Study on the Multi-objective Extraction Method of Images of Difficult Martial Arts Moves

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Abstract: The multi-objective extraction of images of difficult martial arts moves is an important way to determine the standard of a player's difficult martial arts moves. However, most multi-objective extractions of martial arts moves are conducted by extracting the images of martial arts moves through their geometric feature parameters, but the method is difficult to extract and inconvenient to conduct. Therefore, a multi-objective extraction method of difficult martial arts moves based on Weber Local Descriptor (WLD) is proposed, the segmentation of images and multi-objective extraction. Experiments show that with the method proposed in the paper, the multi-objective extraction and identification of images of difficult martial arts moves can be conducted well.

Keywords: Difficult moves of martial arts; Multi-objective; Extraction of images

1. Introduction

Martial arts are an excellent traditional sports event with rich contents and varieties in our country. Exercising martial arts for a long term can make people strong, healthy, strong-willed, and well-educated[1-2].With the increasing importance attached to martial arts , the standard of movements are being given more and more requirements[3-4]. Because of the continuity of martial arts moves, the standard of moves is difficult to determine[5-6], especially those moves being made. The multi-objective extraction of images of difficult martial arts moves is to extract difficult martial arts moves from their backgrounds to serve as a way to determine their standards[7-8]. However, currently, the multi-objective extraction of difficult martial arts move images is realized based on wavelet transformation[9-10], first analyzing the characteristics of images of difficult martial arts moves, and contrasting wavelet transformation coefficients , wavelet transformation coefficient clustering and wavelet packet coefficients[11-12], selecting wavelet transformation coefficients extraction features that can be decomposed into much high-frequency and low-frequency information, and defining wavelet energy ratio parameters according to wavelet transformation coefficients[13-14], integrating wavelet energy ratio parameters into gray value of difficult martial arts moves, adopting self-adaptive threshold and neural networks to extract the transition zone of the difficult action images of martial arts, and conducting the multi-objective extraction of difficult martial arts move images. The method has become an important one because of its extraction accuracy[15]. With the increasing importance attached to martial arts, the subject has gradually come into experts' and scholars' view, and as the researches go on, they are very fruitful[16-17].

The paper[18] presents a method of multi-objective extraction of difficult action images of martial arts. Firstly, difficult action images are pre-processed in light and shade with total variation-based image denoising and muti-scale retinex with color restoration (MSRCR) and then they are spatially averaged with Gabor filter, and the color structure tensor is established, and with the Canny algorithm, the image edge extraction of difficult actions of martial arts is carried out, and on that basis by means of morphological method, the small-areaed edge of the images is filtered out and regionally connected so as to complete the multi-objective extraction of the difficult action images. This method can not effectively denoise the difficult images of martial arts, resulting in the unprecise extraction of the images of difficult actions of martial arts. Based on visual saliency, Paper[19] proposes a method of multi-objective extraction of difficult action images of martial arts. In the method, visual saliency is taken as a rule, and through the computation and integration and the acquisition of evident imaged algorithm, actions of martial arts are extracted from the backgrounds of difficult actions of martial arts.

Then with visual saliency competition, difficulty movement areas of martial arts are marked, and according to salient threshold, the difficulty action of martial arts is identified, thus reducing the amount of data processing, eliminating the interference of other parts of the images of difficulty movement. The paper proposes that on the saliency map, focus of attention serves as seed points to complete the multi-objective extraction of difficult action images of martial arts. However, the process of the method is complicated, and there may be distortion and inaccuracy in the extraction. Paper[20] presents a method of using weighted quantification to achieve the multi-objective extraction of difficult action images of martial arts. First, according to the visual selectivity, 9 new structuring elements are defined, and the continuous attributes and the hierarchical statistical model are constructed. Then by changing the color of images of difficult movements of martial arts and matching the structuring elements, corresponding mapping graphs are generated, and extract statistical structuring elements and connecting feature vector of difficult action images of martial arts. However, this method is complicated in calculation procedures, and it is difficult to extract and is not good for operation.

