

Retraction

Retracted: Aerobics Exercise Posture Tracking and Recognition System Based on Wireless Smart Sensors

Journal of Sensors

Received 13 September 2023; Accepted 13 September 2023; Published 14 September 2023

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

In addition, our investigation has also shown that one or more of the following human-subject reporting requirements has not been met in this article: ethical approval by an Institutional Review Board (IRB) committee or equivalent, patient/participant consent to participate, and/or agreement to publish patient/participant details (where relevant).

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

- [1] W. Zhou, "Aerobics Exercise Posture Tracking and Recognition System Based on Wireless Smart Sensors," *Journal of Sensors*, vol. 2021, Article ID 7694835, 13 pages, 2021.

Research Article

Aerobics Exercise Posture Tracking and Recognition System Based on Wireless Smart Sensors

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Received 1 September 2021; Revised 18 October 2021; Accepted 28 October 2021; Published 13 November 2021

Academic Editor: Haibin Lv

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Wireless sensors are a new, high-end, and popular exploration technology. The positioning and tracking of the human body are two important research issues in sensors. Aerobics is a widely popular sports item that is well-loved by the general public and integrates gymnastics, dance, music, fitness, and entertainment. The application of smart sensors helps to improve the coordination and flexibility of movements. In order to deeply study whether wireless smart sensors can play a role in tracking and recognizing aerobics exercise postures, this article uses sensor design methods, motion analysis, and software and hardware equipment architecture methods to collect samples, analyze smart sensors, and streamline algorithms. And it creates a sensor model and system for posture tracking and recognition. When testing the best position for the placement of the sensor, first fix the sensor at a distance of 2.5 cm from the wrist section and at the middle of the lower arm, keep the upper arm still, and do the stretching and contraction movements of the lower arm. Repeat the exercise 5 times and measure the wrist. The movement curve of the juncture, the result shows that the measured juncture curve at a distance of 2.5 cm is basically the same as the actual winding curve, and the fixed position in the middle deviates more from the normal curve point, and its average error is within 0.9 cm, which is correct. To test the effectiveness of the algorithm again, a total of 8 volunteers' data were collected during the experiment, and the duration was more than 25 seconds, and each normal posture tried to maintain stability and lasted for about 6 seconds. The statistical accuracy rate is 90.6%. It shows that the algorithm or the system designed in this paper has extremely high accuracy. It is basically realized that from the theory of wireless sensor network, a system model that can be used for posture tracking and recognition of aerobics is designed.

1. Introduction

Student health is the latest issue of concern from all walks of life. Therefore, in order to strengthen the physical fitness training of students at all levels across the country and eliminate subhealth, a bright physical exercise is proposed. Fitness activities are a coin, with both pros and cons. The scientific exercise can play a very important role in enhancing people's physical fitness and health. On the contrary, if physical exercise is not suitable, it will cause damage and fatigue, which is harmful to the physical and mental development of students. Therefore, the study of scientific and scientific fitness methods and practical methods for adolescents has become a highly focused topic for education and sports practitioners. On this basis, many studies have shown that aerobics exercises can improve this situation. However, there are still many shortcomings in

the existing aerobics theories. We urgently need to redesign the existing aerobics movements.

The human-computer interaction system based on wireless sensors will integrate multimode sensors to collect and resolve information and make effective judgments to identify and determine the natural state and subconsciousness of "people." Smart wireless sensor is a technology that constantly exchanges information with the outside world and makes independent judgments. It needs to provide acceptable decisions based on the collected data. Therefore, the accuracy of human body gesture recognition and the application range of the method are important for the system. The performance has played a key role. Therefore, the intercommunication between intelligent people and machines has broad applications at all levels, which is a decisive factor for the construction of scientific and intelligent daily life in

the future. As a key information access port, human body gesture recognition technology has also received more and more attention. It can also be well applied to the posture tracking of students' aerobics.

