

## Research Article

# Design of Automatic Motion Capture Algorithm for Yao's Long Drum Dance Based on Multieye Machine Vision

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Received 9 December 2021; Revised 30 December 2021; Accepted 15 January 2022; Published 27 March 2022

Academic Editor: Baiyuan Ding

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Aiming at the problems of low accuracy and long time consumption in the existing dance motion automatic capture methods, this study designs an automatic capture algorithm of Yao's long drum dance based on multieye machine vision. The images of Yao's long drum dance are collected by the multieye machine vision measurement system, and the image signals under different lighting conditions are processed; on this basis, by determining the dance action image threshold and analyzing the change law of action image signal, the dance action image extraction of Yao's long drum is completed. By converting the dance action images from different angles, the Euler angle of the images from different angles is determined and fused. On this basis, the observation items of the observation part of the Yao long drum dance action image are set, and the a priori conditions and a posteriori probability of the Yao long drum dance action image preprocessing are determined, so as to obtain the best result of the dance action image, and dance action image preprocessing is completed. According to the preprocessed image, the capture algorithm of area range is designed, the remaining areas to be captured are determined by means of classification, and the automatic capture algorithm design of Yao's long drum dance is completed. The experimental results show that the motion image captured by the automatic motion capture algorithm of Yao's long drum dance based on multieye machine vision has high accuracy, and the capture time is long, which is feasible.

## 1. Introduction

Yao's long drum dance is an important cultural inheritance in China. Its dance movements reflect the integrity and historical flavor of the Chinese nation. Therefore, it is very important to inherit and innovate this dance [1]. This dance movement has its special national flavor. Its movement is quite different from the general dance movement, and its movement details and difficulty are relatively large [2]. In the training of this dance, the effective identification and capture of its movement will contribute to the rapid improvement in its dance training [3]. Therefore, relevant researchers have done a lot of research on the automatic capture of dance movements and achieved some results.

Reference [4] proposed a human motion image recognition method under high-intensity motion. This method is applied to the action capture of Yao's long drum dance. In the research of this method, the threshold of the action

image is calculated by double convolution, and the action characteristics are determined through the calculation of the value. On this basis, the key targets of the action are determined combined with the Gaussian distribution, the background of the image is processed, and the recognition model is constructed by the Bayesian classification algorithm to complete the recognition of the action. This method can track the action well, but the analysis accuracy of the changes in the process of action transformation is poor, which needs to be further improved. Reference [5] proposed a research on aerobic decomposition action image recognition based on feature extraction. In this method, the image is divided into multiple segments through the pyramid, and the noisy image is effectively preprocessed, and the action is analyzed at different heights. Different optical flows in the image are solved by Laplace, and the similarity points in the image are effectively fused. Finally, the action is recognized according to the set threshold. In the research of this method, the

threshold calculation is more accurate, but the operation process is more complex and has some limitations, which need further improvement. In reference [6], a motion recognition method based on global spatiotemporal feature convolution neural network is proposed. The multiframe fusion method is used to improve the accuracy and deeply learn the moving image in the global time stream. Finally, the two streams are combined to identify human motion. However, this method is only suitable for small sample data, resulting in insufficient practical application performance of this method.

To solve some shortcomings of the existing methods, this study designs an automatic capture algorithm of Yao's long drum dance based on multieye machine vision to improve the automatic capture of the dance project. Machine vision refers to the use of machines instead of manual visual inspection to make measurement and judgment. Multicamera machine vision system refers to collecting images through multiple machine vision products and then transmitting the images to the processing unit. Through digital processing, it can judge the size, shape, and color according to the pixel distribution, brightness, color, and other information. Then, the on-site equipment action is controlled according to the discrimination result. With the development of computer technology and fieldbus technology, machine vision technology is becoming more and more mature. It has become an indispensable product in modern processing and manufacturing industry.

