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OBJECT TRACKING USING MODIFIED MEAN-SHIFT ALGORITHM

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Abstract*:* In the field of computer vision object tracking has always been a research area, which has many of applications in real world. The main steps in video analysis are: detection of moving objects and tracking of such objects from frame to frame. There is various tracking algorithms which uses pre-defined methods to process. In this paper, we propose the Modified Mean shift tracking algorithm, which uses joint color-texture histogram to extract the color information as well as spatial information of object. Object tracking is one of the key technologies in intelligent video surveillance and how to describe the moving target is a key issue. Traditional color histogram Mean-shift algorithm only considered object's color statistical information, and didn't contain object's space information, so when the object color was close to the background color, the traditional MS algorithm easily caused object tracking inaccurately or lost. To solve this problem, a novel object tracking algorithm which based on modified MS is proposed in this paper. The experimental results show that the algorithm tracking the object accurately and effectively even though the object color was close to the background color or the target moves fast.

Keywords: Object tracking; Mean-Shift; Local Binary Pattern; color histogram, Feature extraction, color-texture histogram

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INTRODUCTION

Object tracking in a video sequence on the target of interest is widely used and the effective tracking has always been a typical problem in the field of computer vision. These issues are reflected in the performance of the tracking algorithm, which is real-time and robustness. With the continuous development of computer vision the area of pattern recognition technology and digital video technology uses object tracking approach with a lot of new ideas and methods. Of which, how to take into account real-time and soundness of the system is always the forefront of research. Many tracking algorithms have been proposed to get the better of the difficulties arising from noise, occlusion, clutter and changes in the foreground object or in the background environment. Among the various tracking algorithms, Mean-Shift tracking algorithm recently becomes popular due to their simplicity and efficiency. Mean Shift is an iterative kernel-based deterministic procedure which converges to a local maximum of the measurement function with certain assumptions on the kernel behaviors. Furthermore, mean shift is a low complexity algorithm, which provides a general and reliable solution to object tracking and is independent of the target representation.

Recently, a lot of tracking algorithm emerged, such as Mean-shift algorithm, Kalman filter algorithm, particle filter algorithm, etc. the MS algorithm has gained significant attention as an efficient and robust method for visual tracking. As the traditional color histogram MS algorithm caused object tracking inaccurately or lost easily when the object color was close to the background color or the target moves fast. To solve these problems, many researchers proposed various improved methods in recent years, For example, to modeling characteristics of the object better, Yuan et al [14] use the color and texture as the target feature, and then use the detected object contour to track the target; Li et al [5] proposed an object tracking algorithm based on color texture histogram with the right to block average drift.

Mean-Shift object tracking algorithm is proposed in this paper by using the joint color-texture histogram to represent a target. Aside from the ceremonious color histogram features, the extraction of texture features of the object are done by using the local binary pattern (LBP) technique to represent the object. The major consistent LBP patterns are exploited to form a mask for joint color-texture feature selection. Compared with the unvarying color histogram based algorithms that use the whole target region for tracking, the proposed algorithm extracts the edge and corner features in the target region effectively, which characterize better and present more robustly the target. The experimental results validated the proposed method which improves greatly the tracking accuracy and efficiency with fewer mean shift iterations than standard mean shift tracking. It can robustly track the target under complex scenes, such as similar target and background appearance, on which the traditional color based schemes may fail to track.

Object tracking is one of the key technologies in intelligent video surveillance and how to describe the moving target is a key issue. Traditional color histogram Mean-shift (MS) algorithm only considered object's color statistical information, and didn't contain object's space information, so when the object color was close to the background color, the traditional MS algorithm easily caused object tracking inaccurately or lost. To solve this problem, a novel object tracking algorithm which is based on MS using color-texture histogram proposed in this paper. The experimental results show that this algorithm tracking the object accurately and effectively even though the object color was close to the background color.

I. Traditional Mean-Shift (MS)

Object tracking algorithm based on traditional Mean-Shift which uses color histogram for extracting object color information has obtained a wide range of applications, because of the method is simple and good real-time, it can deal with target deformation and some shelter. In these algorithms, a lot of things used statistical model for target tracking with neighbor pixel domain expression, often use a reference model through the nonlinear estimation for the parameters of the moving target model.

