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The subtraction in the application of taekwondo image information based moving objects detection algorithms

Li Chen[1]*, Yan Dai[2]

[1]Sect. of P.E., Jiangxi University of Science and Technology, Ganzhou 341000,Jiangxi, (CHINA)

[2]The sports school in Jiangxi Province, Nan Chang, 330000, Jiangxi, (CHINA)

E-mail: bsh1977@126.com

ABSTRACT

In the case that the camera is fixed, the most common method which is used in carrying out the real-time detection for the moving object of the image sequence is the background subs traction. This algorithm can be estimated the background model without a moving target. The position of the moving object is determined according to calculating the difference between the image frames and the background model, and the detection result is used to update the background model. In a variety of background subtraction algorithms, the main difference lies in adopting the background model and updating algorithm. At present, as for the background model, the statistical model is mostly used to describe the probability distribution of the brightness, and the most practical application is normal probability distribution. As for the background updating algorithm, the different test detection results is basically given the different coefficients to distinguish tending to retain or change the original distribution.

KEYWORDS

Gaussian distribution;
Principal component analysis;
Threshold.

INTRODUCTION

Segmenting body parts in the image can provide the tracking information of the image sequence and help to analyze the interested details of the movement. In the counseling training of the athletes and the training of the Taekwondo student athletes, it can analyze the role of he human motion mechanism. Because of the limitation of the broadband bandwidth limitations, the media of large amount of the data just as the video signal is difficult to play real time on the Internet. And because the human motion analysis can be segmented from the foreground regions of the scene, the video signal can be transmitted partly in the information transfer. If what is passed is regional perspectives and its status information, we can concrete the favorable conditions for the real-time video session. The Key based on the background subtraction is the descriptive model and background model of the background image, which is the basis of the background subtraction method segmenting the future objectives. The background model can be divided into single mode and multimode. The color distribution of the former on each background is relatively concentrated and can be described by the single

probability model. The distribution of the latter is dispersed and require the multiple distribution models to describe together. In the image data of the Taekwondo, many backgrounds and characters emerge the characteristics of the multimode. The most commonly used description of the background color distribution is Gaussian distribution. The method of the background modeling is the mostly common used method of fixing the visual system of camera, which is to realize the fast starting and is favorable to the application of the real-time application.

As for the study of the background image, many people make the great efforts and the technology is developed continuously accompanying with the results of advent of the results, including: Lin Wen, Tu Dan and Li Guohui in the management science and engineering Multimedia Lab in the National Defense University write the paper the detection method of the moving object based on the statistical background model, which studies the problem of abstraction, update of background, background disturbance, illumination changes and shadow monitoring of the background model, proposes a kind of the effective moving object detection methods and solve the above problem better. Firstly, the statistical method is used to obtain the background model and update the background in real time to adapt the changes of light and scene, and the morphological method is used and the connected area measurement are introduced to solve the noise and background disturbance problem's QIdan, Li Ke, Zhang Zhi and Cai Chengtao write the paper The Improved Gaussian Mixture Adaptive Background Model, which puts forward two improvements as for the actual defects of the Gaussian Mixture Model: Pixel filtration and the adaptive vector method are carried out according to the evolution of the background, and the improved algorithm is used to carry out the comparative test on achieving both ends of receiving surveillance video homology algorithm, the improved algorithm is obtained to enhance the anti-jamming capability of the algorithm or improve the speed of the formation and switch of the background, which is used in dealing with the video processing as the basic algorithm; Xu Dongbin, Liu Changping and Huang Lei in the Automatization Institute of Chinese Academy write the paper Adaptive Background Model Based on Probability and Statistics motion moving Target Detection Method puts forward a kind of the moving object detection methods of adaptive background model based on the probability statistics. The method can be adapted to choose the background and the prospects for threshold and carry out the self-adaptation choices in the different scenes without carrying out the training. On this basis, according to the blind update and the deficiency of choosing the update, the background update module is combined with the the pixel clustering statistics and probability. The tests show that the method can get reliable background and improve the motion detection effect; Pi Wenkai, Liu Hong and Zha Hongbin in the Visual and Auditory Information Processing state key laboratory, in the Graduate School of Computer Science of Peiking University write the paper adaptive background model based human motion detection Omni directional vision, which designs a kind of comprehensive vision technology to carry out the real-time motion detection for several human objects indoor. The system uses the Omni-directional camera as the image capture equipment to obtain the horizontal 360^{O} environmental information in the picture. The experiment show that: the system can achieve better real-time and detection results in the complicated background indoor environments. In the paper, the background subtraction algorithm which carried on the Taekwondo image data is studied on the base of the former studies; the single Gaussian background model, hybrid Gaussian background model and the principal component analysis modeling method and the advantages and disadvantages of three algorithms are reviewed to expect the technology to push the higher realm of the transmission of the Taekwondo.