With the increasing popularity of aerobics, there are more and more researches on the latest related motion posture sensors. In 2020, Koyuncu et al. discussed the problem of sensor failure and introduced a kind of intelligence to detect communication signals. The characteristics of these sensors are identified by signal-to-noise ratio (SNR) readings. The proposed sensor system has high performance, and the proposed sensor detection scheme performs well in terms of sensing time. However, the stability of the system is questionable [1]. In 2018, Craven discussed the use of smart sensor technology to reduce the energy consumption of heating, ventilation, and air conditioning (HVAC) systems in commercial buildings. It focuses on occupancy-based wireless thermostats, carbon dioxide demand controlled ventilation (DCV) sensors, and smart solar films. However, the research only stays in the theoretical part [2]. In 2017, Guesmi proposed a wireless sensor network for real-time flood monitoring and early warning systems. The real-time flood monitoring system based on wireless smart sensors measures hydrological data and captures remote images. Reduce possible personnel and material losses. The early warning process begins at an appropriate time before the disaster. The research process is complete, but the research object is not suitable [3]. In 2017, Shirazi introduced data reduction technology using principal component analysis, which is applied to carbon fiber reinforced plastic panels for structural health posture tracking and monitoring methods. The carbon fiber reinforced plastic panels that were damaged and repaired are consistent with the typical aircraft maintenance procedures in the aircraft structure maintenance manual. However, there are deviations in the research process [4]. In 2019, Khalid et al. used smoke, temperature, humidity, and light intensity sensors in their proposed network segment, which has low cost, small size, and power saving. The experiment was conducted in a well-controlled real-time environment. The results confirmed the effectiveness of the proposed method in terms of accuracy and fewer false positives. Unfortunately, the experimental analysis process is still not enough [5]. In 2016, Yao et al. proposed a near-field radio system for millimeter-level wireless smart sensor segments, which can be implanted with a 14-gauge syringe needle. The radio frequency energy absorption organization demonstrated the active near-field wireless communication between the millimeter-level sensor segment point and the base station equipment. The designed system has an expected life span of two weeks and does not require battery charging. However, the energy consumption of the system is too large [6]. In 2020, Graziano et al. aim to provide a comprehensive, up-to-date, and important literature review of wireless sensor networks for road health monitoring, while taking into account the experience gained from wired sensors as a basic reference point. It briefly analyzes other possible supplementary applications of smart sensor networks, such as traffic and surface condition monitoring [7].

The innovations of this paper are as follows: (1) Select the model used in human motion tracking, and according to the research of human motion geometric constraints and motion curves, the human body posture tracking can be reproduced truly. (2) Analyze the performance characteristics of each sensor, put forward an effective error model, correct the static error, and reduce the influence of external interference on the measurement. (3) Select the reference coordinate system, and obtain the optimal attitude representation by fusing the data after the sensor error correction in the measuring unit. Through the above work, the recognition effect of the aerobics posture tracking and recognition model based on the wireless smart sensor created in this paper is very accurate and the human body tracking is more real-time.

2. Implementation Method of Aerobics Posture Tracking and Recognition System Based on Wireless Smart Sensors

2.1. Aerobics. Aerobics is aerobics for the purpose of physical exercise, that is, mass aerobics. Aerobics has the characteristics of remuneration [8]. The posture of aerobics is that people deliberately create movements to practice according to their needs. In order to achieve the purpose of strengthening the body, aerobics can standardly change the orientation of the body shape, the action route, and the rhythm of the action. Aerobics generally has the following characteristics: (1) Exercises are simple and understandable, suitable for people of different ages. (2) Emphasis on movement norms and repeated exercises and (3) emphasis on a wide range of exercises. (4) Group exercises are the main. (5) With the vivid rhythm forms dynamic and rhythmic spirit.

Aerobics started in the late 20th century. The original name means aerobics and fitness. Since the American physical exercise star Jane compiled and published "Bodybuilding" and it has been widely circulated in the world, it has brought an important impetus to the development of aerobics. Aerobics entered China in the early 1980s. With the continuous improvement of people's living standards, more and more people pay attention to the practical value of health care, conditioning, fitness, and entertainment [9].

2.2. Wireless Smart Sensor Network. Wireless technologies are also divided into different types, which are usually distinguished by the way of generating wireless signals. At present, the main methods are FM wireless technology, infrared wireless technology, and Bluetooth wireless technology, and their costs and characteristics are also different. It is widely used in various content, such as audio, keyboard, and mouse, and has a good development prospect. Intelligent sensor is a sensor with information processing function. Smart sensors can store various physical quantities detected and process these data in accordance with instructions to create new data. Intelligent sensors can exchange information, decide which data should be transmitted, discard abnormal data, and complete analysis and statistical calculations. A wireless sensor network is a wireless network composed of spatially distributed independent devices. The

