Research Article

Analysis and Improvement of Tennis Motion Recognition Algorithm Based on Human Body Sensor Network

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Received 9 July 2022; Revised 6 August 2022; Accepted 17 August 2022; Published 14 September 2022

Academic Editor: R. Mo

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With the development of digital image technology and human body sensor network, the error recognition model of tennis serving motion constructed by human beings based on this technology has also attracted more and more attention of the tennis lovers. Among the traditional methods, the tennis serve error recognition method mainly includes the tennis serve error recognition method based on feature resolution reconstruction, but it is difficult to realize the tennis serve error recognition. The traditional method of tennis serve action error recognition has poor feature recognition ability and detection and recognition ability. In this paper, a tennis serve error identification method based on human body sensor network (body area network) is proposed, and the simulation test analysis is carried out. The experimental results show that this method has superior performance in improving the ability of tennis serve error recognition. Relevant research can not only improve the accuracy of tennis movement error recognition, but also effectively promote the technical application and theoretical improvement of this technology in related fields.

1. Introduction

With the development of digital image technology, combined with image information processing and information recognition technology, a tennis serve action error recognition model is established. The image information fusion method is used to process the image information of tennis serve action, and a tennis serve action error feature analysis model is established [1, 2]. The tennis serve action error information is analyzed by combining the joint feature analysis and image edge contour detection methods. To improve the analysis ability of tennis movement characteristics, the research on relevant tennis serve movement error recognition methods has attracted great attention [3–6].

Relevant research needs to face the difficulties of technical diagnosis. The action of tennis is based on various motion systems, which is a mechanical system. Every human behavior has a basic mechanical structure. Finding out the key mechanical characteristics of each action is the key to evaluate the quality of the action. However, the motion system is composed of multiple human links. Whether it is to analyze the relatively simple gait or to optimize the complex tennis technology, it involves the movement and stability of multiple human links. The resulting large amount of biomechanical data needs to be comprehensively analyzed by experts from multiple disciplines. In view of the complexity of data processing, in the 1960s, foreign experts in the field of human body began to try to use computers to collect and process the biomechanical data of human gait, infer the data, and draw medical response suggestions for diseases in motion control, so as to assist the clinical doctors in surgery and treatment. At present, there have been several major breakthroughs in the construction of computer programs based on human body sensor networks, which are mainly divided into two different methods: expert system and neural network technology.

In recent years, with the change of technology, WBAN (wireless body area networks) has been widely concerned by academia and industry [7–9]. WBAN integrates many cutting-edge technologies such as wireless communication,
sensor data acquisition and processing, intelligent wearing and human health, which will bring great changes and impacts on human production and life in the future. It can be widely used in medical [10, 11], physical rehabilitation [12–14], military [15, 16], sports [17–19], and other fields. Especially in sports competition, WBAN is a network composed of sensor nodes with different functions that are reasonably distributed on sports facilities according to their respective needs and characteristics. The position of the sensor can be located on the body, on the body surface, or in the body. It can carry out real-time and dynamic monitoring of various motion characteristic parameters of the sphere, and expand various applications based on this, so as to better serve the competitive life of human sports and escort the cause of human health [20–22].

Tennis, as a very popular sport mode, has strong antagonism and interest, and requires high technical requirements. Therefore, it requires professional guidance and training. However, this part of the cost exceeds the affordability of some people, and it also requires special appointment time, resulting in the decline in the feasibility of citizens engaging in this sport [23]. In order to solve this problem, many sports software have emerged in the market. People can watch teaching videos with this software, which is popular with many athletes and amateurs. However, this software can only mechanically display human movement behavior, poor interactivity, and cannot correct tennis errors in time, resulting in a decline in learning effect. So far, some progress has been made in the field of error action recognition. For example, linshuiqiang et al. [24] proposed the pose sequence finite state method to improve the universality and efficiency of users’ recognition of natural behavior, so as to establish the limb node coordinate system. Taking the user as the starting point, when describing the number of limb nodes of users’ behavior, it is no longer the device space, but the user space. Experiments show that this method can be well extended and has strong applicability. It can meet the needs of somatosensory interactive applications, but the recognition accuracy is very low; Shixiangbin et al. [25] adopted K-means clustering algorithm in human motion video sequence clustering, so as to improve the practicability and accuracy of motion recognition and reduce the complexity of the computer in the calculation process. By extracting the key frames of human motion video sequence from the clustering data, they have two features: the position of joint points in the key frames and the skeleton angle between various parts of the human body. The SVM classifier [26–28] is used to classify the action sequences. The experimental results show that the recognition accuracy is not very high.