The images of Yao's long drum dance are collected by the multieye machine vision measurement system, and the image signals under different lighting conditions are processed; on this basis, by determining the dance action image threshold and analyzing the change law of action image signal, the dance action image extraction of Yao's long drum is completed. By converting the dance action images from different angles, the Euler angle of the images from different angles is determined and fused. On this basis, the observation items of the observation part of the Yao long drum dance action image are set, and the a priori conditions and a posteriori probability of the Yao long drum dance action image preprocessing are determined, to obtain the best result of the dance action image, and dance action image preprocessing is completed. According to the preprocessed image, the capture algorithm of area range is designed, and the remaining areas to be captured are determined by means of classification, and the automatic capture algorithm design of Yao's long drum dance is completed. The main technical route of this study is as follows:

- (1) The images of Yao's long drum dance are collected by the multieye machine vision measurement system, and the image signals under different lighting conditions are processed;
- (2) On this basis, by determining the dance action image threshold and analyzing the change law of action image signal, the dance action image extraction of Yao's long drum is completed. By converting the dance action images from different angles, the Euler angle of the images from different angles is

determined and fused. On this basis, the observation items of the observation part of the Yao long drum dance action image are set, and the a priori conditions and a posteriori probability of the Yao long drum dance action image preprocessing are determined, to obtain the best result of the dance action image, and dance action image preprocessing is completed.

- (3) According to the preprocessed image, the capture algorithm of area range is designed, and the remaining areas to be captured are determined by means of classification, and the automatic capture algorithm design of Yao's long drum dance is completed.
- (4) Experimental analysis is given.
- (5) Conclusion is presented finally.

## 2. Yao's Long Drum Dance Action Image Extraction and Preprocessing

*2.1. Motion Image Extraction of Yao's Long Drum Dance Based on Multieye Machine Vision.* To improve the effectiveness of the Yao long drum dance action automatic capture algorithm, it is necessary to extract the Yao long drum dance action image. To extract the Yao long drum dance action in more detail, this study first extracts the Yao long drum dance action with the help of multieye machine vision. The pipeline measurement method based on multivision uses the camera to capture the two-dimensional gray images of Yao's long drum dance at different angles [7], obtains the pipeline centerline through feature extraction, feature fitting, and other technologies, and reconstructs the three-dimensional space points of the centerline using the stereovision reconstruction method, to realize the reconstruction of Yao's long drum dance. When the measurement system is calibrated well, the processing result of Yao's long drum dance image is an important factor affecting Yao's long drum dance, and obtaining high-quality Yao's long drum dance image is a powerful guarantee for the successful processing of pipeline image [8].

This study analyzes the lighting mode adopted by the multivision system for the extraction of Yao's long drum dance. On this basis, Yao's long drum dance image is preprocessed to eliminate the influence of optical fiber on Yao's long drum dance, to improve the quality of Yao's long drum dance image to be processed [9].

In machine vision measurement system, the light source is an important part. The light source projects the light onto the surface of the measured object in an appropriate way and highlights the contrast of the features to be measured and is captured by the camera, to realize the extraction of the features to be measured. The selection of light source lighting mode has a great impact on the measurement system. A good lighting mode can improve the resolution of the whole measurement system and highlight the characteristics of the object to be measured, to reduce the pressure of subsequent image processing. If the lighting mode is improperly selected, it will have a certain adverse impact on the

subsequent processing of the measurement system. Therefore, it is necessary to select different lighting methods for different measurement objects [10].

In the Yao long drum dance action image extraction, the multivision light source and the camera are located on the same side of the dancer to be tested. The camera distinguishes the features to be tested and irrelevant features by receiving the reflected light of the Yao long drum dance action [11], as shown in Figure 1.

In the action image of Yao's long drum dance collected by the multi-eye machine vision system, the detailed information of the action is obtained through the reflection of the light source [12]. The action image obtained by the multi-camera machine vision centralized camera is carried out through the Lambert body reflection model. The light intensity in the action image can be expressed as follows:

$$G(I) = a_I \times S, \quad (1)$$

where  $a_I$  represents the action attribute vector of point  $I$  and  $S$  represents the parameter value of the multiocular machine visual illumination attribute.

When the gray level of the collected Yao long drum dance action image changes to a certain extent, the gray level of the Yao long drum dance action image in the Lambert body reflection model [13] is expressed as follows:

$$E(I) = \text{MAX}(a_I \times S, O). \quad (2)$$

Among them,  $O$  represents the grayscale value of the Yao long drum dance action images.