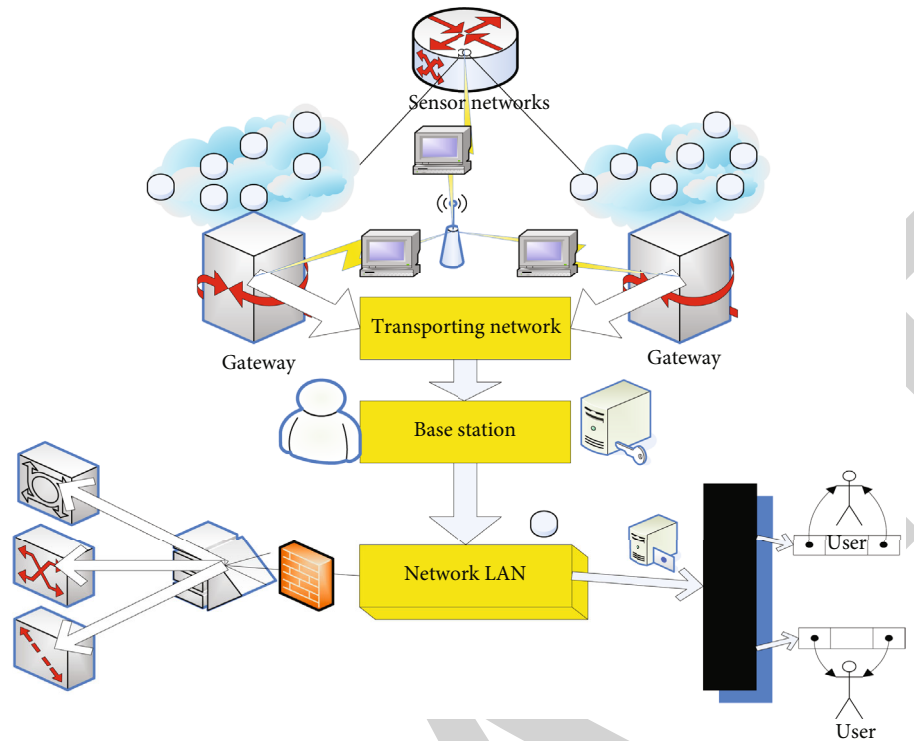


FIGURE 1: The structure of the wireless sensor network.

independent devices use sensors at different locations to monitor physical or environmental conditions, such as temperature, sound, alarm, pressure, movement, or pollution [10]. Although wireless sensor networks are used in many civilian and industrial applications, the original development of wireless sensor networks was for military applications such as battlefield surveillance. Basically, wireless sensor networks are ubiquitous in human life and play an important role. In our application, sensor segment points refer to reference segment points with known location information and special segment points with unknown locations and need to estimate the unknown location [11]. But in general, the sensor segment can also be guessed as a small electronic device, such as a small computer, which is very basic in terms of its components and interfaces [12]. The basic architecture of a wireless smart sensor network is shown in Figure 1.

It can be seen from Figure 1 that in most cases, wireless sensor networks need to be combined with existing wired or wireless networks. The figure represents a typical design of wireless sensor network structure [13]. The smart sensor has a microprocessor with the ability to collect, process, and exchange information. It is the product of the integration of sensors and microprocessors. A good “smart sensor” is a set of sensors and meters driven by a microprocessor and has functions such as communication and on-board diagnostics. In this network structure, observers sitting in various positions will be able to remotely access the sensor segment points. Generally speaking, a sensor segment roughly includes four basic parts: a sensing unit, a processing unit, a transceiver unit, and a power supply part [14].

The wireless sensor network is characterized according to several parameters, such as segment point deployment, segment point function, application, and energy and communication constraints. Some of the general characteristics are shown in Table 1.

Target positioning and tracking based on wireless sensor networks has been used for a long time. With the development of multidimensional sensors using wireless sensor networks and powerful communication and computing capabilities, the emergence of small sensor segment points for target positioning and tracking has gained researchers' wide attention. As a result, many algorithms have been proposed for target positioning and tracking in wireless sensor networks [15].

2.3. Human Body Motion Posture Tracking Recognition and Algorithm. Human posture recognition methods usually include vision-based human posture recognition and sensor-based human posture recognition [16]. Vision-based human gesture recognition technology started relatively early, and the theory is relatively mature. It mainly uses algorithms such as YMEKF. The recognition completion or the efficiency of the algorithm is relatively ideal. However, the vision-based human gesture recognition method is more dependent on the surrounding situation. Data samples can only be obtained in an environment with good lighting conditions, and vision-based human gesture recognition cannot be used in a fuzzy or noisy scene [17]. Compared with vision-based human gesture recognition, sensor-based human gesture recognition has obvious advantages: it is not restricted by environmental factors such as

TABLE 1: Parameter characteristics of wireless sensor networks.