Related research needs to face the difficulty of technical diagnosis. Human action is based on the musculoskeletal system, which is a mechanical system. Every human action has a basic mechanical structure. Finding out the key mechanical characteristics of each movement is the key to evaluate the quality of the movement. However, the musculoskeletal system is composed of multiple human links. Whether analyzing the relatively simple gait or optimizing the complex tennis technology, it involves the movement and stability of multiple human links. The resulting large amount of biomechanical data needs to be comprehensively analyzed by experts from multiple disciplines. In view of the complexity of data processing, in the 1960s, foreign experts in the field of human body began to try to use computers to collect and process biomechanical data of human gait, infer the data, and come up with medical response suggestions for diseases in motion control, so as to assist clinical doctors in surgery and treatment [29]. At present, there have been several major breakthroughs in the construction of computer programs based on artificial intelligence methods, which are mainly divided into two different methods: expert system and neural network technology. It is worth noting that various sports activities, including tennis, have become popular since the twentieth century. Although they have brought many benefits to people’s physical and mental health, the injuries of the musculoskeletal system have also increased. This kind of injury is common not only among professional athletes, but also among the general public in their participation in sports leisure activities. Therefore, more and more attention has been paid to the movement quality of human movement. Among them, the more mature is the FMS movement screening system established by American physiotherapist gray cook [30]. At present, various intelligent products for physiological monitoring of professional athletes have been relatively mature, but artificial intelligence products for human movement quality monitoring have not appeared in China.

Based on the above research background, in view of the shortcomings of the above research, this paper combines the existing technology, fully analyzes the application prospect of the existing technology, applies the machine vision technology to the sports tennis wrong technical action recognition, and constructs the related wrong action recognition model, in order to improve the sports tennis wrong technical action recognition ability.

2. Image Acquisition and Feature Analysis of Tennis Serve

2.1. Image Acquisition of Tennis Serve. In order to realize the error recognition of tennis serve action based on image segmentation, it is necessary to first build the image acquisition model of tennis serve action. Combined with the feature analysis of tennis serve action video acquisition image, the output template feature matching model of tennis serve action image acquisition is established by using template matching and optimized feature detection methods, combined with image template feature matching and information fusion methods. Through the matching results of the action database, edge contour feature detection is carried out, and the joint image segmentation technology is used to match the position information and action information of the tennis serve action, so as to realize the error detection. The overall structure is shown in Figure 1.

According to the overall structure model shown in Figure 1, we can use the texture detection and fuzzy feature matching technology to detect the corners in the image acquisition process of tennis serve action. According to the
joint information feature point scanning method, we can realize the texture matching of the image of tennis serve action, and the image pixel distribution is as follows:

\[ m_i = \frac{1}{N} L(x, y, \sigma) \sum_{k=1}^{N} y_k I(x, y) \frac{s(n)m_i}{w}, \quad (1) \]

where: \( I(x, y) \) represents the image-related parameters of the tennis serve action, \( s(n) \) represents the image-related pixel value of the tennis serve action, and \( L(x, y, \sigma) \) represents the feature recognition coefficient of the image of the tennis serve action.

Calculate the map prediction result of the image of tennis serve, which is expressed as:

\[ L(k, i) = \exp\{G(x, y, \sigma)\varphi(k) \times \alpha \cdot D(i)\}, \quad (2) \]

where: \( G(x, y, \sigma) \) is the non-significant feature of the image, and \( \varphi(k) \) is the correlation factor. Using the correlation detection method, combined with the feature noise reduction technology of the tennis serve video capture image, the gray pixel value of the tennis serve video capture image is \( E(d(x, y)) \). Through template information matching and filter analysis, the tennis serve video feature analysis and corner information detection model are established, and the optimized collection results of the tennis serve video capture image are obtained.