Aimed at problems above, this paper presents a multi-objective extraction method of difficult martial art moves based on Weber Local Descriptor (WLD). Firstly, the two dimensional OTSU method is used to segment the images of difficult martial art actions. On that basis, with the Weber Local description method, by weber, by improving the transmission function of the anisotropic diffusion algorithm and introducing a new gradient descriptor to facilitate describing the image gradient, and by using the local description and the spatial gradient ,the gradient of the action images of martial arts is described. The paper introduces the principles of pre-processing images of difficult martial art moves based on center-symmetric logarithmic transformation so as to realize the multi-target extraction of images of difficult martial arts based on Weber local description. The experiments show that the method proposed in the paper is effective in segmentation , and lays a solid foundation for the application research in this field.

2. The Multi-Target Extraction of Images of Difficult Martial Arts

In the multi-target extraction of images of difficult martial arts, the characteristics of various parts of the player's body are extracted in the process of the action to determine the standard of the action.

2.1. The method of image segmentation based on the two-dimensional otsu

The segmentation of action images of difficult martial arts is an important means to improve the quality of difficult movement images, and the segmentation quality influences the multi-target extraction of martial arts difficult movements. In the segmentation of the difficult action images of martial arts, a few problems need to be solved .

Due to the inherent speckle noise of the action image of martial arts, in the difficult action image of martial arts, the gray value of uniform homogeneous areas of back-scattering coefficient is not average, but fluctuates up and down around a mean, which can cause uniform homogeneous area to be different in luminance and eventually form a coherent spot. Because of the speckle noise of the difficult action images of martial arts, it can also affect the segmentation quality of the difficult action image.

Selection of optimal threshold criteria: The key to using threshold segmentation is to select the optimal threshold value, and its selection quality seriously affects the image segmentation effect.

Suppose the gray value of difficult martial arts movements is expressed as $1-L$, define the two-dimensional histogram, and its horizontal coordinates represent the pixel value of the image pixel in the region, and the vertical coordinate represents the average gray value of the adjacent field of the pixel, P_{ij} is he pixel value of any point on the histogram, which represents the frequency of the two-element groups (i,j) in the histogram region. When the difficult action images of martial arts are divided into two categories C_o and C_b by the threshold pair (s,t) , and $\omega_o(s,t)$ expresses the corresponding prior probabilities respectively, then:

$$\omega_o(s,t)=\sum_{i=1}^{s}\sum_{j=1}^{t}P_{ij} \quad (1)$$

$$\omega_b(s,t)=\sum_{i=s+1}^{L}\sum_{j=t+1}^{L}P_{ij} \quad (2)$$

The mean vectors of the corresponding classes m_o and m_b can be expressed as the mean vectors

$$m_o=(m_{oi},m_{oj})^T=\left(\sum_{i=1}^{s}\sum_{j=1}^{t}iP_{ij}/\omega_o,\sum_{i=1}^{s}\sum_{j=1}^{t}jP_{ij}/\omega_o\right)^T \quad (3)$$

$$=(m_i(s,t)/\omega_o(s,t),m_j(s,t)/\omega_o(s,t))^T$$

$$m_b=(m_{bi},m_{bj})^T=\left(\sum_{i=s+1}^{L}\sum_{j=t+1}^{L}iP_{ij}/\omega_b,\sum_{i=s+1}^{L}\sum_{j=t+1}^{L}jP_{ij}/\omega_b\right)^T \quad (4)$$

In the formula above , $m_i(s,t)=\sum_{i=1}^{s}\sum_{j=1}^{t}iP_{ij}$, $m_j(s,t)=\sum_{i=1}^{s}\sum_{j=1}^{t}jP_{ij}$ 。

The total mean vector of the two-dimensional histogram of the difficult action image of martial arts can be expressed as:

$$m_T=(m_{Ti},m_{Tj})^T=\left(\sum_{i=1}^{L}\sum_{j=1}^{L}iP_{ij},\sum_{i=1}^{L}\sum_{j=1}^{L}jP_{ij}\right)^T \quad (5)$$

Suppose the probability of a two-dimensional histogram is ignored, then:

$$\begin{cases}\omega_o+\omega_b\approx 1\\ m_T\approx \omega_o m_o+\omega_b m_b\end{cases} \qquad (6)$$

Classes square error σ_B is defined as:

$$\sigma_B=\omega_o\left[(m_o-m_T)(m_o-m_T)^T\right]+\omega_b\left[(m_b-m_T)(m_b-m_T)^T\right] \qquad (7)$$