Currently, a widely used form of target representation is the color histogram which could be viewed as the discrete probability density function (PDF) of the target region. Color histogram estimates mode of point of sample distribution. In representing the target object appearance it is very robust. Using only color histogram in mean shift tracking has some problems. First spatial information is lost. Second, when target has similar appearance to the background, color histogram will become invalid to distinguish them. Due to loss of information caused by projection of the 3D on a 2D image, noise in images, object complex motion, articulated nature of objects, partial object occlusions, complex shapes scene tracking objects can be complex. The texture pattern is to reflect the spatial structure of the object. They have features to represent and recognize targets. The texture features introduce new information which Color histogram does not convey.

II. Joint Color-Texture Histogram

Color histograms consists very useful information about color images. The color dissimilarity measure called histogram intersection, and its successors, have been widely used for object recognition and image retrieval. The texture patterns which reflect the spatial structure of the objects are effective features to represent and recognize targets. Since the texture features introduce new information that the color histogram does not convey, using the joint color-texture histogram for target representation is more reliable than using only color histogram in tracking complex scenes.

Using joint color-texture histogram for target representation is more reliable than using only color histogram in tracking complex video scenes. Idea of combining edge and color for target object representation has been exploited by researchers. The local binary pattern (LBP) technique is very effective to describe image texture features. LBP has advantages such as rotation invariance fast computation and, which facilitates wide usage in the fields of image retrieval, texture analysis, and face recognition. LBP was successfully applied to the detection of moving objects. In LBP, each pixel is assigned a texture value. It can be naturally combined with the color value of the pixel to represent targets. LBP feature is used to construct a two dimensional histogram representation of the target for tracking monochromatic and thermo graphic video. This target representation scheme eliminates noise and smooth background in the tracking process. Compared with the traditional RGB color space based target representation, it exploits the target structural information. This method improves greatly tracking accuracy with fewer mean shift iterations than standard mean shift object tracking. It can robustly track target object under complex scenes, such as similar background appearance and target.

III. Mean-shift Tracking

Recently, a lot of tracking algorithm introduced, the Mean-Sift algorithm has gained significant attention as an efficient and robust method for visual tracking. As the traditional color histogram MS algorithm caused object tracking inaccurately or lost easily when the object color was close to the background color or the target moves fast. To solve these problems, many researchers proposed various improved methods in recent years

In this paper, proposed the LBP scheme to represent the target texture feature and then propose a joint color-texture histogram method for a more distinctive and effective target representation. Mean shift object tracking is consist of two parts, first is appearance description and second one is tracking. Figure 1 shows two parts of mean shift algorithm.

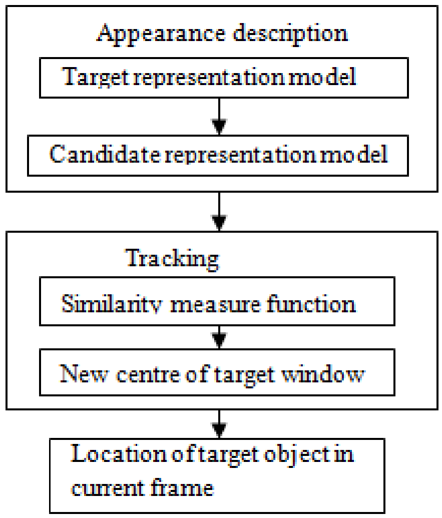

Figure 1: Two parts of Mean- Shift Algorithm

○ *Target Representation Model*

A target is usually defined by a rectangle or an ellipsoidal region in the image. Most of the existing target tracking schemes uses the color histogram to represent the rectangle or ellipsoidal target. In this paper, we will present a new target representation approach by using the joint color-texture histogram. First let us review the target representation in the mean shift tracking algorithm. Denote by {x∗i}i=1···n the normalized pixel positions in the target region, which is supposed to be centered at the origin point. The target model ˆq corresponding to the target region is computed as

$$\begin{cases} \hat{q} = \{\hat{q}_u\}_{u=1\cdots m} \\ \hat{q}_u = C\sum_{i=1}^{n} k(\|x_i^*\|^2)\delta[b(x_i^*) - u] \end{cases} \quad (1)$$