According to the determined gray level of Yao's long drum dance action image, the signal in Yao's long drum dance action image fluctuates greatly from a natural action of Yao's long drum dance action to the contraction state [14]. In this study, the signal in the stable Yao's long drum dance action image is used as Yao's long drum dance action image data collected in this study [15].

In the signal in the Yao long drum dance action image, the maximum value of the image signal is set as  $\text{MAX}_t\{x_i\}$  and the average value is  $x$ , and the key threshold [3] of the acquired image can be obtained as follows:

$$H = \begin{cases} \frac{3}{v} \sum_{i=1}^L |x_i| \text{MAX}_t\{x_i\} > \frac{3}{v} \\ \text{MAX}_t\{x_i\}/3, \text{ other.} \end{cases} \quad (3)$$

Among them,  $v$  represents the discrete Yao long drum dance action image signal,  $t$  represents the length of the Yao long drum dance action image signal, and  $\{x_i\}$  represents the range of values.

The Yao long drum dance action image signal is obtained. In the process from the signal in the intermediate state to stability, the real Yao long drum dance action image signal value [16] is as follows:

$$D(a, b) = u \frac{1}{k} \sum_{i=1}^t \left[ \frac{1}{n} \sum H \right]^2. \quad (4)$$

Among them,  $D(a, b)$  represents the signal of the dance action at the actual moment,  $u$  represents the number of

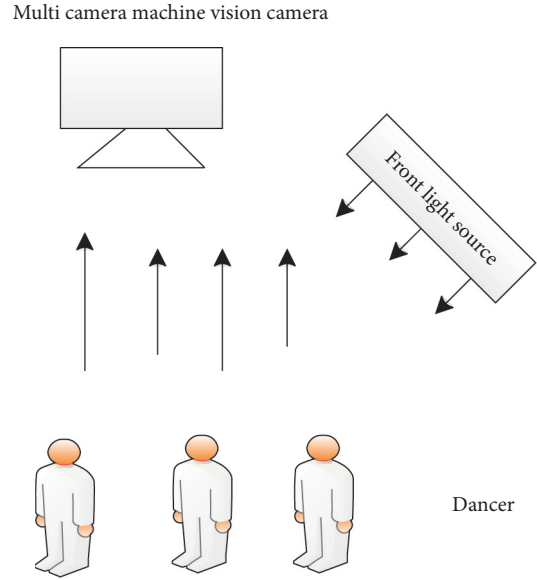


FIGURE 1: Schematic diagram of front light source of multicamera machine vision and camera on the same side of the dancer to be tested.

channels sampled, and  $k$  represents the wavelength of the signal.

The initial to final changes in Yao's long drum dance action image signal are shown in Figure 2.

In the Yao long drum dance movement image extraction, the Yao long drum dance movement image is collected by the multi-eye machine vision measurement system, and the image signals under different lighting conditions are processed; on this basis, by determining the dance action image threshold and analyzing the change law of action image signal, the dance action image extraction of Yao's long drum is completed.

**2.2. Image Preprocessing of Yao's Long Drum Dance.** On the basis of the above collected Yao long drum dance action image extraction, due to the change and variability of action angle in the Yao long drum dance action image, there is a certain noise in the Yao long drum dance action image. Therefore, this study carries out multiangle preprocessing in the image preprocessing of Yao's long drum dance [17]. For any reference system of Yao's long drum dance action image, its orientation is determined by the rotation order of three Euler angles relative to the reference system. First, the coordinate system of the Yao long drum dance action image is rotated around the  $z$ -axis by  $20^\circ$ , then rotated around the  $y$ -axis by  $30^\circ$ , and finally rotated around the  $x$ -axis by  $40^\circ$ , and finally, the state is obtained after the coordinate system is combined with the original reference system, as shown in Figure 3.

In the image preprocessing of Yao's long drum dance, the whole process is regarded as the rotation of a bone joint in the movement process; that is, the rotation process in Yao's long drum dance is decomposed into three angles.