Suppose $tr\sigma_B$ to be the measure of classes square error, then:

$$tr\sigma_B=\omega_o\left[(m_{oi}-m_{Ti})^2+(m_{oj}-m_{Tj})^2\right]+ \omega_b\left[(m_{bi}-m_{Ti})^2+(m_{bj}-m_{Tj})^2\right] \qquad (8)$$

And then put the formula (6) in the formula above:

$$tr\sigma_B\approx\frac{[m_{Ti}\omega_o-m_i(s,t)]^2+[m_{Tj}\omega_o-m_j(s,t)]^2}{\omega_o(1-\omega_o)} \qquad (9)$$

The optimal threshold (s^*,t^*) can be determined by the following formula in the segmentation of action images of difficult martial arts:

$$(s^*,t^*)=\arg\max_{1\le s,t\le L}\{tr\sigma_B(s,t)\} \qquad (10)$$

The corresponding two-dimensional threshold function can be expressed as:

$$f_{s^*,t^*}(x,y)=\begin{cases}b_o, & f(x,y)<s^*\ And\ g(x,y)<t^*\\ b_b, & f(x,y)\ge s^*Or\ g(x,y)\ge t^*\end{cases} \qquad (11)$$

In the formula above, $1\le b_o$, $s^*,t^*,b_b\le L$.

Although this method can be segment difficult action images of martial arts, the total computational complexity of this method is $O(L)^2$, which is larger. Aimed at this problem, the paper uses the rapid recursion method of the 2-d OTSU , presenting the rapid recurrence formula of $\omega_o(s,t)$, $m_i(s,t)$ and $m_j(s,t)$, to reduce the computational complexity of the method of segmentation of difficult actions .

Suppose $PA_{st}=\omega_o(s,t)$, $PC_{st}=\omega_b(s,t)$, then:

$$PA_{s1}=PA_{(s-1)1}+P_{s1} \qquad (12)$$

$$PA_{st}=\sum_{i=1}^{s}\sum_{j=1}^{t-1}P_{ij}+\sum_{i=1}^{s}P_{it}$$

$$=PA_{s(t-1)}+\sum_{i=1}^{s-1}P_{it}+P_{st} \qquad (13)$$

$$=PA_{s(t-1)}+PA_{(s-1)t}+PA_{(s-1)(t-1)}+P_{st}$$

$$PC_{st}=1-PA_{st} \qquad (14)$$

From the statement above , a two dimensional OTSU method is put forward for the segmentation of difficult martial art actions, and because of the complex problems in the calculation of the 2-d OTSU method, the rapid recursion of the 2-d OTSU method is used to realize the segmentation of the images of the difficult actions of martial arts.

2.2. The multi-objective extraction method of difficult martial art moves based on weber local descriptor (WLD)

Through the statement above, the image segmentation of difficult martial art movement is realized, and on that basis, the Weber Local Description method is used to achieve the image extraction of difficult martial art actions.

The difference stimulation process for the difficult action images of martial arts is shown in Figure 1.

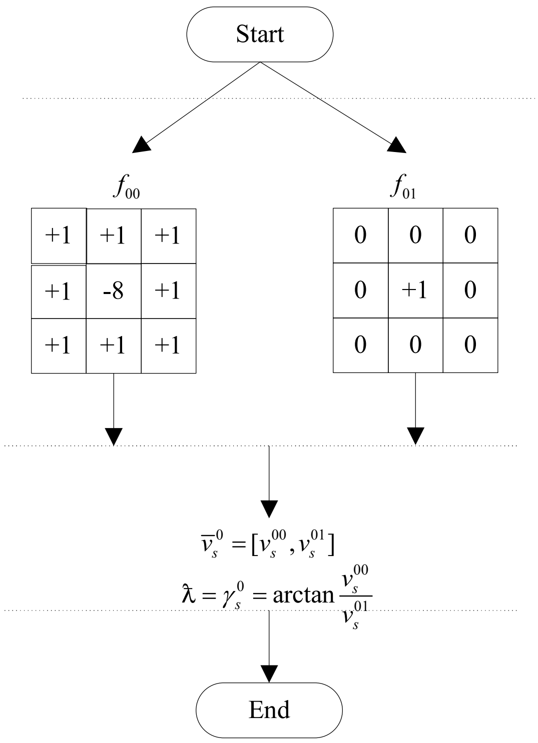


Figure 1. The difference stimulation process for the difficult action images of martial arts