Parameter	Feature	Data sources	Reliability
Ad hoc deployment	Random way	UNI777	91.5%
Dynamic topology	Change quickly	CT326	90.5%
Scalability	>81.6%	UL025	89.4%
Application specific	Very dependent	MO478	85.4%
Energy constraints	Rely on battery	WE236	95.6%
Bandwidth limitation	Rely on radio components	77SE	92.2%
Robustness	Excellent execution ability	UK124	95.5%
Autonomous restructuring	Self-reconfiguration ability	CR360	93.5%

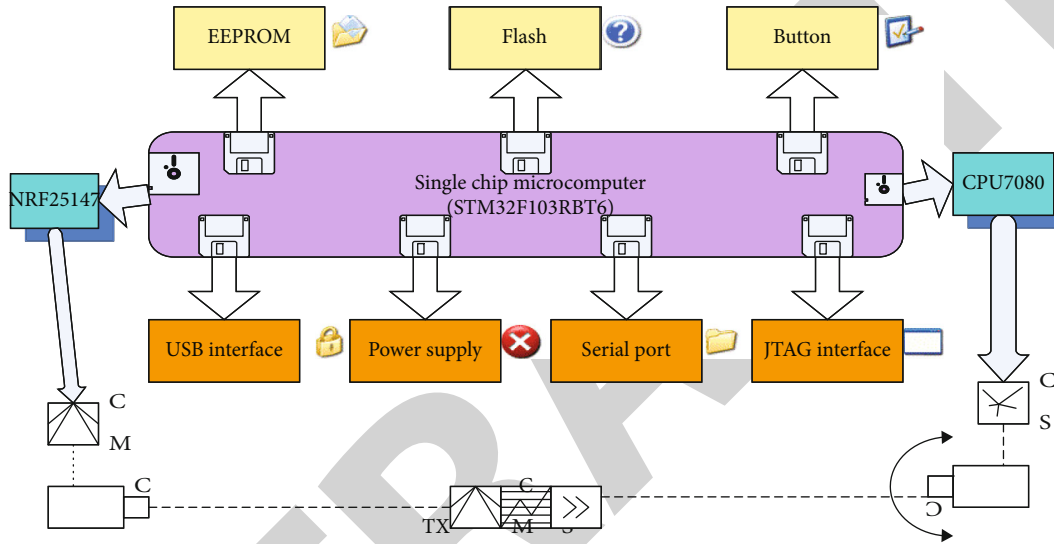


FIGURE 2: Block diagram of the wireless human body gesture recognition system.

gloss and angle; the holder can do their own habitual actions to obtain data and search. The sensor used in the human body posture has the characteristics of small form and high recognition efficiency, and it can be placed in any position of the body for the user to lead.

The wireless human posture recognition system mainly completes the recognition of human posture actions and the wireless transmission of recognition results. The system hardware design block diagram is shown as in Figure 2. It mainly includes the following parts:

It can be seen from Figure 2 that on this basis, the system software functional block diagram is shown in Figure 3 [18].

It can be seen from Figure 3 that the main functions implemented by the program of the wireless human body gesture recognition system include collecting human body posture data and calculating posture angle, human posture recognition, and wireless transmission of recognition results [19].

(1) Attitude acquisition module

The CGQ7080 sensor chip is used in the design of this article. This chip can simultaneously measure the range of angular velocity data and acceleration data of the measured human body [20]. Compared with the multinode acquisition scheme, it can effectively avoid the interaxis difference problem of the

combined gyroscope and accelerometer. The measurement interval can be controlled, and the appearance is small, and the weight is small [21]. It is widely used in reference equipment, pad digital equipment, 3D remote sensing, and other fields. It integrates a three-axis gyroscope and a three-axis accelerometer, as well as an outward expansion digital motion CPU. Its constituent parts are shown in Figure 4.

It can be seen from Figure 4 that if z_1 and z_2 are regarded as ideal pad batteries, and $z_1 = z_2$, the feedback strength is as shown in Equation (1):

$$l = \frac{ft(m_{wz} + \Delta m)^2}{2w^2} - \frac{ft(m_{wz} - \Delta m)^2}{2w^2} = \frac{2ftm_{wz}\Delta m}{w^2}. \quad (1)$$

In the formula, t is the battery plate area; Δm is the return voltage; f is a constant; n is the mass node mass; x is the inertial acceleration; w is the distance between the upper and lower battery plates [22]. The direction in which the speed is generated on the human body is along the X axis, and the speed can be calculated by Equation (2).

$$x_{zps} = -2\vec{d} * \vec{m} + \sum_{\substack{0 \leq i \leq m \\ 0 < j < n}} P(i, j). \quad (2)$$