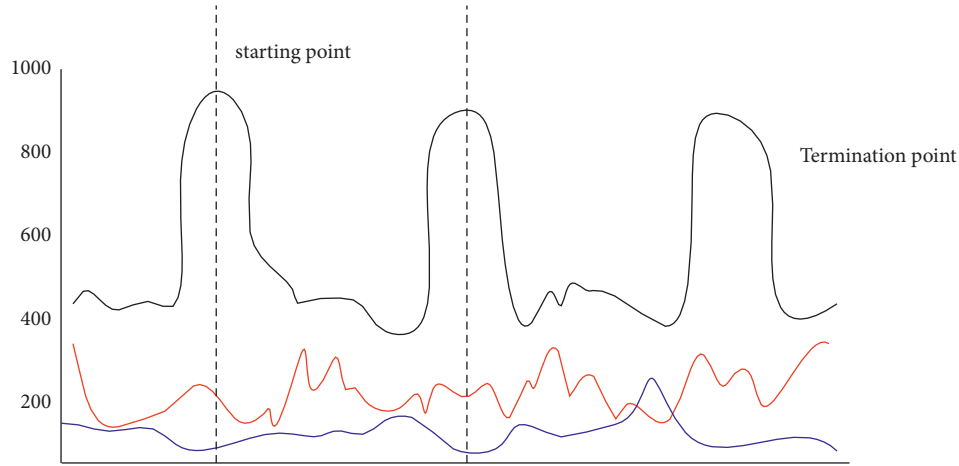


FIGURE 2: Change characteristics of Yao's long drum dance action image signal.

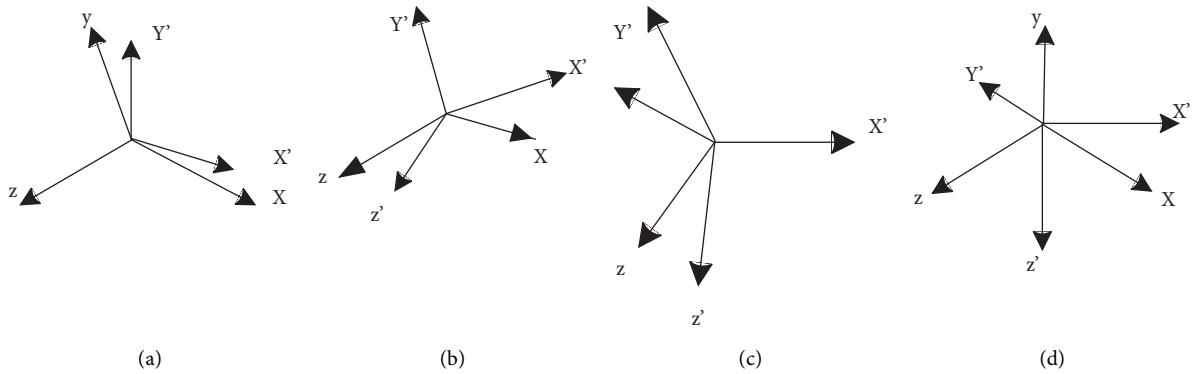


FIGURE 3: Rotation diagram of Yao's long drum dance action image in different states.

In different coordinate systems of Yao's long drum dance action images, the Euler angle is the key to measure its action amplitude. This angle represents the rotation degree of three coordinate axes. In this dance action, one rotation is transformed into the rotation angle of different coordinates [18].

To represent the angle of the Yao long drum dance movement image, the angle  $q(\theta)$  is set after the rotation around the  $z$ -axis,  $y(\alpha)$  represents the angle after the  $Y$  movement, and  $x(\beta)$  represents the rotation after the horizontal axis. At this time, the Euler angle of the Yao long drum dance action images is expressed as follows:

$$\begin{aligned}
 q(\theta) &= \begin{bmatrix} \cos \theta \sin \theta, 0 \\ -\sin \theta \cos \theta, 0 \\ 0, 0, 1 \end{bmatrix}, \\
 y(\alpha) &= \begin{bmatrix} 10, 0 \\ 0, \cos \alpha \sin \alpha, 0 \\ 0, -\sin \alpha, \cos \alpha \end{bmatrix}, \\
 x(\beta) &= \begin{bmatrix} \cos \beta \sin \beta, 0 \\ -\sin \beta \cos \beta, 0 \\ 0, 0, 1 \end{bmatrix}.
 \end{aligned} \quad (5)$$