With window function f_{00} （the size of the window function : 3×3 ） , the whole image of difficult martial art action is filtered, and the result of filtering is that for a given point computing x_c of the given point is to calculate the pixel point difference v_s^{00} of the pixel point and its neighbor (the size of the neighborhood being 3×3) , which can be expressed in the formula below:

$$v_s^{00}=\sum_{i=0}^{p-1}(x_i-x_c) \qquad (15)$$

In the formula above, x_i stands for the neighboring point i of the current central point $p=9$ .Window function f_{01} expresses the original action image for the filtering result of difficult actions of martial arts.

According to the Weber rule, the ratio of f_{00} and f_{01} to the filtering result of difficult actions is difference ratio, and it can be expressed in the formula below:

$$G_{ratio}(x_c) = \frac{v_s^{00}}{v_s^{01}} \quad (16)$$

In the formula, v_s^{00} the difference of a given pixel point ; v_s^{01} gray value of a pixel point in the original image

The formula above can be arc tangent transformed into:

$$G_{\arctan}\left(G_{ratio}(x_c)\right) = \arctan\frac{v_s^{00}}{v_s^{01}} \quad (17)$$

Put formula（14） into the formula above:

$$G_{\arctan}\left(G_{ratio}(x_c)\right) = \arctan\frac{v_s^{00}}{v_s^{01}} = \arctan(\sum_{i=0}^{p-1}\frac{x_i - x_c}{x_c}) \quad (18)$$

So the differentiation stimulation $\lambda(x_c)$ of a given point x_c can be expressed as:

$$\lambda(x_c) = \arctan\frac{v_s^{00}}{v_s^{01}} = \arctan(\sum_{i=0}^{p-1}\frac{x_i - x_c}{x_c}) \quad (19)$$

The difference ratio is arc tangent transformed, and the obtained result is limited between $(-\frac{\pi}{2}, +\frac{\pi}{2})$, avoiding a sharp difference ratio of a pixel point of a difficult action image, to a certain extent playing the role of normalization .

The relative local changes of images are described by using the difference stimulation of Weber's description. Each pixel point is given differentiate stimulation operation, and the calculation process is as follows:

$$wld(x,y) = \arctan\left\{\sum_{i=-1}^{1}\sum_{j=-1}^{1}\left[I(x+i,y+j) - I(x,y)\right]/I(x,y)\right\} \quad (20)$$

In the formula above, $I(x,y)$ stands for the original image of difficult action ,and the size of its neighborhood is 3×3 .

The formula above can be normalized , and there is:

$$wld'(x,y) = \frac{wld(x,y) - wld_{\min}}{wld_{\max} - wld_{\min}} \quad (21)$$

In the formula above, $wld_{\max}$ and $wld_{\min}$ express respectively the maximum and minimum of differentiation stimulation of all pixel points of difficult martial art actions.

The differentiation stimulation and spatial gradient of Weber's local description , the gradient change of action images of martial arts is described. According to transferring functions $g_{new}(d,k) = \frac{I}{1+\sqrt{d/k}}$, the auxiliary weight coefficient α of Weber's local description and the main weight coefficient β is as follows:

$$\alpha(x,y) = g_{new}(wld'(x,y), k_1) \quad (22)$$

$$\beta(x,y) = g_{new}(\left|\nabla I(x,y)\right|, k_2) \quad (23)$$

In the formula above, k_1 and k_2 stand for parameters. Combining α and β can give weight parameter:

$$\omega(x,y) = \alpha(x,y)\beta(x,y) \quad (24)$$

The gray scale transformation is a simple and effective method of preprocessing images , which changes the gray scale $I(x,y)$ of the image of a difficult action of martial arts into a new image $I'(x,y)$ through a transformation function $T\{\bullet\}$, namely $I'(x,y) = T\{I(x,y)\}$. Through the transformation, it can extend the gray-scale dynamic range of the image of the difficult actions of martial arts and improve the contrast of the overall image.