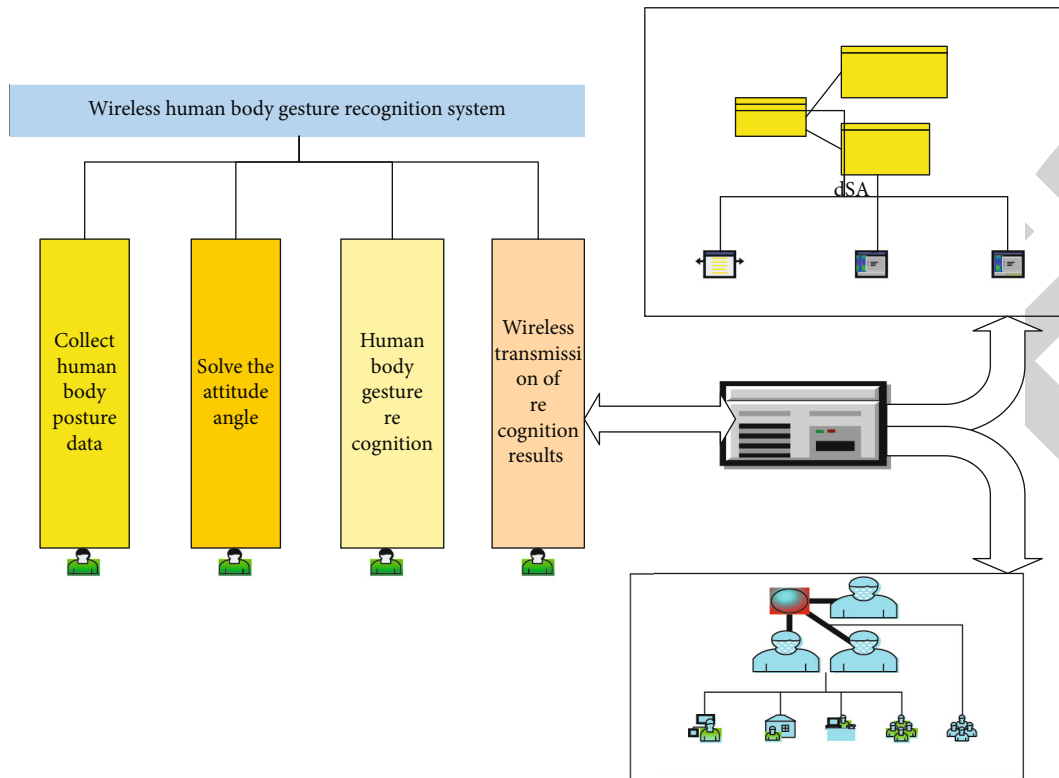


FIGURE 3: Software functional block diagram of wireless human body gesture recognition system.

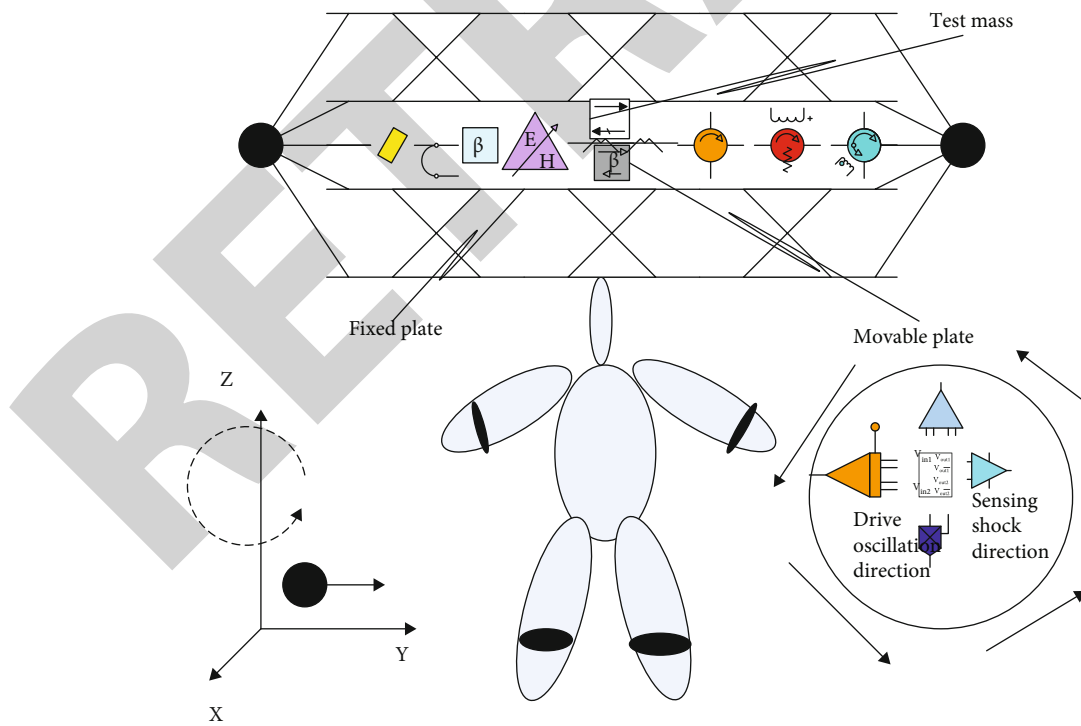


FIGURE 4: CGQ6050 sensor principle.

