Rahul Mishra, Dr. Dhiiraj Nitnawwre

Department of Electronics Engineering,  
I.E.T., D.A.V.V., Indore  
India

*Abstract— Movable Object tracking is an interesting subject in the field of video tracking and its applications. When object is moving then its tracking is a challenging task in much vision area. In movable object tracking two tasks are perform first detection and second following the object path. This paper introduces an adjusted background histogram with mean shift for movable object tracking. In the proposed method, the adjusted background- histogram (ABH) plays an important role to reduce the interference of background in target localization in mean shift method. In this propose method a formula is generated by transforming only the target model. The proposed method has good accuracy to track a moving object in successive frames under some difficulties such as appearance changes due to image noise, etc. The advantages of this method are faster convergence and correct location of object as compare to mean shift. We will employ this approach for increasing the capability of moving object tracking.*

**Keywords:** Movable Object Tracking, Mean Shift method, Target Representation, Background Histogram, Mean Shift method with Adjusted Background Histogram (MS with ABH)

## I. INTRODUCTION

Movable object tracking is a complex task in the area of computer vision. Object tracking is a basic requirement for visual analysis. Various problems are occurs in movable object tracking such as noises, clutters and appearance changes, etc. All these problems are solving by several algorithms. Any video tracking is completing by three processes:

- Detect the object
- Tracking the movement of object
- Observe the behaviour of object

In various objects tracking methods the mean shift tracking method [4], [7] is a simple and popular method. The Mean Shift Tracking is an accurate and fast object tracking for small sequence. Mean shift method is use in some situations such as segmentation, target representation and localization. In mean shift method a kernel function are used. This kernel function is a rectangle region [1], [2]. By this rectangle region we can detect and track the objects path. Target model and target candidate are two important factor of mean shift method [1], [4], [8]. By these two factors we can estimate the Bhattacharyya coefficient. It is also known as similarity function [1], [2], [3], [4].

Here we proposed a tracking method with the help of mean shift method and adjusted background histogram (MS with ABH). This proposed method use the background information and to reduce the interference of background in target localization in mean shift method. The proposed method is based on mean shift algorithm. The main requirement of proposed method is target model. The main task of the proposed method (MS with ABH) is it can work if the target model

contains much background information. Thus it decreases the sensitivity of mean shift tracking to target initialization.

We organized the paper as follows: In Section II, we give an overview of mean shift algorithm. Section III explains the proposed method (MS with ABH). In Section IV, we describe the experimental results. Last Section V will give the conclusions.

## II. MEAN SHIFT METHOD

Mean shift method is a nonparametric density estimator and their procedures are iterative type to obtain the nearest mode of distribution [4], [6], [7]. Mean shift is dependent on the static distribution, which are not updated until the target experiences the significant change in the shape, size and color. It has two components i.e. target model and target candidate [1], [4], [8]. The target model is represented by its probability density function in feature space.

### A. Target Representation

In target representation we can select a feature space (Feature space:  $16 \times 16 \times 16$  quantized RGB, Target: manually selected on 1<sup>st</sup> frame) by characterizing the target. The reference target model is described by its probability density function (pdf) in the feature space [1]. The target candidate is defined at location  $y$  and is characterized by the probability density function (pdf)  $p(y)$ .

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

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

Where  $\hat{q}$  is the target model and  $\delta$  is the Kronecker delta function.

Let  $\{Y\}$  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  $u=1\dots m$  in the target candidate  $\hat{p}(y)$  is obtained as

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

Where  $\hat{p}(y)$  is the target candidate and  $C_p$  is normalization constant.

Bhattacharyya coefficient  $\rho$  is a similarity function that is used to calculate the similarity between the target model and target candidate [1], [2], [3], [4]. In the mean shift tracking algorithm the object center move from current location  $y$  to a new location  $y_1$  according to the mean shift iteration equation  $\hat{y}_1$ .

$$w_i = \sum_{u=1}^m \sqrt{\frac{\hat{q}_u}{\hat{p}_u(y_0)}} \delta[b(x_i) - u] \tag{3}$$

and

$$\hat{y}_1 = \frac{\sum_{i=1}^{np} x_i w_i g(\|y_0 - x_i\|^2)}{\sum_{i=1}^{np} w_i g(\|y_0 - x_i\|^2)} \tag{4}$$

where  $g(x) = -k'(x)$  and  $k(x)$  is kernel function.

