Research on The Design of Table Tennis Training System Based on Computerized Body Sensing Technology

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Abstract. Table tennis is a sport that is easy to learn, difficult to master, and fun to play, and is arguably one of the most brain-burning sports in sports. As grip training is the foundation of table tennis training, it is important to study intelligent grip training methods for table tennis in order to improve the level of competition and training. Based on this, this paper combines computerized somatosensory technology to build a table tennis grip training system, so as to realize the optimal design of table tennis grip training system.

Keywords: Computer Somatosensory Technology, Table Tennis Training System, Design

1. Introduction

Somatosensory technology allows people to interact directly with the surrounding devices or environment using body movements, without the need for any complex control devices, allowing people to interact with the content in an immersive manner. For example, when you stand in front of a TV, if there is a body-sensing device that can detect your hand movements, if we wave our hands up, down, left and right to control the TV's fast forward, reverse, pause and end functions, this is an example of directly controlling the peripheral devices with body-sensing, or if these four movements directly correspond to the reactions of game characters, it allows The four actions directly correspond to the reactions of the game characters, so that people can get an immersive gaming experience. However, it is too narrow to apply it only to the game field, and it can be applied to the sports training field [1].

2. Sensory information collection and information fusion

2.1. Collection of body sense information for table tennis grip training

In order to realize the design of table tennis grip training system based on somatosensory recognition technology, we combine image information processing and somatosensory recognition technology for
somatosensory information acquisition of grip training, firstly, we use sensors for data information acquisition of somatosensory recognition, analyze the best grip state of table tennis in the process of table tennis movement combined with human kinetic model, extract the pixel points of table tennis grip change, use quantization feature analysis method, establish the rotational moment of the ping pong ball in the air, analyze the position of the ping pong ball in the air after it is taken off the hand by combining the normalized pixel point analysis method of human grip, and use the sparse 1-dimensional distance imaging method to obtain the probability density function of the somatosensory distribution of the ping pong ball grip:

\[
P(I) = \omega y_{id}(t) + c_1 r_1(p_{id} - x_{id}(t)) + c_2 r_2(p_{pe} - x_{id}(t)) \quad (1)
\]

Where the letters represent sparse vectors, if the distribution of somatosensory dynamic eigenvolume of the table tennis grip image pixel i is a fixed encoding between frames, then the compensation value relative to the somatosensory dynamic eigenvolume of the table tennis grip image can be treated as 0, e is a composite window template, and the viewpoint switching equation of motion for optimal adjustment of the table tennis grip training is obtained using the somatosensory recognition method as:

\[
\frac{\partial u(x, y; t)}{\partial t} = \frac{\sigma}{\rho s} \nabla G(x, y; t) = k \left[ \frac{\partial G_x(x, y; t)}{\partial x} + \frac{\partial G_y(x, y; t)}{\partial y} \right] \quad (2)
\]

The collected table tennis grip image information is monitored for somatosensory features, and the somatosensory dynamic feature quantity of the table tennis grip image is extracted, and the standard normal distribution function is used to calculate the dynamic feature quantity on the larger outer window as:

\[
p^k = \langle x_0, (x_i)_{0 \leq i \leq \tau}, (x_i')_{0 \leq i \leq \tau - 1}, (\Pi_i)_{0 \leq i \leq \tau - 1} \rangle \quad (3)
\]

T+ The sensor is used to automatically collect the grip information of table tennis players, the force angle and the selection speed of table tennis [2], combine with the rotation invariant moment information for data fusion and information feature sampling, assume that in the spatial distribution position, the grip conversion set of table tennis players target bit shape is unknown, for the body sensing data filtering using radial filter, assume that the enhancement information of the inner window is:

\[
\eta = \frac{a}{a + b + c} \cdot \frac{E[MA] + E[MB]}{E[VA] + E[VB]} \quad (4)
\]

Under natural conditions, the dynamic measurement equation of table tennis posture is as follows:

\[
E[MA] = E[VA] = \sum_{i=0}^{\infty} i(1 - p)^i p = \frac{1 - p}{p} \quad (5)
\]

The optimal wrist bending state characteristics of table tennis grip training can be obtained by constructing the spatial coordinate system A and B, of grip posture:

\[
\]
Based on the non-curvature algorithm, the kinematics decomposition is carried out in the non-flat surface \( P'' \), \( P,e \times 6x' \), and the minimum area of the membrane surface is obtained. The kinematics equation of the somatosensory feature distribution of table tennis is obtained [3]:

\[
\dot{\theta} = J^* \dot{\epsilon} + (I - J^*J)^{-1} \tag{8}
\]

The letters are the load information of table tennis serve action in equilibrium state respectively [4]. According to the method of rotating around the bend line, the kinematics solution of table tennis power direction is as follows:

\[
\dot{\theta} = J^* \dot{\epsilon} + (I - J^*J)^{-1} \tag{8}
\]

The letters are the inertia distribution matrices under the peak load change, and since \( J \) is a Moore-Penrose generalized inverse matrix, the analysis of the form characteristics of the table tennis grip is achieved by the above analysis [5].