THE MOTION DETECT ALGORITHMS BASED ON THE BACKGROUND SUBTRACTION

Single Gaussian background model

The single Gaussian background model is applicable to single-mode model, that is, the changes of the background is not large and the trends of the changes is relatively simple. The gray value of the background pixel possesses the statistical characters on time. The Figure 1 shows the curves of gray values of the background

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pixel value in time and the distribution of the value.

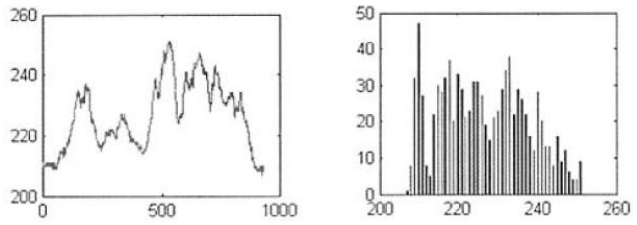

Figure1 : Background pixel gray value curve and the gray value distribution diagram

In the Figure 1, the left diagram shows the background pixel gray value curve and the right diagram shows the distribution of each gray value curve.

The single Gaussian background model uses the Gaussian distribution function to describe the statistical properties and uses the variances and mean value to represent the mathematical model, just shows in Figure 1.

$$I(x,y) \sim N\left(u(x,y), \sum(x,y)\right) \quad (1)$$

$\sum I(x,y)$ in the formula 1 expresses the gray value of the pixel coordinates, $u(x,y)$ represents the, mean value of the Gaussian distribution, and $\sum_{I(x,y)}$ represents variances of the Gaussian distribution. Generally speaking, the discriminate method of the background or the foreground of the new frame pixels is based on the distance of the gray value and the mean value, which is shown in Figure 2.

$$|I(x,y) - u(x,y)| > 2\sqrt{\sum(x,y,t-1)} \quad (2)$$

When meeting the demands of the formula 2,the pixel is determined as the background, otherwise, the pixel is the foreground. After the determination, the Gaussian background model is needed to update and adopts the formula 3.

$$\begin{cases} u(x,y,t) = (1-a)\cdot u(x,y,t-1) + aI(x,y,t) \\ \sum(x,y,t) = (1-a)\cdot\sum(x,y,t-1) + a\cdot d(x,y,t)\cdot d^T(x,y,t) \end{cases} \quad (3)$$

$d(x,y,t)$ in the formula 3 to express the gray scale differences $d(x,y,t)=I(x,y,t)-u(x,y,t-1)$, $a(0\le a\le 1)$ expresses the update coefficient,which reflects the update speed in the model.

If the x point is detected as the foreground, the original probability distribution in the background model should be retained, and the value of a is small and is often zero; if the point is detected as the background, then the value of a is larger, and the probability distribution of the background model can keep with the actual changes.

Hybrid Gaussian background model

Mixture Gaussian background model is applicable to the background model which presents a dual-modal and multi-model, and its color component presents the obvious distribution characteristics. The Figure 2 shows that the gray value changes of the pixel and the corresponding histogram, and we can see the gray values change interval [30,240] is comparatively large. If we use the single Gaussian model, the we can not describe the gray value distribution of the background pixel completely.

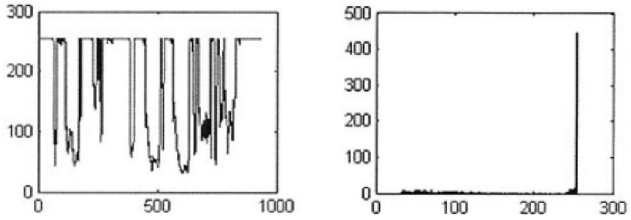

Figure 2 : Gray value changes and histogram distribution

In the Figure 2, the left diagram is the gray value changing curve with the time, and the right diagram is the histogram distribution of the pixel.