2.2. Image Acquisition of Tennis Serve. Combined with the remote information recognition method, the feature detection model of tennis serve image is established. Combined with the scale transformation method, the feature collection of tennis serve image is carried out, and the sparsity fusion model of tennis serve image is obtained. Then, the fuzzy fusion control function of tennis serve video acquisition image is

\[ F_d = \sum_{p=1}^{n} E_p A^2 \left[ r_p(k) - y_p(k) \right], \quad (3) \]

where: \( A^2 \) represents the edge scale component of the tennis serve action image.

Using the edge scale feature segmentation method, the order mixed cumulant of the tennis serve action image is expressed as:

\[ G_{new} = h(j)h^3 (j + \tau)(T^2/\Delta^2), \quad (4) \]

where: \( h(j) \) is the feature set. The fourth-order cumulative mixed feature quantity of tennis serve action image is expressed as:

\[ H_1 = mf_{s} \sum_{k=1}^{n} (g_k - g_1), \quad (5) \]

where: \( f_s \) is the trend function and \( g_k \) is the directivity of image features. According to the contour information feature point acquisition results of the tennis serve video acquisition image, the boundary feature quantity of the tennis serve video acquisition image is reconstructed, which is expressed as follows:

![Diagram](image-url)
3. Recognition and Optimization of Tennis Serve Movement Error

3.1. Analysis on Error Characteristics of Tennis Serve

Combined with the scale transformation method, the multiscale feature segmentation of tennis serve video capture image is carried out [31], and the edge contour feature detection model of tennis serve video capture image is constructed. The average pixel set of tennis serve video capture image is obtained as follows:

$$\bar{x}_T = \frac{1}{T} \sum_{i=1}^{T} x_i \gamma K(a,b),$$  \hspace{1cm} (9)

where: $x_i = (x_{1i}, x_{2i}, \ldots, x_{Ti})$ is the error distribution template matching set of the tennis serve video capture image, and $T$ is the pixel distribution density of the tennis serve video capture image.

The error information detection model of the video capture image of multi tennis serve is established, and the distributed pixel set of the error vector of the video capture image of tennis serve is obtained as follows:

$$F = \sum_{i=1}^{s} \mu_{ik} \times \eta f_i(\omega)\bar{x}_T.$$  \hspace{1cm} (10)

Calculate the pixel intensity of the error frequency response modulus at $z = e^{j\omega_0}$ of the tennis serve video capture image. According to the difference of pixel intensity, the dynamic image adaptive detection matrix of the tennis serve video capture is described as:

$$R_i = 3A_+^4|\gamma|\sum_{j=0}^{4} h_{j}^4(j),$$  \hspace{1cm} (6)

where: $\gamma$ refers to the action frequency. Through the multimode state detection results, the multimodal high-frequency components and low-frequency components of the tennis serve video capture image are obtained. Combined with the multiscale detection results of the tennis serve video capture image, the edge scale information components of the tennis serve video capture image are

$$\text{SNR}_i = Kr + \sum_{i=0}^{4} |\gamma| A_i^4,$$  \hspace{1cm} (7)

where: $Kr$ is the image feature distribution point set. Carry out multimode feature calibration on the texture information feature distribution points of the tennis serve video capture image to obtain the error distribution track of the image. According to the difference of pixel intensity, the action frequency $f_X$ through the multiscale feature segmentation of the tennis serve video capture image is obtained, and the error recognition is carried out according to the difference level of motion error [31].

The error characteristic analysis model of tennis serve motion video capture image is recorded as:

$$G = W_i^T x_{ir} H_1 - f(g_i)kS^*(\omega)e^{-j\omega t},$$  \hspace{1cm} (14)

where: $H_1 = tr\left(\begin{array}{c} G_{\alpha} \\ G_{\beta} \end{array}\right)\alpha_{\alpha\beta}$,

$$\begin{align*}
\{GT^{[3]}(t) & = T^{[3]}(t) - G^{[3]}(t) \\
A^{[3]}(t) & = f^{[3]}(t) - A^{[3]}(t) \\
B^{[3]}(t) & = k^{[3]}(t) - B^{[3]}(t) \\
E^{[3]}(t) & = B^{[3]}(t) - E^{[3]}(t) \\
FQ^{[3]}(t) & = Q^{[3]}(t) - F^{[3]}(t)
\end{align*}$$

and $tr$ represents the pixel tracking distribution track of the image.