After determining the above different angles, basically the angle after rotating the Yao long drum dance action image is rotated. At this time, the obtained angle is as follows:

$$P = \begin{bmatrix} \cos \theta \sin \theta, 0 \\ -\sin \theta \cos \theta, 0 \\ 0, 0, 1 \end{bmatrix} \begin{bmatrix} 10, 0 \\ 0, \cos \alpha \sin \alpha, 0 \\ 0, -\sin \alpha, \cos \alpha \end{bmatrix} \begin{bmatrix} \cos \beta \sin \beta, 0 \\ -\sin \beta \cos \beta, 0 \\ 0, 0, 1 \end{bmatrix}. \quad (6)$$

According to the motion data of the Yao long drum dance action image, it can be described by a rotation matrix, which effectively avoids the different final orientations of the joints due to different rotation sequences. Although the Euler angle can accurately describe the movement image of Yao's long drum dance, a large number of matrix operations will be involved in the process of the Euler angle processing, which will undoubtedly consume system space and time. At the same time, objects rotating around three angles in three-dimensional space will lose the autonomy of any axis due to rotation [19]. Therefore, to reduce the complexity of image preprocessing of Yao's long drum dance, further preprocessing is required.

According to the change in the rotation angle of the Yao long drum dance action image, the three-dimensional action

of the rotated action image is set in a known space, and a synchronous observation image of the Yao long drum dance action image is obtained. At this time, the observation item [6] of the observation part of the corresponding Yao long drum dance action image is expressed as follows:

$$\phi(A, B) = \aleph \prod_{i=1}^n \phi(F_k, v_k). \quad (7)$$

Among them,  $\phi(A, B)$  represents the observation site of the action image of Yao's long drum dance,  $(F_k, v_k)$  represents the action decomposition value, and  $\aleph$  represents the key noise value [7].

Setting table: the independence of Yao's long drum dance action images exists:

$$\varepsilon(A, B) = \tau \prod_{k=1}^M \varepsilon(A, B) \sigma. \quad (8)$$

Among them,  $\tau$  represents the observation input value of Yao's long drum dance action under different visual angles, and  $\sigma$  represents the projection value of Yao's long drum dance action node position under machine vision.

Considering the a priori constraint of Yao's long drum dance action image [20], this is also the key to image preprocessing. Therefore, in the Yao long drum dance action image, the action image reflects the length of the action in the image through a graph structure model. At this time, the set constraint conditions [21] are as follows:

$$\rho = \gamma \prod_{(V_j, V_l)}^M \varepsilon(A, B) \mu. \quad (9)$$

Among them,  $\gamma$  is the relationship function representing the Yao long drum dance action image, and  $\mu$  represents the length of the image action.

According to the determined a priori conditions for the image preprocessing of Yao's long drum dance action, the posture of dance action in the image will be analyzed by a posteriori probability from different perspectives [22], and the following results are obtained:

$$H(g) = \prod_{V_j, V_l}^n \rho \prod_q p(\vartheta|c_i), \quad (10)$$

Among these,  $H(g)$  represents the postural posterior probability of the dance action, and  $c_i$  represents the conversion rate of the action at different angles.

Finally, the best result obtained from the preprocessed dance action image is as follows:

$$S^* = \text{Targmax} p \prod_{i=1}^n \prod B(\vartheta|c_i). \quad (11)$$

Among them,  $T$  is the lowest equivalence problem representing the dance action image, and  $B(\vartheta|c_i)$  represents the preprocessed dance action image.

In the dance action image preprocessing, it is preferred to convert the dance action images at different angles, determine the Euler angle of the images at different angles, and

fuse them. On this basis, the observation items of the observation position of the Yao long drum dance action image are set, and the a priori condition and a posteriori probability of the Yao long drum dance action image preprocessing are determined, the best result obtained from the dance action image [23] is acquired, and the dance action image preprocessing is completed.