Hybrid Gaussian background model uses K Gaussian Model to describe the distribution of each pixel, the formula 4 expresses:

$$P(x,y) = \sum_K w_{i,j}\cdot\eta\left(x_{i,j}, y_{i,j}, u_{i,j}, \sum_{i,j}\right) \quad (4)$$

In the formula (4), $u_{i,j}, \sum_{i,j}$ expresses the ith mean vector of Gaussian distribution and covariance matrix. Generally speaking, EM algorithm and the K means clustering algorithm estimates the parameters, and each model has the weighting parameters $w_{i,j}$ and the priority parameter $p_{i,j}$. The weighting parameters and the priority parameter expresses the priority sequence of the model, the relation is just as the formula 5,

$$p(x,y,t,i) = \frac{w(x,y,t,i)}{\det\left(\sqrt{\sum(x,y,t,i)}\right)} \quad (5)$$

The K model does not expresses the distribution of the background pixel, but may express the distribution of the foreground. According to priority, the K model can be sequenced from large to small. The former b_i model can be regarded as the distribution of the background pixel, the rest is the distribution of the background pixel, the standard of the sequencing is shown

in the formula 6.

$$b(x,y,t)=\arg\min_{j}\left(\sum_{i=1}^{j}w(x,y,t,i)>B\right) \quad (6)$$

B in the formula 6 expresses an empirical threshold value, and the new color value is matched with the chosen b_i distribution. Usually the matching mechanism satisfy the formula 7,

$$|I(x,y,t)-u_i(x,y,t-1)|<2\cdot\delta(x,y,t-1) \quad (7)$$

In the adaptive update of the hybrid Gaussian model, the parameters of the Gaussian distribution needs to be updated and the distribution value also need to be updated. If any distribution is not matched in the detection, the smallest weight distribution should be puts forward according to the new gray value introducing the new distribution and its relative variance is relative large. Then the weights of the other Gaussian distribution carries out the normalization processing and the matched background model is updated according to the formula 8.

$$\begin{cases}u(x,y,t,i)=(1-\alpha)\cdot u(x,y,t-1,i)+\alpha I(x,y,t)\\ \sum(x,y,t,i)=(1-\alpha)\cdot\sum(x,y,t-1,i)+\alpha\cdot d(x,y,t,i)\cdot d^T(x,y,t,i)\end{cases} \quad (8)$$

In the formula 8, α expresses the information administration, the weight is updated according to the formula 9,

$$w(x,y,t,i)=\begin{cases}(1-\beta)\cdot w(x,y,t-1,i)+\beta & i=matched\\ (1-\beta)\cdot w(x,y,t-1,i) & otherwise\end{cases} \quad (9)$$

$\beta(0<\beta<1)$ in the formula 8 expresses the update coefficients.

Principal component analysis model

The moving objects make little contribution to the statistical properties of the background, the statistical properties of the background is used to establish the background model. If the image region is regarded as the random vector, $K-L$ transform is applied to obtain the orthogonally $K-L$ base, the according basement of the bigger Eigen value represents the characteristics of static background, that is the principal component analysis. In the real operation, the principal component analysis obtains the background characteristics.

Assume the background have N frame, the dimension of each image of frame is $m\times n$, thus the vector of $mn\times 1$ can be used to express, background value can be expressed by formula 10,

$$\varphi=\frac{1}{N}\sum_{i=1}^{N}L_i \quad (10)$$

Then the background of the pixel and the average background can be represented by the formula 11:

$$\delta_i=L_i-\varphi \quad (11)$$

Let the matrix $A=\{\delta_1,\delta_2,...,\delta_N\}$, and the matrix is known as the $mn\times N$ matrix, then the background features is to identify the previous zth eigenvector of the greater vectors AA^T, is shown in the formula 12:

$$AA^Tu_i=\lambda_iu_i \quad (i=1,2,...,N) \quad (12)$$

The vector and the eigenvector of the A^TA satisfy the formula 13,

$$\begin{cases}A^TAu_i'=\lambda_iu_i'\\ u_i=Au_i\lambda_i^{-0.5}\end{cases} \quad (13)$$

u_i and u_i' in the formula 13 represents respectively eigenvector of AA^T and A^TA. The λ_i represents the characteristic value of AA^T, and the eigenvector u_i is the background feature, and u_i can be formed to projection matrix to deal with the dimension reduction process, the formula 14 is obtained,

$$W=(u_1,u_2,...,u_Z) \quad (14)$$

The detection process of the principal component analysis is to abstract the feature background, reconstruction of the frame and the difference between linearization reconstruction background and the new frame, then the moving regions is obtained and the steps are as follows:

Step 1: Assume the new image of frame is L', then the according the feature background is shown as the formula 15,

$$q'=W^T(L'-\varphi) \quad (15)$$

Step 2: Reconstructing the frame to obtain L'', the new frame is shown as formula 16,

$$L''=Wq'+\varphi \quad (16)$$

Step 3: Calculating the difference T between the reconstructing frame and the original frame, the difference calculation is shown in the formula 17,and the Matlab software is used to generate absolute difference value Figure 3,

$$T=\|L'-L''\| \quad (17)$$

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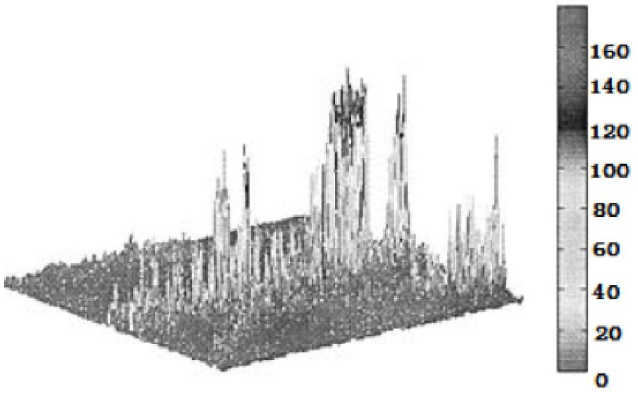

Figure 3 : The absolute difference value

Step 4: the threshold value is chosen, the foreground and background are obtained by linearization.

ANALYZING THE ADVANTAGES AND DISADVANTAGES OF THREE MODELS

As for single mode background image, the singe Gaussian model performs very well, possessing the advantage of simplexes and speediness, but is sensitive to local disturbance and noise;

In the case of portraying the multimode accurately, the hybrid Gaussian model possesses the stronger robustness, but its parameter estimation needs to use the $_{EM}$ algorithm or $_{K}$ averaging method, and its computational process takes a lot of time, at the same time it is comparative small as for the simple Gaussian model.

Based on the modeling method of principal component analysis, eigenvector can be abstracted by the $K-L$ transform in the rare number of samples. The method possess the simplexes and the effectiveness in the real application, but the modeling method is more sensitive to the changes of light and the threshold is difficult to determine

CONCLUSIONS

The single Gaussian model is applicable to the single-mode background image, and the single-mode Gaussian model possesses the advantage of the fast speed and convenience, but as for the model, the choice of the threshold is single and it is not adapt to the noise and the intensive disturbance environment.

The hybrid Gaussian model makes up the disadvantage of the single Gaussian model, at the same time, the variable weights are added to the update background to make the hybrid Gaussian model is superior to the single Gaussian model in the aspects of robustness. But because of estimation of its parameters generating more distribution, it is prone to generate the unnecessary calculation.

The modelling method of the principal component analysis is adaptable to the background of the smaller samples and the eigenvector is abstracted by the $K-L$ changes. In the practical application, it possess the advantages of the fast speed and implementation convenience, and the modeling method is more sensitive to the changes of the light and the threshold value is more difficult to determine.

Synthesizing the three modeling algorithm can be known, as for the Taekwondo video is captured in the indo or environment and is not reliable for the background. The image background models in the video of single performance and teaching routine use the single Gaussian model and the principal component analysis modeling method. As for the video image background model of the double sparring performances with the audience and the judges, the hybrid Gaussian model is applicable.

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