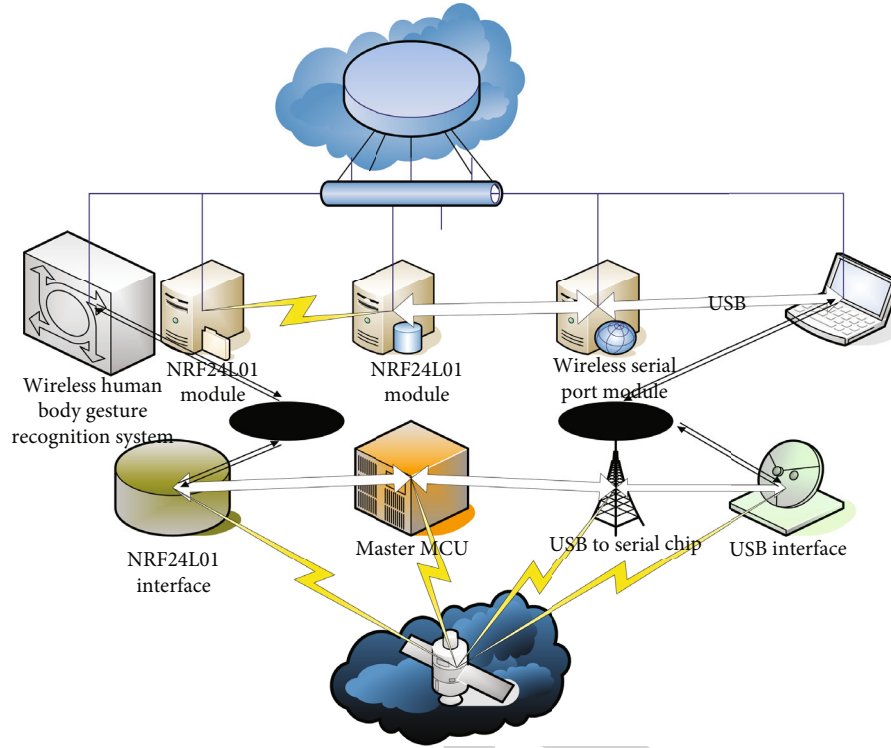


FIGURE 5: Schematic diagram of communication between wireless human body gesture recognition system and PC.

x_{zps} is the speed, and the speed is inversely proportional to the local angular speed, so the angular speed can be calculated by the change of the battery [23].

(2) Communication module

The wireless human posture recognition system can complete the real-time collection of human posture movement data [24]. The system needs to be worn on the human body. In order to avoid excessive connections and affect the normal activities of the human body, this article uses the wireless way. The schematic diagram of wireless communication between the wireless human body gesture recognition system and the PC is shown in Figure 5 [25].

It can be seen from Figure 5 that this module can meet the requirements for transmission distance and speed in the project and is very suitable for the application in this article.

(3) Identification algorithm

In human pose recognition, classification algorithm is an important content [26]. The particle swarm optimization algorithm is a stochastic optimization algorithm based on swarm intelligence proposed by Ken and Equan in 1995. Compared with optimization algorithms such as transfer algorithms, PSO has the advantages of fast constraining speed and strong global optimization ability.

In each transmission process, the node updates its own speed and position according to Equations (3) and (4).

When the end condition is reached, the process ends and the best result is output [27].

$$m_{uw}^{g+1} = \sigma * m_{uw}^g + z_1 * e_1 * (q_{uw}^g - a_{uw}^g) + z_2 * e_2 * (q_{hw}^g - a_{uw}^g), \quad (3)$$

$$a_{uw}^{g+1} = a_{uw}^g + m_{uw}^{g+1} + \sum_{i=0}^n k. \quad (4)$$

In the formula, g is the number of transmissions; w is the number of spatial dimensions; σ is the average value of inertia; z_1 and z_2 are acceleration units; e_1 and e_2 are arbitrary numbers distributed between [0,1].