*2.3. Design of Automatic Capture Algorithm for Yao's Long Drum Dance.* Based on the above preprocessed Yao long drum dance action images, an automatic capture algorithm is designed to realize the automatic capture of Yao's long drum dance action and provide help to improve the accuracy of Yao's long drum dance action [24].

The area of Yao's long drum dance action image is large, and there is a certain gap. In the design of automatic capture algorithm in this study, firstly, the local action is effectively captured, and on this basis, the global over diffusion research is carried out. In this study, the local region capture method of window is studied. The basic process of local area capture of Yao long drum dance action image is as follows:

*Step 1.* Determining the cost function setting of the local area of the Yao long drum dance action image and determining its change law.

*Step 2.* Matching the aggregate value of the cost in the window according to the determined cost function [25].

*Step 3.* Finding the optimal value of the local area of the Yao long drum dance action image [26].

*Step 4.* Performing correction calculation in the local area of the dance action image of the Yao long drum.

It is determined that the image on one side of the regional range of the Yao long drum dance action image is the control object, and the image on the other side is regarded as the key value in the region. The cost function in the regional range of the Yao long drum dance action image obtained after the search is as follows:

$$\text{COST}_i = [R_i(d_i, d_j)] + [R_j(d_i, d_j)]^2. \quad (12)$$

Among them,  $R_i$  represents the pixels to be matched within the regional range of the Yao long drum dance action images, and  $R_j$  represents the parallax values.

$W_i$  is set to change the central point within the area range, the image range window is built, and the cost is effectively unified, and we get the following:

$$W_i = \frac{1}{k \times j} \left\{ \sum_{j=1}^n [R_i(d_i, d_j)] + [R_j(d_i, d_j)]^2 \right\}. \quad (13)$$

According to the above determined image area range, the value of the point of the unified parallax value is determined, that is, the capture of the action within the area range of the Yao long drum dance action image, and the following is obtained:

$$d_i = \operatorname{argmin} \left\{ y [R_j(d_i, d_j)]^2, (d_i, d_j), m \right\}. \quad (14)$$

Among them,  $y$  represents the capture results of the movements within the regional range of the Yao long drum dance action images, and  $m$  indicates the range.

After the movement within the region of the above Yao long drum dance movement image is automatically captured, the overall Yao long drum dance movement needs to be automatically captured [22, 27–29]. The remaining areas that cannot be captured directly and automatically are marked, the areas where different actions are located are determined, and then the overall action capture research is realized. The schematic diagram of remaining range division is shown in Figure 4.

Firstly, the remaining areas of the automatic capture of Yao's long drum dance action are labeled, and the area where the action is located is determined. The following results are obtained:

$$U_i = \{x | \exists_{ij} > 0, i = 1, 2, 3 \dots j \neq i\}. \quad (15)$$

Among them,  $\exists_{ij}$  represents different labels.

Assuming that the Yao long drum dance action points belong  $E_i$ , it is classified and [19, 30, 31] is divided into the area with the largest number by voting:

$$E_i(x) = i = 1 \sum_{i=1}^n \operatorname{sig}(E_i(x)). \quad (16)$$

On this basis, the track points of Yao's long drum dance in the remaining area are captured.

The running track of its action to  $L$  is set, and the track point is as follows:  $o_1, o_2, \dots, o_L$ , and the capture motion feature point in the remaining area is as follows:

$$S(D) = \sum_{i=1}^1 \sqrt[2]{s_{i+1}^2 - s^2}. \quad (17)$$

The captured motion feature points are in the remaining regions of the generated table, and  $s$  represents the midline pixels.

The overall flow of the design of the Yao long drum dance motion automatic capture algorithm is shown in Figure 5.

### 3. Experimental Verification

To verify the practical application effect of the proposed automatic capture method of Yao's long drum dance based on multieye machine vision, a comparative verification experiment is carried out.