Set the filter input as the power spectral density of $G_{\mu}(\omega) = N_0/2$, and combine the image filtering and optimized feature detection technology to obtain the dynamic distribution function of tennis serve video capture acquisition as follows:

$$HR(W_i) = G_{sd}(t)\bar{r}^T \sum_{i=1}^{s} W_i^T x_{id},$$  \hspace{1cm} (15)

where: $s_d(t)$ is the $M \times d$ direction matrix; $x_d$ is a $d \times 1$ image signal vector. According to the image segmentation results, the ambiguity boundary error function of the tennis serve video capture image is obtained as follows:

$$U(x, y) = HR(W_i) \sum_{y_i} V_c(x)p(y_i | x),$$  \hspace{1cm} (16)
4. Design of Recognition Method for Sports Tennis Wrong Technical Action

4.1. Extracting the Characteristics of Wrong Technical Movements in Sports Tennis. According to the understanding of the human body structure, the human body can be divided into five parts, namely, the trunk, left arm, right arm, left leg, and right leg. The trunk is an important part to support the human body. Some joints of the waist of the human body can reflect the information of their motion characteristics, while the motion information characteristics of the hands and feet are represented by the joints of the limbs of this part. The division results of the five major parts of the human body are shown in Figure 3.

Through the division of human body structure, the combination of these five parts can be used to represent some basic movements of the human body, so the hierarchical strategy is adopted in the classification. The first level: the actions of the five related combination modes should be summarized into a large category. For example, only two arm movements are the combination of the second part and the third part, which is the result of rough motion classification. Level 2: reclassify the actions of the same combination mode to determine the detailed classification of actions. The joint angle feature vector formed by the projection on the two-dimensional plane is verified from the 17 joint angles of the human body, and it is used as the first rough classification feature of human motion. According to the principle of kinematics, the features of the same combination of human body are extracted [8]. According to the principle of kinematics, the features of the same combination of human body are extracted. The complete movements of tennis players can be divided into active and auxiliary movements. The main action reflects the overall state of the motion mode, while the auxiliary action reflects the local state of the motion mode. Only by combining the characteristics of the main and auxiliary actions can we express this action more accurately. For the five major parts of the human body, such as the trunk, left arm, right arm, left leg, and right leg, the limb vectors in the three-dimensional space coordinates are established, respectively, which are expressed as the following formula:

\[
\begin{align*}
GT^{[3]}(t) &= T^{[3]}(t) - G^{[3]}(t), \\
AJ^{[3]}(t) &= J^{[3]}(t) - A^{[3]}(t), \\
BK^{[3]}(t) &= K^{[3]}(t) - B^{[3]}(t), \\
EP^{[3]}(t) &= P^{[3]}(t) - E^{[3]}(t), \\
FQ^{[3]}(t) &= Q^{[3]}(t) - F^{[3]}(t),
\end{align*}
\]

where, [3] represents three-dimensional space; Indicates the moment when the limb moves; \(GT^{[3]}\), \(AJ^{[3]}\), \(BK^{[3]}\), \(EP^{[3]}\) and \(FQ^{[3]}\), respectively, represent the limb vectors of the human body’s trunk, left arm, right arm, left leg, and right leg in the three-dimensional space. In sports tennis, the contribution of human motion expression is different. Two joint angles are selected from each part as active joint angles. The following formula can be used to calculate the size of each joint angle of the human body in the three-dimensional space, so the angular velocity of the joint angle is \(\omega(t)\):

\[
\omega(t) = \theta(t+1) - \theta(t).
\]
and limbs, and the change of the distance between joint points is represented by the bending of the human limbs and trunk. The human body also projects the YOZ side plane from the left view direction. The distance from the five parts of the tennis player to the joint point is

\[
\begin{align*}
    d_{GR}(y, z) &= \sqrt{(y_G(t) - y_r(t))^2 + (z_G(t) - z_r(t))^2}, \\
    d_{CL}(y, z) &= \sqrt{(y_C(t) - y_L(t))^2 + (z_C(t) - z_L(t))^2}, \\
    d_{CM}(y, z) &= \sqrt{(y_C(t) - y_M(t))^2 + (z_C(t) - z_M(t))^2}, \\
    d_{GR}(y, z) &= \sqrt{(y_G(t) - y_S(t))^2 + (z_G(t) - z_S(t))^2}, \\
    d_{GS}(y, z) &= \sqrt{(y_G(t) - y_B(t))^2 + (z_G(t) - z_B(t))^2},
\end{align*}
\]