2.2. Processing of Visual Information Fusion in Table Tennis Grip Training

Assuming that the visual information contour line of table tennis grip training under uniform distribution of transmission medium is the standard action bit shape obtained by using discriminative model, the visual tracking recognition of table tennis grip based on the joint sparse representation of tracking method He, the rectangular image block \( N \), \( N \) is the visual area containing the edges, and the viewpoint switching equation of motion for table tennis grip training is constructed as [6]:

\[
imag_{err} = T_{ij} - W_{ij} = \left[ \text{quater}(R) \right] \times \left[ \text{quater}(Q_i) \times W_{ij}' + T_{ij}' \right] - W_{ij} \tag{9}
\]

For the purpose of measuring the sparse expression coefficient and analyzing the similarity between the optimal inertial state feature \( Q \), \( Q \) of table tennis grip training, the optimal spatial mapping relationship of table tennis grip training is constructed as follows:
In the formula, there are reconstructed target template coefficients:

\[
\begin{bmatrix}
  x \\
  y
\end{bmatrix} = \begin{bmatrix}
  \cos \theta & -\sin \theta \\
  \sin \theta & \cos \theta
\end{bmatrix} \begin{bmatrix}
  \xi \\
  \eta
\end{bmatrix}
\]

(10)

The visual tracking figure of table tennis grip is binary segmented by generative model for the appearance model, and the body sense of the best grip posture is taken as the body sense, as long as the A,B,C ≥ 0, the region fuzzy dynamic fusion feature matrix ZeroArraybnA,B,C≥0. The similarity distribution coefficient of reference template for table tennis grip is satisfied:

\[
\theta = \arctan \left( \frac{\partial u}{\partial y} / \frac{\partial u}{\partial x} \right)
\]

(11)

\[
A = B_{40} + \frac{1-\lambda}{4} B_{41}, B = \frac{3+\lambda}{4} B_{42} + \frac{3+\lambda}{4} B_{43}, C = \frac{1-\lambda}{4} B_{43} + B_{44}
\]

(12)

\[
\dot{\theta} = \omega, \sin \gamma + \omega, \cos \gamma
\]

(13)

\[
\dot{\psi} = (\omega, \cos \gamma - \omega, \sin \gamma) / \cos \theta
\]

(14)

\[
\dot{\gamma} = \omega, -\tan \theta (\omega, \cos \gamma - \omega, \sin \gamma)
\]

(15)

Where, the letters denote the rotation angle of the best somatosensory distribution of the table tennis grip, respectively, and the expression is the distribution angle of the viewpoint motion axial [7]; y is the fusion offset angle between the tracking data. The target image block in the first frame is fused with the template information, and Xp is used to denote the (i,j) corner point information, and the target template update aspect is used for the corner point marking of the best grip by the weight update method, and the following sensing detection method is used for the grip training optimization of table tennis [8].

3. There are still many problems in computer- foreign language teaching

3.1. Extraction of Body Sense Dynamic Feature

The joint sparse representation method is used to analyze the best position points of the table tennis grip, and the current somatosensory recognition target template is calculated as W, height as H using dark primary color a priori detection method to divide the amount of table tennis grip features in 3D space into sub-blocks, the feature points of table tennis grip calibrated along the gradient direction as X, and then calculate all the manually calibrated points separately, using smoothing technique can get the distribution of somatosensory features of table tennis grip training as [9]

\[
P(i,j) (i \in [0, \text{int}(W/2) - 1], j \in [0, \text{int}(H/2) - 1])
\]

(16)
Among them, there are 2 pixels in the grid surface of the pose feature distribution of table tennis grip training. The mean square error of collecting the pose information of table tennis grip training is \( \times 2 \):

\[
err_{ij} = \frac{1}{N} \sum_{j=1}^{N} \sqrt{(x_{ij}' - x_{ij})^2 + (y_{ij}' - y_{ij})^2}
\]

(17)

The N is the total number of somatosensory feature sampling samples for table tennis grip training, \( n \) the number of somatosensory feature points for table tennis grip training. The sampling error of somatosensory feature for table tennis grip training is as follows:

\[
ERR = \frac{1}{n} \sum_{j=0}^{n-1} err_{ij} = \frac{1}{n} \times \frac{1}{N} \sum_{j=0}^{n-1} \sum_{i=1}^{N} \sqrt{(x_{ij}' - x_{ij})^2 + (y_{ij}' - y_{ij})^2}
\]

(18)

Therefore, the body sense feature extraction and spatial position information recognition of table tennis grip training are realized, and the intelligent level of table tennis grip training is improved by combining the different pixel feature decomposition technology [10].