**3.1. Experimental Preparation.** To verify the effectiveness of the capture method in this study, the MySQL database is taken as the research object in the experiment, and the Yao long drum dance action images are selected as the research object. A total of 100 sample images are selected to train the image training set, and the most typical images are selected for research and analysis. The size of the image is  $256 * 256$ ,

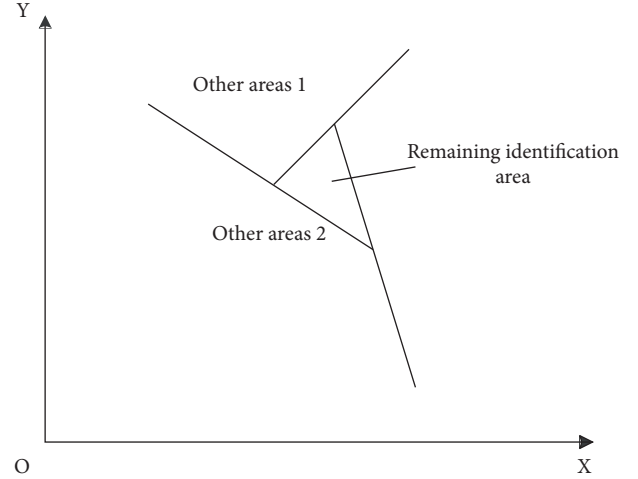


FIGURE 4: Schematic diagram of remaining range division.

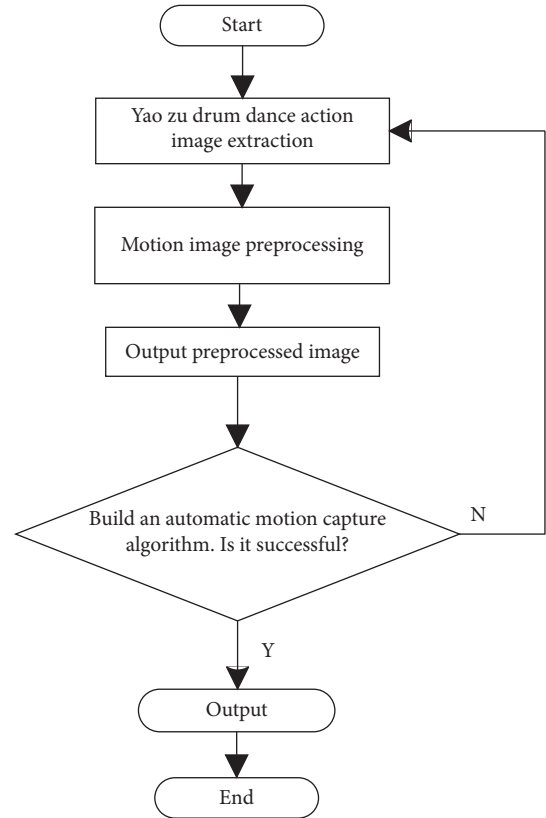


FIGURE 5: Overall flow chart of Yao's long drum dance motion automatic capture algorithm design.

and the pixels are large. The sample image is shown in Figure 6.

The experimental environment parameters are shown in Table 1.

**3.2. Experimental Index.** In the experiment, the accuracy and time consumption of sample image action capture are taken as the experimental indicators. The higher the





FIGURE 6: Experimental sample image.

TABLE 1: Experimental environment parameters.

Name	Parameter
Computer system	Windows 10
Development tools	C++
Processor	Intel (R)Core(TM)i7-4710HQ CPU @ 2.50 GHz
Memory size	8 GB
Simulation software	MATLAB 7.2



FIGURE 7: Analysis of sample image action recognition effect of different methods.