(20)

where, \(d(y, z)\) represents the Euclidean distance between two joints of the sports tennis player. In order to eliminate the differences between different individuals in sports tennis, each item in (18) and (20), as well as the width of the human shoulder and the mean value of the Euclidean distance between joints are standardized to obtain:

\[
\begin{align*}
    d_{AB}(x, y, z) &= \sqrt{(x_A - x_B)^2 + (y_A - y_B)^2 + (z_A - z_B)^2}, \\
    \bar{d}(y, z) &= \frac{\sum_{t=1}^{n} d(t)}{n}.
\end{align*}
\]

(21)

where: \(d_{AB}\) refers to the width of human shoulder; \(\bar{d}\) represents the mean value of the Euclidean distance between joints in the five major parts of the human body.

According to the division results of the five parts of the human body, the limb vectors of the human body’s trunk, left arm, right arm, left leg, and right leg in the three-dimensional space coordinates are established, and then the wrong technical action characteristics of sports tennis are extracted by using the distance between the five parts of the human body’s bones and joints.

### 4.2 Motion Tracking and Adjustment Based on Body Area Network Technology

In the sports tennis teaching video or the live video of the game, the position of the camera is dynamic. Therefore, there are many non-static pictures in the sports tennis match video. Because the camera is always moving, it cannot well reflect the athlete’s information. Therefore, it is necessary to use machine vision technology to track the moving target to obtain the athlete’s activity field, and adjust the athlete’s image within this range to offset the influence of external factors.

In the expanded tracking target area, symmetrical vertical and horizontal tracking is carried out to generate and adjust the image of the moving target. Calculate the “centroid” coordinate of the target area through (22), move the centroid coordinate \((m_x, m_y)\) according to the central area, and then generate the tennis player target tracking image.

\[
\begin{align*}
    m_x &= \frac{\sum_{x \in R} \sum_{y \in R} x \cdot f(x, y)}{\sum_{x \in R} \sum_{y \in R} f(x, y)}, \\
    m_y &= \frac{\sum_{x \in R} \sum_{y \in R} y \cdot f(x, y)}{\sum_{x \in R} \sum_{y \in R} f(x, y)}.
\end{align*}
\]

(22)

After such processing, the target tracking image sequence can be adjusted. The adjusted image sequence only includes the athlete’s limb motion and the motion generated by the racket, and cannot reflect the camera motion in the original image.

By tracking the sports tennis goal, the tennis player’s activity area is obtained. By calculating the centroid coordinates of the sports tennis wrong technical action recognition area, the sports tennis wrong technical action tracking image is generated to realize the tracking and adjustment of sports tennis wrong technical action.

### 4.3 Design the Identification Process of Sports Tennis Wrong Technical Action

On the basis of sports tennis wrong technical action, the identification process of sports tennis wrong technical action is designed by calculating the sports tennis wrong technical action descriptor.

Machine vision technology is based on the characteristics of optical flow. The optical flow information set is established by the time displacement of each pixel, which requires high accuracy of optical flow. In order to transform the optical flow vector of moving video into a vector field, and then form a movable spatial distribution relationship, especially the optical flow field needs to be analyzed. Because the optical flow can only reflect the motion information in the tennis player’s foreground image when tracking the image, the background in the tracking image will have an impact on the calculation of optical flow. Therefore, we must clear up the background first. Not only the uniformity of background color should be considered, but also the global foreground image of tennis players should be obtained by processing the region growth algorithm based on the Gaussian mixture model. The athlete-centered background color elimination is shown in Figure 4.