For the convenience of expression, we denote by  $g_i = g(\|y_0 - x_i\|^2)$  Thus Eq. (4) can be re-written as:

$$\hat{y}_1 = \frac{\sum_{i=1}^{np} x_i w_i g_i}{\sum_{i=1}^{np} w_i g_i} \tag{5}$$

By equation (5) the mean shift tracking algorithm can find the most similar region to the target object in the new frame.

### B. Background Histogram

In movable object tracking, the background is very important and it is included in the detected target region [5]. If the correlation between target and background is high, the localization accuracy of the object will be decreased. This background is obtained by using target surrounding area. The background is denoted by  $\{\hat{o}_u\}_{u=1\dots m}$ . The background region is represented with the help of  $\hat{o}^*$  the minimal non-zero value in  $\{\hat{o}_u\}_{u=1\dots m}$ .

The coefficients a transformation function and it is calculated between the representations of target model

and target candidate. So the coefficients is describe by as

$$\left\{ v_u = \min \left( \frac{\hat{o}^*}{\hat{o}_{w,1}} \right) \right\}_{u=1\dots m} \tag{6}$$

Then the new target model is defined by as

$$\hat{q}'_u = C' v_u \sum_{i=1}^n k(\|X_i^*\|^2) \delta[b(x_i^*) - u] \tag{7}$$

### III. PROPOSED ALGORITHM (MS with ABH)

The MS with ABH algorithm is applied to transform only the target model but not the target candidate. So the a new weight formula is define as

$$w_i'' = \sqrt{\frac{\hat{q}'_u}{\hat{p}'_u(y)}} \tag{8}$$

Now Eq. (13) can be written as

$$w_i'' = \sqrt{C'/C} \cdot \sqrt{v_u'} \cdot w_i \tag{9}$$

where  $\sqrt{C'/C}$  is constant scaling factor, so Eq. (14) can be written as

$$w_i'' = \sqrt{v_u'} \cdot w_i \tag{10}$$

where  $w_i''$  is adjusted weight histogram and  $v_u'$  is the background information.

Hence the point's weight is decreased with the help of Eq. (10) and its relevance for target localization is reduced. By this Eq. (10) the mean shift's convergence is much faster.

#### A. Updating the Background Information in MS with ABH

By this background updated operation we can improve the movable object tracking accuracy.

Here we propose a simple background model updating method. First, the background features  $\{\hat{o}'_u\}_{u=1\dots m}$  and

$\{\hat{v}'_u\}_{u=1\dots m}$  in the current frame are calculated. Then

the Bhattacharyya similarity between  $\{\hat{o}'_u\}_{u=1\dots m}$  and

the old background model  $\{\hat{o}_u\}_{u=1\dots m}$  is computed by

$$\rho = \sum_{u=1}^m \sqrt{\hat{o}_u \hat{o}'_u} \tag{11}$$

If  $\rho$  is smaller than a threshold, the background is changeable, and then we update by replace  $\{\hat{o}_u\}_{u=1...m}$  by  $\{\hat{o}'_u\}_{u=1...m}$  and update  $\{\hat{v}_u\}_{u=1...m}$  by  $\{\hat{v}'_u\}_{u=1...m}$ . The proposed MS with ABH algorithm can be summarized as follows.

**MS with ABH algorithm**

1. Compute the target model  $\hat{q}$  by Eq. (1) and the background histogram  $\hat{o}_u$  then compute transformed target model  $\hat{q}'$  by Eq. (7) and  $\hat{v}_u$  by Eq. (6).
2. Initialize the location  $y_0$  of the target candidate in the previous frame.
3. Assume that  $k \leftarrow 0$ .
4. Compute the target candidate  $\hat{p}(y_0)$  by Eq. (2).
5. Compute the weights  $w_i^k$  by Eq. (8).
6. Compute the new position  $y_1$  of the target candidate by Eq. (5).
7. Assume that  $d \leftarrow \|y_1 - y_0\|$ . Set the error threshold  $\epsilon_1$  (default value: 0.1) and the background model update threshold  $\epsilon_2$  (default value: 0.5).
8. If  $d < \epsilon_1$  then compute  $\{\hat{o}'_u\}_{u=1...m}$  and  $\{\hat{v}'_u\}_{u=1...m}$ .
9. If Bhattacharyya similarity  $\rho$  is smaller than  $\epsilon_2$  then  $\{\hat{o}_u\}_{u=1...m} \leftarrow \{\hat{o}'_u\}_{u=1...m}$  and  $\{\hat{v}_u\}_{u=1...m} \leftarrow \{\hat{v}'_u\}_{u=1...m}$  and  $\hat{q}'_u$  is updated by Eq. (7).
10. Stop iteration and go to step 3 for next frame. Otherwise go to step 4.