This paper proposes an improved algorithm, which is based on the initial algorithm, selects and interleaves the nodes that alternate a certain number of times according to certain possibilities, and enhances the ability of nodes to leave some minimums [28]. Among them, the possibility of the particles performing the transfer operation automatically changes according to the Euclidean distance between the group particles during the transfer process. Assuming that the codes of particles a_u and a_k are $[x_1, x_2, \dots, x_w]$ and $[\gamma_1, \gamma_2, \dots, \gamma_w]$, respectively, the Euclidean distance between them is shown in Equation (5), and the distance between different particles in the population after each iteration is defined as Equation (6).

$$w(u, k) = x_{y^2} + dy \sqrt{\sum_{g=1}^w (x_g - y_g)^2}, \quad (5)$$

$$\vec{w}(s) = (w_1(s), w_2(s), \dots, w_o(s)), s = 1, 2, \dots \quad (6)$$

In the formula, s is the number of iterations; o represents the number of possible combinations between different nodes.

The control function $q(s)$ that enables the particles to perform the transfer operation is defined as follows:

$$q(s) = \frac{w_{\min}(s) - w_{\text{normal}}(s)}{w_{\min}(s) - w_{\max}(s)}. \quad (7)$$

In the formula, $w_{\min}(s)$, $w_{\max}(s)$, and $w_{\text{normal}}(s)$, respectively, represent the maximum, minimum, and average distances between nodes when they are passed to the s -th time. In order to improve the recognition accuracy of human postures, we use the improved PSO algorithm to practice the neural network, and after obtaining the neural network classification module with the best average and lowest value, we can recognize different human postures. The nodes are fabricated by real numbers, and their individual positions represent all the weights and the lowest value of the neural network to be optimized. The degree of adaptation of the particles is shown in formula (8), which is the average root deviation of the neural network.

$$f^q = \frac{1}{2q} \sum_{q=1}^q \sum_{g=1}^n (b_g^q - w_g^q)^2. \quad (8)$$

In the formula, n is the number of output segment points, q is the number of learning samples, and b_g^q and w_g^q are the actual output and expected output of the g -th output segment point of the q -th sample, respectively.

(4) Tracking algorithm

In target positioning and tracking based on wireless sensor networks, a hierarchical target tracking architecture is adopted. The bottom layer of the first-level system architecture is the detection base station deployed in a specific area. There are common sensor detection points and cluster head detection segment points. The sensor data collected by the SN segment points are sent to the base station after simple data fusion through the CH segment points. The BS aggregates the point information of each CH segment and sends it to the upper transmission network. The transmission network can use various transmission methods, such as satellites, microwave relay stations, and wired networks, to transmit information to the monitoring center.

Almost all target location tracking methods are model-based. Taking the target detection by a single sensor site as an example, the mathematical model of the target location

and tracking in the wireless sensor network is introduced. According to the setting, there are observation models:

$$c(g) = t(g) + m(g) + f(g) = \begin{cases} -g, & g < 0, \\ g, & g \geq 0. \end{cases} \quad (9)$$

Among them, $m(g)$ represents the observation deviation of the sensor. It is the best study to obtain the true value $t(g)$ from the observed value $c(g)$ polluted by the observed noise $m(g)$. For this, a mathematical template for the signal $t(g)$ needs to be created. Assuming that the target acceleration at time is $x(g)$, the formula for normal motion is as follows:

$$t(g+1) = t(g) + i(g)s_p + \frac{1}{2}s_p^2x(g), \quad (10)$$

$$i(g+1) = i(g) + s_p x(g). \quad (11)$$

Here, acceleration $x(g)$ is composed of two parts: maneuver acceleration $v(g)$ and random acceleration $d(g)$.

$$x(g) = v(g) + d(g) + \lim_{n \rightarrow \infty} \left(1 + \frac{1}{n}\right)^n. \quad (12)$$

Among them, $v(g)$ is the control signal of the target's own power system, which is a known flexible signal given by rewards, and $d(g)$ is determined by external random conditions such as wind factors. Suppose it is noise independent of $m(g)$ with zero mean and variance τ_d^2 .

Combining Equations (11) and (12) can get the following state space model:

$$\begin{bmatrix} t(g+1) \\ i(g+1) \end{bmatrix} = \begin{bmatrix} 1 & s_0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} t(g) \\ i(g) \end{bmatrix} + \begin{bmatrix} 0.45s_0^2 \\ s_0 \end{bmatrix} v(g) + \begin{bmatrix} 0.45s_0^2 \\ s_0 \end{bmatrix} d(g),$$

$$c(g) = [1 \ 0] \begin{bmatrix} t(g) \\ i(g) \end{bmatrix} + m(g) + \lim_{n \rightarrow \infty} \sqrt{a^2 + b^2}^n. \quad (13)$$

