Acta Technica 62 (2017), No. 4A, 673–680

Motion characteristics accuracy judgment based on behavioral visual analysis

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Abstract. Traditional way of identifying image motion characteristics based on template-based matching method obtains the difference between motion characteristics by the operation of higher order moments, which is susceptible to noise interference and recognition accuracy is low. Therefore, the judging method of motion characteristics accuracy of behavioral visual analysis is proposed, which uses key characteristics matching algorithm in behavioral visual analysis to generate the attributes of critical attitude set in behavioral view based on human behavior in time series, make periodic analysis of human behavior, and obtain the relationship between the aspect ratio of the smallest circumscribed rectangle of the human body and the key gesture. Key attitude template-based in behavioral visualization is built according to mixed wavelet moment characteristics of the moving image. The distance mean value between test sample and key attitude template-based and the weighted minimum value of the minimum variance are calculated. The similarity of the moving image is analyzed. The motion characteristics in the sample to be tested are judged to see whether they belong to correct behavior type and the accurate judgment of human body movement characteristic is realized. Experimental results show that this method can accurately judge the characteristics of different human movements, and the stability is high.

Key words. Behavioral vision, analysis, motion characteristics, accuracy, judgment.

CLC number: TP391.9 Document code: A

1. Introduction

Moving target vision visual behavior analysis technology is a key part of computer vision analysis. The analysis of human behavior is a classification process of real-time data, which is based on the human behavior types of human body target related characteristics sample sequence. Effective motion description characteristics and movement type division methods, as well as human behavior analysis judgment algorithm are adopted to complete the accurate judgment of human movement char-

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acteristic [1]. Therefore, the judging method of motion characteristics accuracy of behavioral visual analysis is proposed to make accurate judgment of human motion characteristics.

2. Motion characteristics accuracy judgment based on behavioral visual analysis

In this paper, key frame characteristics matching algorithm based on behavioral visual analysis is used to realize the accurate judgment of motion characteristics. The method uses model method to describe moving human body behavior, analyze the similarity between test sample and behavior model, and analyze types of human behavior. According to behavioral visual analysis, same category images are divided into multi-frame images to complete the movement of human motion. [2] Based on human motion cycle characteristics, the characterization description model of key gesture frames in behavioral vision is used to describe the fluctuation of behavioral characteristics in time and space. Therefore, based on the fluctuation of human motion cycle characteristics, this paper uses motion behavior partitioning algorithm of mixed wavelet invariant moments match based on key frame to complete the accurate judgment of human motion characteristics.

A. The moment characteristics of the image

In the process of analyzing target moving behavior and moving target image processing, the characteristics of the moving target image should be collected first. Motion image moments characteristics are geometric description math in image area, which have translation and rotation properties and are the stable moment characteristics of the image, and usually wavelet moment is used to identify the moving image.

1. Wavelet moment

Wavelet moment has higher resolution of image space [3], covering local information and global information of the moving image, which can be used to compare the real-time and effective information of the moving image characteristics to be judged. In the process of identifying moving target image, we should make sure image's wavelet moment has the stability of rotation, translation, and scaling [4], and that the moving image needs to be normalized.

Set body motion two-dimensional image as$f(x, y)$, its (p + q) order norm:

$$M_{pq} = \int\int x^p y^q f(x,y) dxdy \; p,q = 0,1,2... \tag{1}$$

If$x = r\cos(\theta), y = rsin(\theta)$, the above formula's expression being transformed into polar coordinate system to get the matrix characteristics is:

$$F_{pq} = \int\int f(r,\theta) g_p(r) e^{jq\theta} r dr d\theta \tag{2}$$

In the formula, $g_p(r)$ is the function of radial component r of transformation kernel,θ is the angle between poles connection of polar coordinates and polar axis.

$e^{jq\theta}$is changing kernel's angular component [5]. By deducing, $\|F_{pq}\|$'s value is related to $e^{jq\theta}$,if the image is rotated, the eigenvalue model$\|F_{pq}\|$ will also fluctuate. Then,

$$\|F_{pq}^{rotated}\| = \sqrt{F_{pq}^{rotated} \times (F_{pq}^{rotated})^*} = \|F_{pq}\| \tag{3}$$