**IV. RESULTS AND DISCUSSION**

In this paper we are perform an experiment on video sequence and this experiment has a programming that is run on matlab (R2010b) software. In this experiment we can used a feature space i.e. the colour model and it has 16x16x16 RGB bins. The kernel function is used in tracking field and it is denoted by  $k(x)$ . The experiment is perform on the human face sequence and the property details of this sequence are JPG image frames with 320x240 resolution and total number of frames are 73 frames. In this sequential experiment the movable object target is a human face. In figure1, the results at frames 10, 24, 36 and 64 shows the movable object tracking is successful.



Figure1: Successful movable object tracking  
Figure2 show the target model histogram of mean shift method.

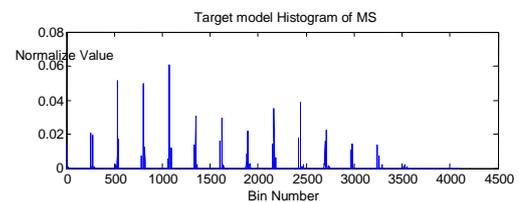


Figure2: Target model histogram of mean shift method  
And figure3 show the target model histogram of mean shift with adjusted background histogram. In this histogram we are use the background information.

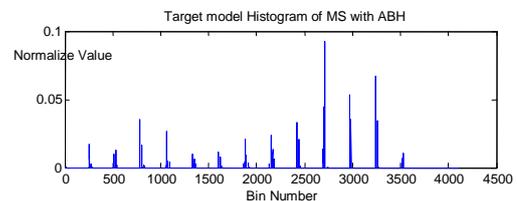


Figure3: Target model histogram of MS with ABH

The tracking results show in figure4 and it is showing that average histogram error between mean shift (MS) histogram and mean shift with adjusted background histogram (MS with ABH).

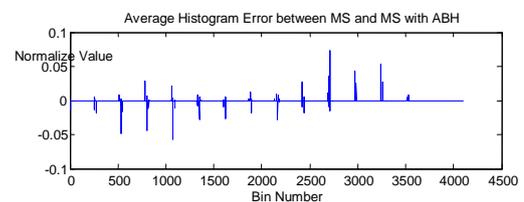


Figure4: Average histogram error between MS and MS with ABH  
By this whole detail the proposed method require less computation. The proposed method is basically same as mean shift but in proposed method the target model are transforming.

## V. CONCLUSIONS

Here we introduced a new proposed method i.e. mean shift with adjusted background histogram (MS with ABH) and that is use the background information. By this background information we can increase the object tracking performance of mean shift method. This proposed method reduces the relevance of background information. By this proposed method the target model histogram is transforms and its probability is reducing. This proposed method is reducing the number of iteration step of mean shift method and increase the object tracking accuracy. Future work consists in considering tracking of multi objects.

## REFERENCES

- [1]. D. Comaniciu, V. Ramesh, P. Meer: Kernel-based object tracking. IEEE Transactions on Pattern Analysis and Machine Intelligence 25(5), 564–577 (2003)
- [2]. G.D. Hager, M. Dewan, C. V. Stewart: Multiple Kernel Tracking with SSD. IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR'04), 1063-6919 (2004)
- [3]. D. Xu, Y. Wang, and J. An: Applying a New Spatial Color Histogram in Mean-ShiftBased Tracking Algorithm. (2005)
- [4]. E. Maggio and A. Cavallaro: Hybrid Particle Filter and Mean Shift Tracker with Adaptive TransitionModel.IEEE-ICASSP 2005,0-7803-8874-7/05, (2005)
- [5]. J. G. Allen, R. Y. D. Xu, J. S. Jin: Object Tracking Using CamShift Algorithm and Multiple Quantized Feature Spaces.(2006)
- [6]. A. Yilmaz: Object Tracking by Asymmetric Kernel Mean Shift with Automatic Scale and Orientation Selection. IEEE-1-4244-1180-7/07 (2007)
- [7]. J. Jeyakar, R.V. Babu, K.R. Ramakrishnan: Robust object tracking with background-weighted local kernels. Journal Computer Vision and Image Understanding 112, 296–309 (2008)