The exponential transformation and logarithmic transformation are the methods commonly used to change the dynamic range of gray scale of images of difficult martial arts , and the exponential transformation and logarithmic transformation can be expressed separately as :

$$y = a^{\frac{x}{b}} \quad (25)$$

$$y = a\log(x+1) \quad (26)$$

Index transform and logarithmic transform can adjust only some gray dynamic ranges of image of difficult martial art movements. Gray scale and the light intensity in shooting forms logarithmic relationship, so in this section, a logarithmic transformation based on central symmetry is proposed to improve the dynamic range of grey scale of the image of difficult martial arts. This transformation can extend the low-gray area and extend the high-gray area, improve the contrast of the image of the difficult actions, and the following formula is used to realize $y = et(x)$ to express the transform.

$$\begin{cases} y = a\log(x+1) & x \le b \\ y = 2c - a\log(2b - x) & x > b \end{cases} \quad (27)$$

In the formula above, (b,c) is the central point. In order to match the gray-scale range $0 \sim 255$ of the pixels, suppose $a = 26$, $b = 128$, $2c = 255$, the mathematical transformation expression based on the central symmetry is:

$$\begin{cases} y = 26\log(x+1) & x \le b \\ y = 255 - 26\log(256 - x) & x > b \end{cases} \quad (28)$$

In the method of multi-objective extraction of difficult action images of martial arts based on Weber, firstly, log transformation based on central symmetry is used to preprocess images, and then anisotropic diffusion of WLD is introduced to estimate the noising elements of the preprocessed images, determine features of images and finally the multi-objective extraction of difficult actions of martial arts is conducted with generalized image.

3. The Result of the Experiment and Analysis

In order to demonstrate the effectiveness and feasibility of the proposed method in the paper, an experiment was conducted. The experiment is conducted on Windows 7, and the model of CPV is Intel Core I3 of 3.2 GHz, the running platform is Microsoft Visual Studio.NET 2010. In building the multi-objective extraction platform, the experiment image is taken from the images of difficult actions of martial arts of the KYH human behavior database. The multi-objective extraction method of difficult actions of martial arts proposed in the paper is contrasted with those methods in[8]and[9],and the result is extracted to complete the experiment.

First, the comparison between the logarithmic transformation and logarithmic transformation of the center is presented, and the comparison is shown in Figure 2:

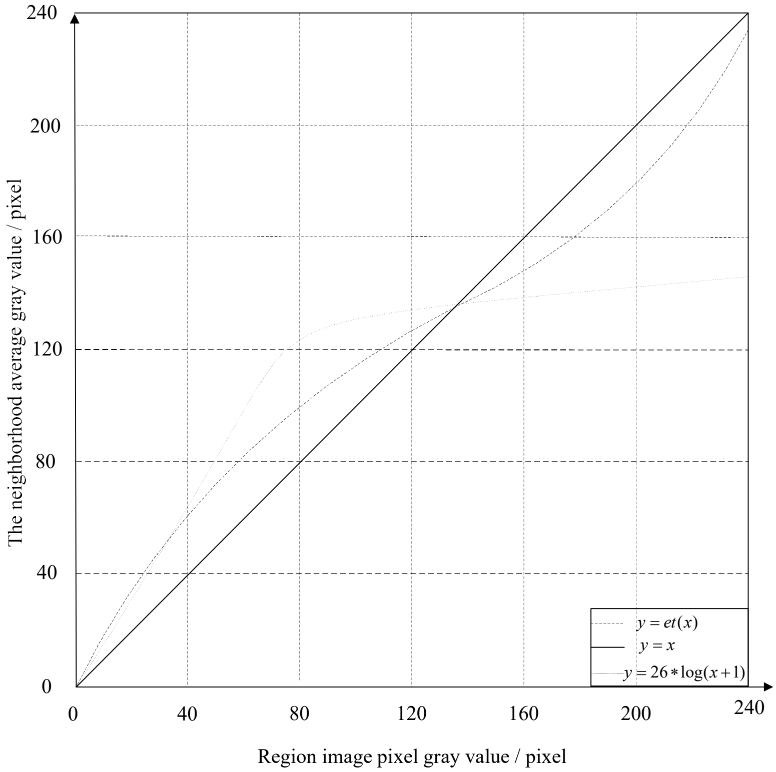


Figure 2. The comparison between the logarithmic transformation and logarithmic transformation curve based on central symmetry

Figure 2 shows log transformation extends low gray scale area while compress high gray scale area ,but the log transformation based on central symmetry $y = et(x)$ not only extends low gray scale area , but also extends high gray scale area , maintaining middle gray scale ,which has the advantages of log transformation and index transformation .Therefore, the transformation can improve dynamic gray-scale range of images of difficult actions of martial arts, which may be too bright , too dark or contain light and dank areas .As a result , the multi-objective extraction quality of images of difficult martial art actions is improved.