Set$S_q(r) = \int f(r,\theta)e^{jq\theta}d\theta$, then the upper formula can be calculated as:

$$F_{pq} = \int s_q(r)g_p(r)rdr \tag{4}$$

$S_q(r) = \int f(r,\theta)e^{jq\theta}d\theta$ is used to describe the qth frequency domain characteristics of the image in phase space$[0, 2\pi]$. If$g_p(r)$is r's global function,F_{pq} is used to describe the global characteristics of the image; if$g_p(r)$is r's local function, $F_{pq}$is used to describe the local characteristics of the image [6]. When$g_p(r) = r^p$constrains p and q at the same time, the Hu moments can be got by degrading, if $g_p(r)$ is the following orthogonal:

$$g_p^{Zerinke}(r) = \sum_{s=0}^{(p-|q|)/2} (-1)^s \times \frac{(p-s)!}{s!(\frac{p+|q|}{2}-s)!(\frac{p-|q|}{2}-s)!} r^{p/2-s} \tag{5}$$

In it, $\left\|F_{pq}^{Zernike}\right\| = \left\|\int s_q(r)g_p^{zernike}(r)rdr\right\|$ is Zernike's velocity moment.

Fuse wavelet properties and moment properties, and $\{g_p(r)\}$is transformed into a wavelet basis function by polar coordinates (4). The formula for wavelet moment is obtained:

$$\psi_{ab}(r) = \frac{1}{\sqrt{b}}\psi(\frac{r-b}{a}) \tag{6}$$

In it, a is scale factor, b is translation factor, the values of the two are controlled, and the global and local properties of the target image can be collected. Update $g_p(r)$in Formula (2) with$\psi_{ab}(r)$, the wavelet moment can be described as:

$$W_{m,n-1} = \int\int f(r,\theta)[\psi_{m,n}(r)e^{jq\theta}]^* rdrd\theta \tag{7}$$

$m = 1, 2, 3, ..., n = 0, 1, ...2^{m+1}$, general n times B-spline wavelet function is taken as a mother wavelet$\psi(r)$, the expression of the wavelet moment is:

$$\psi(r) = \frac{4a^{n+1}}{\sqrt{2\pi(n+1)}}\sigma_w \cos(2\pi f_0(2r-1) \cdot \exp\left(-\frac{(2r-1)^2}{2\sigma_w^2(n+1)}\right) \tag{8}$$

In it, $a = 0.586055$,$f_0 = 0.408266$, $\sigma_w^2 = 0.450387$through three B-spline wavelet [8], the value of n is 3. The values of inner scale factor a and translation factor b of the wavelet function are:

$$\begin{matrix} \{a = 2^{-m} \\ \{b = \frac{n}{2} \cdot 2^{-m} \end{matrix} \tag{9}$$

In the formula,$m = 1, 2, 3, ..., n = 0, 1, ..., 2^{m+1}$, the wavelet basis function of the equation (??) by putting in this formula can be transformed into:

$$\psi_{m,n}(r) = 2^{m/2}\psi(2^m r - \frac{n}{2}) \tag{10}$$

Through different scale factor m and shift factor n [9], it is possible to ensure that $\psi_{m,n}(r)$is throughout general radial space to collect local and global information of the image [0, 1].

2. Combination of velocity wavelet moment and contour wavelet moment

To achieve the effective classification of target movement characteristics [10], comprehensive analysis of movement target scope's local description method and global attributes are implemented to shape movement target's characteristic description model. Figures 1 and 2 describe the contour information of motion range and the local description and global properties of the moving target, respectively.

Fig. 1. Human movement target

Fig. 2. (a) Body contours (b) Pre-treated contours

The mass center of the moving target is obtained by:

$$x_c = \frac{1}{N_b}\sum_{i=1}^{N_b} x_i \ \ y_c = \frac{1}{N_b}\sum_{i=1}^{N_b} y_i \tag{11}$$

In the formula, $(x_c, y_c)$is the position used to describe the mass center of the moving object, $N_b$is the number of pixels in the image, (x_i, y_i) is the pixel in the contour [11]. The distance calculation formula between contour pixel and centroid is:

$$d_i = \sqrt{(x_i - x_c)^2 + (y_i - y_c)^2} \tag{12}$$

The characteristics vector of the contour can be described as:

$$s = \{d_0, d_1, ..., d_n\} \tag{13}$$

The human body contour pixels are projected into complex vectorZ_1, as described in Figure 3:

$$Z_1 = [z_1, z_2, ..., z_i, ..., z_{N_i}]^T \tag{14}$$

In it, $z_i = x_i + j * y_i$,n is the number of sampling points.