According to the definition of the camera, the user can manually adjust the sports tennis error technical action image sequence, and then estimate the length of the light field. First of all, according to the change degree of flash and camera intensity, the brightness of the action image of sports tennis error technology is tracked in real time, which will lead to the error of optical flow calculation results. Therefore, image difference should be used to distinguish brightness and eliminate the influence caused by brightness change. Secondly, by analyzing the theory of biological vision system, it can be seen that machine vision cells are very sensitive to the edge movement of objects. In terms of direction and speed, different optical flows are formed due to different images to reflect the impact of human visual system on Logistics movement. Based on the difference image, the Horn–Schunck algorithm is used to estimate how tennis players track the Horn–Schunck optical flow field, as follows:
where: \( DI_i \) refers to the difference image of tracking sports tennis error technical action images \( HC_i \) and \( HC_{i-1} \); \( HS \) refers to the estimation expression of horn Schunck algorithm; \( OF_i \) represents optical flow field; \( N \) indicates the number of image sequence alignment of sports tennis wrong technical action.

There is a correlation between the athlete’s position and the relative displacement of the body in the image of adjusting the wrong technical action of sports tennis, and this displacement exists in the corresponding image area. For different postures of tennis players, the spatial distribution of optical flow field is different.

According to the kernel density estimation and grid histogram of sports tennis error technical action image, the optical flow histogram is used as the motion descriptor of sports tennis players in the swing process. For the optical vector of a given optical flow field coordinate \( P \), the components in the horizontal and vertical directions are \( G_x(P) \) and \( G_y(P) \), respectively. The amplitude \( M(P) \) and direction angle \( \theta(P) \) of sports tennis players’ wrong technical action can be defined by using the following formula, which is expressed as follows:

\[
\begin{align*}
M(P) &= \sqrt{G_x^2(P) + G_y^2(P)}, \\
\theta(P) &= \arctan\frac{G_x(P)}{G_y(P)}.
\end{align*}
\]

(24)

To sum up, on the basis of machine vision technology, the characteristics of sports tennis wrong technical action are extracted. By tracking and adjusting sports tennis wrong technical action, the sports tennis wrong technical action descriptor is calculated, and the recognition of sports tennis wrong technical action is realized.

5. Simulation Test Analysis

5.1. Error Technical Action Identification Test. In order to verify the performance of the sports tennis wrong technical action recognition method based on the human body area sensor network (body area network) technology, the athlete wrong technical action data collected in the tennis competitions of the 2016 Olympic Games, the 2017 China Masters, the Sudirman cup, and the China open were used. Sports tennis error technical action video is stored in MPEG-1 compression format, and the size of each video frame is 352*288. The types of tennis wrong technical actions in the above four matches are marked in the manual mode. The experimental data are shown in Table 1.

In order to quantitatively evaluate the recognition method of sports tennis wrong technical action based on machine vision technology, recall rate index and accuracy rate index are introduced to determine the recognition ability of each swing in sports tennis wrong technical action. The calculation method of recall rate index and accuracy rate index is as follows:

\[
R = \frac{n_c}{n_l + n_m} \times 100%,
\]

\[
p = \frac{n_l}{n_l + n_m} \times 100%,
\]

(25)

where: \( n_l \) refers to the number of sports tennis wrong technical actions correctly identified; \( n_m \) refers to the number of unrecognized sports tennis wrong technical
actions; \( n_f \) indicates the number of sports tennis wrong technical actions incorrectly identified.

The recall rate test results of tennis error technical action recognition based on body area network are shown in Figure 5, and the accuracy rate test results are shown in Figure 6.

According to the experimental data in Table 1, three cross-validation strategies were used to form the training set and test set of the experiment. Taking the number of sports tennis wrong technical actions as the independent variable, the methods in literature [24] and literature [25] were introduced as comparison. After three iterations, the recall rates of the three action recognition methods were tested. The results are shown in Figure 5. It can be seen from the results in Figure 5 that when the number of wrong technical actions of sports tennis is less than 250, the action recognition recall rate of the three action recognition methods is basically the same. When the number of actions exceeds 250, when this method is used to identify sports tennis wrong technical actions, the recall rate of sports tennis wrong technical action recognition is getting higher and higher.