Where ˆqu represent the probabilities of feature u in target model ˆq, m is the number of feature spaces, δ is the Kronecker delta function, b(x∗i) associates the pixel x∗i to the histogram bin, k(x) is an isotropic kernel profile and constant C is a normalization function defined by

$$C = 1 \Big/ \sum_{i=1}^{n} k(\|x_i^*\|^2) \qquad (2)$$

Similarly, the target candidate model ˆp(y) corresponding to the candidate region is given by

$$\begin{cases} \hat{p}(y) = \{\hat{p}_u(y)\}_{u=1\cdots m} \\ \hat{p}_u(y) = C_h \sum_{i=1}^{n_h} k\left(\left\|\frac{y - x_i}{h}\right\|^2\right) \delta[b(x_i) - u] \end{cases}$$

$$C_h = 1 \Big/ \sum_{i=1}^{n_h} k\left(\left\|\frac{y - x_i}{h}\right\|^2\right) \qquad (3)(4)$$

Where ˆpu(y) represents the probability of feature u in the candidate model ˆp(y), {xi}i=1· · · nh denote the pixel positions in the target candidate region centered at y, h is the bandwidth and constant Ch is a normalization function.

In order to calculate the likelihood of the target model and the candidate model, a metric based on the Bhattacharyya coefficient is defined between the two normalized histograms ˆp(y) and ˆq as follows:

$$\rho[\hat{p}(y), \hat{q}] = \sum_{u=1}^{m} \sqrt{\hat{p}_u(y)\hat{q}_u} \qquad (5)$$

The distance between ˆp(y) and ˆq is then defined as

$$d[\hat{p}(y), \hat{q}] = \sqrt{1 - \rho[\hat{p}(y), \hat{q}]} \qquad (6)$$

- *Tracking*

Minimizing the distance (6) is equivalent to maximizing the Bhattacharyya coefficient (5). The iterative optimization process is initialized with the target location y0 in the previous frame.

Using Taylor expansion around ˆpu(y0), the linear approximation of the Bhattacharyya coefficient (5) is obtained as

$$\rho[\hat{p}(y),\hat{q}] \approx \frac{1}{2}\sum_{u=1}^{m}\sqrt{\hat{p}_u(y_0)\hat{q}_u} + \frac{1}{2}C_h\sum_{i=1}^{n_h} w_i k\left(\left\|\frac{y-x_i}{h}\right\|^2\right) \quad (7)$$

Where

$$w_i = \sum_{u=1}^{m}\sqrt{\frac{\hat{q}_u}{\hat{p}_u(\mathrm{y}_0)}}\delta[b(\mathrm{x}_i)-u] \quad (8)$$

Since the first term in (7) is independent of y, to minimize the distance in (6) is to maximize the second term in (7). In the iterative process, the estimated target moves from y to a new position y1, which is defined as

$$y_1 = \frac{\sum_{i=1}^{n_h} x_i w_i g\left(\left\|\frac{y-x_i}{h}\right\|^2\right)}{\sum_{i=1}^{n_h} w_i g\left(\left\|\frac{y-x_i}{h}\right\|^2\right)} \quad (9)$$

When we choose kernel g with the Epanechnikov profile,7 (9) is reduced to

$$y_1 = \frac{\sum_{i=1}^{n_h} x_i w_i}{\sum_{i=1}^{n_h} w_i} \quad (10)$$

By using (10), the mean shift tracking algorithm finds the new frame the most similar region to the object.