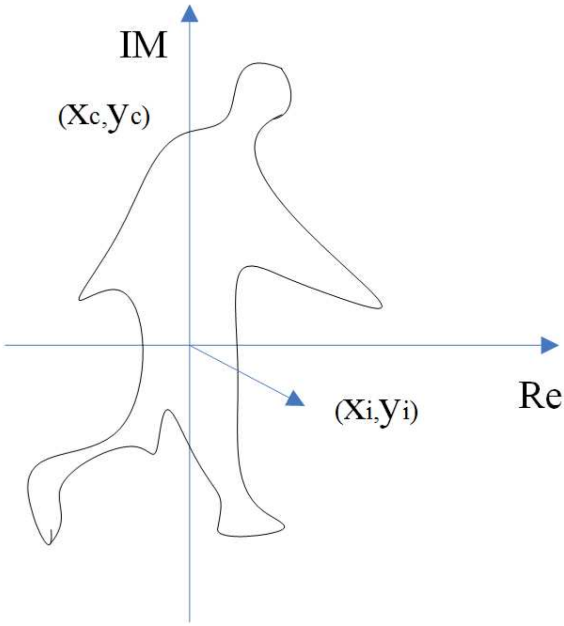

Fig. 3. The complex description of human contours

In order to describe the velocity attribute of the moving target, it should be assumed that the fluctuation rates of the moving objects in horizontal and vertical directions are$v_x$andv_y respectively, then

$$v_x = \frac{x_{c+1} - x_c}{\Delta t} \; v_y = \frac{y_{c+1} - y_c}{\Delta t} \tag{15}$$

$(x_c, y_c)$is the center of mass position,$\Delta t$is used to describe the moving image's frame fluctuation rate. Set the speed variable is$V(j, \beta, \lambda)$:

$$V(j, \beta, \lambda) = (x_c^{j+1} - x_c^j)(y_c^{j+1} - y_c^j)^\beta \tag{16}$$

Velocity characteristics value is centroid's change value function, (β, λ) is usually set to (0,1) and (1,0) to avoid the problem of 0 centroid volatility in human body level or vertical motion . Based on acquired contour characteristics value $Z_i^j$and$V(i, \beta, \lambda)$, the obtained motion image contour wavelet moment WCM and velocity wavelet moment WVM are as follows:

$$WCM = W_{nuqj} = \sum_{j=1}^{T} \sum_{r} \sum_{\theta} Z_j \psi_{mn}(r) e^{jq\theta} f_j(r, \theta) r \Delta r \Delta \theta \tag{17}$$

$$WVM = W_{nmq\beta\lambda} = \sum_{j=1}^{T}\sum_{r}\sum_{\theta} V(j,\beta,\lambda)\psi_{mn}(r)e^{jq\theta}f_j(r,\theta)r\Delta r\Delta\theta \tag{18}$$

In order to ensure the stability of the scale, the above results should be normalized. For the speed moment setting$r = \sqrt{x^2+y^2}$, the speed is constrained in unit circle, then$x^2+y^2 \leq 1$,the defined equation of normalized 3 times B-spline velocity wavelet moment$\overline{WVM}$is $\overline{WVM} = \frac{WVM}{A \cdot T}$. A represents the approximate range of the moving target, and T is the length of the video segment. Similarly, normalized 3 times B-spline wavelet moment $\overline{WCM}$ can be obtained. By means of the difference scale factor m and shift factor n, it is possible to ensure that $\psi_{mn}(r)$is throughout general local radial [0,1] . Contour wavelet moment can be used to obtain the local properties of the moving image of different layers from coarse to fine. Velocity wavelet moment not only has best spatial frequency local properties, but also fully analyzes the interference of the global properties of human body motion speed.

The similarity between the two image sequences can be detected by means of mixed wavelet moment, which requires the fusion of wavelet moment and velocity wavelet moment. Then,

$$S(i,j) = \sum_{k=1}^{K}[((WVM_i(k) - WVM_j(k))^2 + ((WCM_i(k) - WCM_j(k))^2]/K \tag{19}$$

In it, i and j represent the sequence number of the test sample image sequence and the sequence number of the training sample image sequence respectively, and K is used to describe the characteristic number of 3 times B-spline mixed wavelet moment. $WVM_i(k)$ describes kth$WVM_i(k)$ attribute in description sequence j, and all characteristics value need to be normalized before calculating the similarity.

3. Conclusion

In order to solve the existence of low efficiency and poor dryness resistance of traditional template-based matching method in identifying movement characteristics, this paper presents a motion characteristics accuracy judging method based on behavioral visual analysis. The experimental results show that this method can accurately judge the characteristics of different human movements, and the stability is high.

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Received November 16, 2016