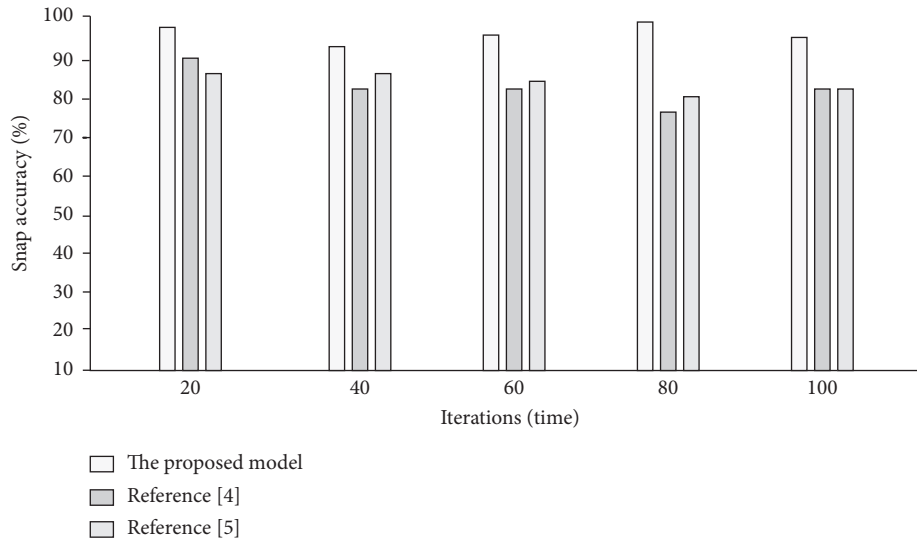


FIGURE 8: Analysis of accuracy results of sample image action recognition by different methods.

TABLE 2: Time consumption analysis of Yao's long drum dance movement image capture by different methods.

Capture times	The method of this study	Reference [4] method	Reference [5] method
20	1.2	2.3	2.4
40	1.3	2.5	2.6
60	1.2	2.8	2.8
80	1.3	3.0	3.1
100	1.2	3.2	3.3

accuracy of sample image action capture in the experiment, the better the effectiveness of the representative method.

**3.3. Analysis of Experimental Results.** In the experiment, the accuracy of sample image action recognition by this method, reference [4] method, and reference [5] method is compared. The recognition effect is shown in Figure 7.

By analyzing the experimental results in Figure 7, it can be seen that there are some differences in the effect of sample image action recognition using the methods in this study, literature [4], and literature [5]. Among them, the action identified by this method is consistent with the ideal value. There are some deficiencies in the identification of reference [4] method and reference [5], which is better than that of this method. The reason for the above experimental results is that this method determines the Euler angle of the images from different angles by converting the dance action images from different angles and fuses them. On this basis, it sets the observation items of the observation part of the Yao long drum dance action image and determines the a priori condition and a posteriori probability of the Yao long drum dance action image preprocessing, the best result of dance action image is obtained, and the action recognition effect of your method in this study is better.

The accuracy results of sample image motion recognition by this method, reference [4] method, and reference [5] method are shown in Figure 8.

By analyzing the experimental results in Figure 8, it can be seen that there are some differences in the motion recognition accuracy of sample images using the methods in this study, reference [4], and reference [5]. Among them, the recognition accuracy of this method is higher and always higher than 90%, while the capture accuracy of the other two methods is lower. This is because this method collects the Yao long drum dance action image through the multi-eye machine vision measurement system and processes the image signal under different illumination conditions; on this basis, by determining the dance action image threshold and analyzing the change law of action image signal, the Yao long drum dance action image extraction is completed, and then, the research accuracy is improved.

While ensuring the accuracy of sample image motion capture, the time consumption of sample image motion recognition is experimentally analyzed. The results are shown in Table 2.

By analyzing the experimental results, it can be seen that the three methods have different results in recognition time. With the continuous change in iteration times, the maximum time consumption of this method is about 1.3s, while the time consumption of the other two methods is always higher than that of this method. This is because this study designs the area range capture algorithm according to the preprocessed image, determines the remaining areas to be captured with the help of classification, completes the design of the automatic capture algorithm of Yao's long drum dance, and increases capture speed.



## 4. Conclusion

To improve the accuracy of dance motion capture, an automatic capture algorithm of Yao's long drum dance motion based on multieye machine vision is designed in this study. The performance of the algorithm is verified from both theoretical and experimental aspects. This method has high motion recognition accuracy and short recognition time when automatically capturing the movements of Yao's long drum dance. In particular, compared with the method using double convolution to capture, the motion recognition accuracy of this method is significantly improved, which is always higher than 90%; compared with the capture method based on feature extraction, the capture time of this method is significantly reduced, and the longest time is 1.3s. Therefore, it fully shows that the proposed capture algorithm based on multieye machine vision can better meet the requirements of automatic dance motion capture.

## Data Availability

The raw data supporting the conclusions of this article will be made available by the author, without undue reservation.

## Conflicts of Interest

The author declares that there are no conflicts of interest regarding this work.

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