IV. Mean-Shift Tracking Using Joint Color-Texture Histogram

A. LBP

The texture of object is a relatively stable feature that could reflect the information of the object space characteristics, usually not subject to the impact of light and background color. The LBP operator labels the pixel in an image by threshold its neighborhood with the center value and considering the result as a binary number (binary pattern). The general version of the LBP operator is defined as follows:

$$LBP_{P,R}(x_c, y_c) = \sum_{p=0}^{P-1} s(g_p - g_c)2^p \quad (11)$$

Where *c g* corresponds to the gray value of the center pixel

(*x c*, *y c*) of a local neighborhood and *g p* to the gray values of P equally spaced pixels on a circle with radius R. The function s(x) is defined as follows:

$$s(x) = \begin{cases} 1, x \geq 0 \\ 0, x < 0 \end{cases} \quad (12)$$

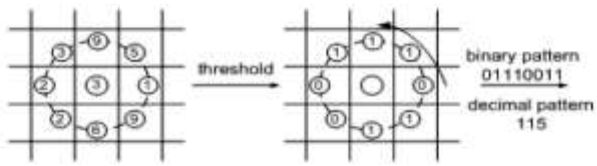

Figure 2: $LBP_{8,1}$ texture models example

Figure 2 is an example of $LBP_{8,1}$ (P = 8, R = 1). By varying P and R, we have the LBP operators under different quantization of the angular space and spatial resolution, and multiresolution analysis can be accomplished by using multiple $LBP_{P,R}$ operators.

The texture model derived by (11) has only gray-scale invariance. The gray-scale and rotation invariant LBP texture model is obtained by

$$\mathrm{LBP}_{P,R}^{riu2} = \begin{cases} \sum_{p=0}^{P-1} s(g_p - g_c) & \text{if } U(\mathrm{LBP}_{P,R}) \leq 2 \\ P+1 & \text{otherwise} \end{cases} \quad (13)$$

Where

$$U(\mathrm{LBP}_{P,R}) = |s(g_{P-1} - g_c) - s(g_0 - g_c)| + \sum_{p=1}^{P-1} |s(g_p - g_c) - s(g_{p-1} - g_c)| \quad (14)$$

LBP has advantages such as rotation invariance fast computation and, which facilitates wide usage in the fields of image retrieval, texture analysis, and face recognition. LBP was successfully applied to the detection of moving objects. In LBP, each pixel is assigned a texture value. It can be naturally combined with the color value of the pixel to represent targets. LBP feature is used to construct a two dimensional histogram representation of the target for tracking monochromatic and thermo graphic video. This target representation scheme eliminates noise and smooth background in the tracking process. Compared with the traditional RGB color space based target representation, it exploits the target structural information. This method improves greatly tracking accuracy with fewer mean shift iterations than standard mean shift object tracking. It can robustly track target object under complex scenes, such as similar background appearance and target.

V. MODULE DESCRIPTION

1. In first module we implement and calculate the target model using joint color-texture histogram Image which considers 1st frame of video as the center of target window and calculate bandwidth of target window and provide quantification scheme of RGB space which in make target model for tracking. In this module the local binary pattern (LBP) technique is used. This technique is very effective to describe the image texture features. LBP has advantages such as fast computation and rotation invariance, which facilitates the wide usage in the fields of texture analysis, image retrieval, face recognition, image segmentation, etc. In LBP, each pixel is assigned a texture value, which can be naturally combined with the color value of the pixel to represent targets.
2. In working of second module is to design the tracking window which is in the range of image, which window of tracking result and define height, width: the size of image. The tracking window represents the tracked object frame to frame.
3. In third module we design basic means shift tracking algorithm and compare it with modified mean shift tracking which improve in tracking window capture.
4. In fourth module we do comparison of both algorithm with different video and calculate correlation between them. It shows the strength of algorithm.
5. In fifth module we do comparison of this algorithm with different algorithms and check the efficiency of algorithm.

VI. CONCLUSION

In this paper Joint color-texture histogram is used to extract the color as well as spatial or textural information for effective object tracking. To reduce the computational cost and improve the robustness of target representation, we proposed a joint color and LBP texture based mean shift tracking algorithm in this paper. LBP operator is an effective tool to measure the spatial structure of local image texture. In this paper proposed target representation model effectively extracts the edges and corners, which are important and robust features, of the object while suppressing the smooth background features. Experimental results designate that the proposed joint color-texture based method performs much better than the original color based method with fewer iteration numbers, especially when the tracking objects that have similar color appearance to the background.

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