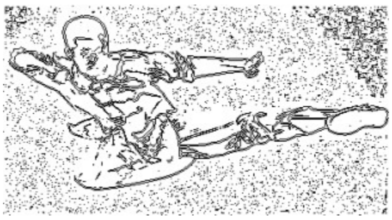
Image segmentation is an important task in the multi-objective extraction of images, and the segmentation quality has significant influence on the extraction of images. Firstly the paper make a contrast among image segmentation method, 2D maximum entropy method and the segmentation quality with the method of one-dimensional DOTSU and the result is shown in figure 3.

The results show that the threshold value of the one-dimensional OTSU method is 37, and the two dimensional maximum entropy method is (36,38), both of whose segmentation results are not ideal.

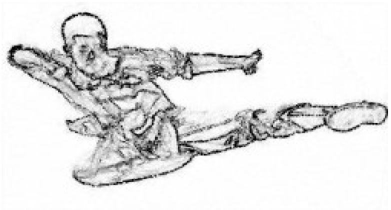
With the method in this paper, the obtained threshold of the main diagonal area after calculating the probability alone is(20,49), and the segmentation of difficult actions of martial arts from images is effective.

Finally, the multi-target extraction method of difficult action images of martial arts proposed in this paper is contrased with the one in literature[8] and[9], and the result is shown in figure 4.

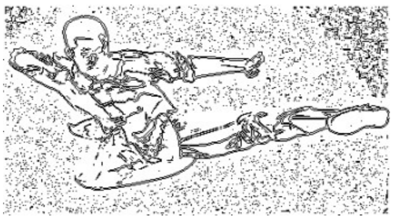
(a) The original images of difficult actions of martial arts



(b) The normal image segmentation of one-dimensional OTSU method



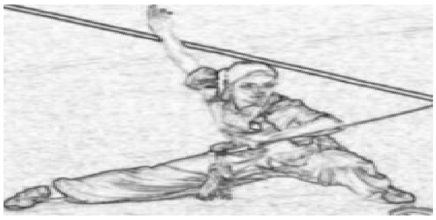
(c) 2D maximum entropy method and the segmentation



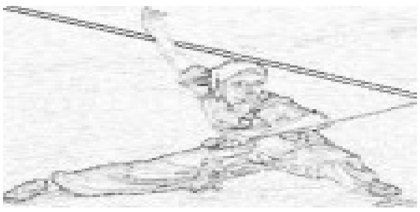
(d) The image segmentation with the method in this paper

Figure 3. The contrast of three segmentation methods

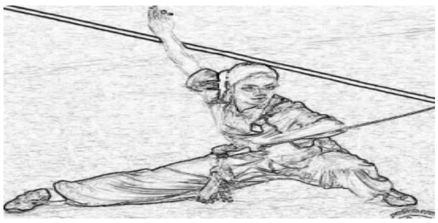
(a) The original images of difficult actions of martial arts



(b) The extraction effect of difficult action images of martial arts proposed in[8]



(c) The extraction effect of difficult action images of martial arts proposed in[9]



(d) The extraction effect of difficult action images of martial arts proposed in the paper

Figure 4. The contrast of three extraction effects of difficult action images of martial arts

The figure shows that the multi-objetive extraction of difficult art movements with the proposed method can effectively extract difficult actions of martial arts with excellent results. To sum up, with the proposed method , difficult actions can be segmented effectively from their backgrounds with good results.

4. Conclusions

With the development of the internet and the application of photographic technique, the determination of standard of martial arts by difficult actions is conducted but currently, At present, most images of difficult actions of martial arts cannot be accurately extracted, deviation existing . Therefore, a method based on Webor is proposed. The experiment shows images of difficult actions of martial arts can be effectively segmented and extracted with the method proposed in the paper, which carets a good atmosphere for the application research.

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