According to the method of literature [24], due to the low quality of the identified sports tennis wrong technical action video, the recall rate appeared a turning point when the number of actions was 300 and began to decrease gradually. However, due to the influence of camera movement, the recall rate in reference [25] shows an upward trend, but the upward trend is relatively slow. Therefore, it can be concluded that the sports tennis wrong technical action recognition method based on machine vision technology has good performance in the recall rate test of sports tennis wrong technical action recognition.

It can be seen from the results in Figure 6 that with the increase of the number of sports tennis wrong technical actions, the methods in literature [24] and literature [25] cannot effectively distinguish when the movement direction of tennis players changes, resulting in a gradual decrease in the accuracy of sports tennis wrong technical action recognition. However, when this method is used to identify sports tennis wrong technical actions, the trend of the accuracy of identification is slow. When the number of sports tennis wrong technical actions reaches 500, the accuracy of action identification is as high as 77%.

### Table 1: Experimental data.

| Sports tennis video clip                  | Left swing times | Up swing times | Right swing times |
|------------------------------------------|------------------|----------------|-------------------|
| Tennis competition of 2016 olympic games | 112              | 38             | 124               |
| 2017 China masters                       | 706              | 234            | 291               |
| Sudirman cup 2017                        | 297              | 202            | 712               |
| 2017 China open                          | 124              | 264            | 153               |
| Total                                    | 1239             | 738            | 1280              |

#### 5.2 Error Test of Service Action.

In order to test the implementation of the method in this paper, set the number of pixels sampled for tennis serve video information is 250, the number of frames of the image is 120, and the image segmentation coefficient is 0.18. The regularization fusion parameter of image detection is 0.14. According to the above parameter settings, the tennis serve action error identification is carried out, and the original collected tennis serve action image acquisition results are shown in Figure 7.

Taking the image in Figure 7 as the research object, the tennis serve action error recognition is realized, and the image error recognition results are shown in Figure 8.
According to the analysis of Figure 8, the image resolution of tennis serve error recognition by this method is high, and the recognition ability is good. If the accuracy of tennis serve error recognition by different methods is tested, and the comparison results are shown in Table 2.

| Iterations | Paper method | Method 1 | Method 2 |
|------------|--------------|----------|----------|
| 100        | 0.019        | 0.154    | 0.314    |
| 200        | 0.016        | 0.087    | 0.297    |
| 300        | 0.012        | 0.026    | 0.188    |
| 400        | 0.001        | 0.017    | 0.125    |

According to Table 2, in the above three different tennis serve action recognition methods, the error rate shows a negative correlation trend with the increase of network iteration times, but for different methods, the error rate is quite different. When this method is used to identify the tennis serve action error, its recognition accuracy is higher than that of literature [24] and literature [25], and the maximum error is close to zero. When using literature 24 and literature 25 to identify the tennis service action error, the error is much greater than that of the method used in this paper. This experiment verifies that the tennis movement recognition model based on human body area sensor network (body area network) has good recognition ability and certain use advantages.
6. Conclusion

Build a tennis serve error recognition model, and use the image information fusion method to process the image information of tennis serve. This paper proposes a tennis serve error recognition method based on image segmentation. Through the matching results of the action database, the edge contour feature detection is carried out, and the joint image segmentation technology is used to match the position information and action information of the tennis serve action. Through the adaptive learning and scale transformation methods, the joint feature point location and fuzzy action feature detection of the tennis serve action video capture image are carried out to realize the optimization of tennis serve action error recognition. The research shows that this method has better error and recognition performance in tennis serve error recognition.

In order to correct the wrong technical action of sports tennis in time, this paper proposes a tennis wrong technical action recognition method based on human body area sensor network (body area network). The human body area sensor network technology is used to extract the specific characteristics of sports tennis wrong technical action. Through tracking and adjusting Sports Tennis wrong technical action, the sports tennis wrong technical action recognition process is designed. The recognition of sports tennis wrong technical action is realized. The experimental results show that compared with the other methods, this method has better recognition performance, higher accuracy, the lowest error rate, and strong applicability. This proves that this research has high reliability and strong applicability, and the related technology and theory can also provide reliable theoretical support for the development of related research.

Data Availability

The data used to support the findings of this study can be obtained from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

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