3.2. SVM Classification Recognition

The collected table tennis grip image information is monitored for somatosensory features, the somatosensory dynamic feature amount of the table tennis grip image is extracted, and the support vector machine model is used to classify the somatosensory features of the table tennis grip, and the somatosensory feature weight matrix of the table tennis grip training under machine vision is calculated. The spatial location point information of the somatosensory feature detection of the table tennis grip training is a high-dimensional vector, here the table tennis grip is defined. The cost function of support vector machine classification of somatosensory features for table tennis grip training is defined here [11]:

In order to obtain the distribution vector matrix of grip posture, the classification support vector machine (SVM) is used to detect the somatosensory characteristics of table tennis grip training in the high dimensional troposphere as follows:

\[
Q_{jm}^i = (x_i - x_{ij})^T (x_i - x_{ij})
\]

(20)

Based on support vector machine (SVM) learning, the model of body sense feature distribution (tangent, learning function of SVM) is constructed, which is used as regression analysis function to represent input vector by \( X \). Optimal reconstruction weight matrix for body sense detection of table tennis grip training [12]:
Using the downflow method to establish the pixel spatial distribution function, the visual information transmission feature quantity of table tennis grip posture is obtained [13]:

\[
\mathbf{w}_j^i = \frac{\sum_{m=1}^{k} \left( Q^i \right)_{jm}^{-1}}{\sum_{p=1}^{k} \sum_{q=1}^{k} \left( Q^i \right)_{pq}^{-1}}
\]

(21)

Among them,

\[
F = \sqrt{p(x,y)} = p(x,y) \left( \frac{v(x)}{v(y)} \right)^{1/2}
\]

(22)

In practical application, it may be a singular matrix to regularize the detected optimal body sense characteristics of table tennis grip training, and obtain:

\[
Q^i = Q^i + rI
\]

(24)

Among them, I is a unit matrix, the optimal body sense feature samples of all table tennis grip training are trained adaptively, and the optimal body sense recognition output of the optimized table tennis grip training is as follows:

\[
s(k|k-1) = \varphi \cdot s(k-1|k-1)
\]

(25)

The \( p \) is azimuth and the \( k \) is the number of iterations. According to the above analysis, the training control of table tennis holding posture based on improving recognition is realized.

4. Simulation experiment and result analysis

Based on the above mentioned system algorithm design, the hardware development and design of the table tennis grip training system is carried out using program loading and command control methods, and the embedded bus control of the table tennis grip automatic training system is combined with the body sense recognition technology [14]. The ISA/EISA/Micro Channel expansion bus is used for the real-time program read/write and AD conversion control of the automatic table tennis grip training system, the clock sampling and bus output conversion design of the automatic table tennis grip training system is realized by using the DSP control SEL1 level, and the ADSP-BF537BBC-5A is used for the automatic table tennis grip training system. The original information is collected, the load power of the baseline restorer of the automatic table tennis grip training system is set, and the hardware development of the table tennis grip training system is realized according to the above analysis. The hardware design of the system is shown in Figure 1 [15].
Figure 1. Hardware Design of the System

In order to test the application performance of the system designed in this paper, the experimental analysis was performed. 8 AD inputs were used for the system, the conversion end could be done in query and interrupt mode, the maximum clock of ADC0809 was 640 K, the microcontroller used 12 M crystal, the sampling pixel value for the physical recognition information of table tennis grip training was 400x640, and the sampling spectrum bandwidth was 24 dB. According to the above simulation parameter settings, the body sense recognition of table tennis grip training is performed, and the common table tennis grip training is shown in Figure 2 [16].
(a). Clamp grip method

(b). Punch the ball straight

**Figure 2.** Common table tennis grip techniques

The results show that the distribution curves of the pincer grip and the straight chipping grip in the horizontal racket are obtained by comparing the somatosensory-based recognition technology method and the traditional method, and the amplitude stability of the somatosensory-based recognition technology method is strong, the recognition accuracy is high, and the improved feature detection ability of the table tennis grip training is good. The improved feature detection capability for table tennis grip training improves the level of automatic training of table tennis grip and demonstrates the superior performance of this method in improving the grip intelligence training system for table tennis teams.

5. Conclusion

The design of the table tennis grip training system is based on the recognition and data sampling of somatosensory information, using the embedded somatosensory information sampling technology to
achieve the optimal design of the table tennis grip training system. The sensor is used to collect the data information of body sensory recognition, analyze the best grip state of the table tennis during the motion of the table tennis, extract the pixel points of the change of the grip of the table tennis, use the quantitative feature analysis method to establish the rotation moment of the table tennis in the air, and combine the normalized pixel point analysis method of the human grip to realize the regulation of the table tennis grip training. It is known that this method can effectively realize the automatic training adjustment of table tennis grip.

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