Further promotion, changing the target state into four dimensions $a(g) = [a \ m_a \ b \ m_b]^s$, $c(g) = [a \ b]^s$, the system's positioning area variable model is as follows:

$$a(g+1) = \rho a(g) + \gamma v(g) + \pi d(g) + e^{-i\omega t} \sum_k \left(\frac{n}{g}\right), \quad (14)$$

$$c(g) = ga(g) + m(g) * \prod_{cg}^{uk} i = 1.$$

In the formula, $c(g)$ is the spatial change value. In target tracking, we often do not consider the target's own power control signal, so the dynamic change formula is often expressed as follows:

$$a(g+1) = \rho a(g) + \sigma d(g) + e^{-i\omega t} \xrightarrow{\text{yields}} \begin{bmatrix} u & v \\ k & g \end{bmatrix}. \quad (15)$$

Among them, if $\rho = \begin{bmatrix} 1 & s_0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & s_0 \end{bmatrix}$, $\sigma = \begin{bmatrix} s_0^2/2 & 0 \\ s_0 & s_0^2/2 \\ 0 & s_0 \end{bmatrix}$ is

the distance between the sensor and the target, the observation equation is as follows:

$$c(g) = \sqrt{(a(g) - a_0)^2 + (b(g) - b_0)^2} + m(g). \quad (16)$$

The target position $(a(g), b(g))$ is unknown, and the sensor position (a_0, b_0) is known. Similarly, if it is pure azimuth target tracking and the observation is the azimuth angle, the observation equation can be written as follows:

$$c(g) = xez \cos \frac{b(g) - b_0}{a(g) - a_0} + m(g). \quad (17)$$

When detecting a target, the sensor can often roughly judge the distance from the target based on the intensity of the detected target, such as the intensity of sound information (dB) and the strength of the wireless received signal, and use this intensity as an average value. Such a weighted centroid location algorithm can be expressed as follows:

$$a = \frac{\sum_{u=1}^{\circ} d_u a_u}{\sum_{u=1}^{\circ} d_u}, b = \frac{\sum_{u=1}^{\circ} d_u b_u}{\sum_{u=1}^{\circ} d_u}, \quad (18)$$

where (a, b) represents the estimated location of the target, (a_u, b_u) represents the location of the u -th base station, and d is the weight.

3. Experiments and Conclusions of the Design and Implementation Method of Aerobics Posture Tracking and Recognition System Based on Wireless Smart Sensors

3.1. Select Sensor Operation

(1) Sensor initialization

When the CGQ7080 sensor is reset, the internal parameters need to be set. The initialization content is shown in Table 2.

CGQ7080 write data mode has single-field input mode and multifield input mode. When writing the CGQ7080 sensor, the main controller needs to send an e/d bit in addition to the start tag (S) and address bit. 0 means writing, and 1 means reading. The signal will be generated in the ninth clock range. Then, the main controller starts to transmit the address, and after receiving the payment, it starts to transmit the data, and then, there is still a response signal, which is deduced in turn. The timing can be seen in Table 3.

(2) Read data

Each time CGQ7080 collects data; it will store the data in the internal data and issue a D_R termination. The main

controller can obtain the collected sensor data by extracting the data. The reading content is shown in Table 4.

The data extraction module of CGQ7080 can be divided into two types: single extraction module and multiple extraction modules. When reading the value of CGQ7080, the master first sends a start signal (S), continues to send the slave device address and a write data bit, then sends the internal address to be read, and finally starts to read. After receiving the signal sent by CGQ7080, the master sends the start signal again and then sends the slave system address and a reading bit. Then, the CGQ7080 as the slave system sends an ACK signal and starts sending data. The communication is stopped by the screen signal and termination bit (q) generated by the master. When the SDA data is always high in the 9th cycle, a screen response signal is generated.

3.2. Communication Transmission Protocol. The receiver and transmitter can communicate with each other only when they are configured on the same channel. The frequency of the RF channel determines the center frequency used for the RF transmission channel. The NRF has five working modes: standby mode I, standby mode II, receiving mode, sending mode, and power off mode. Mode configuration options are shown in Table 5.

The modes used in this article are sending mode, receiving mode, and standby mode I. The working mode adopted by the wireless transmission module of the wireless human body gesture recognition system is two working modes: sending mode and standby mode I. The working mode of the PC is the receiving mode and the standby mode I.

The length of the module is 5 bytes, and the length is fixed. When setting the address, it includes the setting of the target address and the local address. The target address and local receiving address in this article are both: 0xFF. Of course, the address can be modified according to your own needs to ensure that the sender's target address is the same as the receiver's local address to complete normal communication.

3.3. Attitude Tracking System. Based on the guidance of the abovementioned sensor basic theory, the design of the tracking and recognition system model for aerobics movements is shown in Figure 6.

As can be seen from Figure 6, the posture tracking system of a single human arm takes the shoulder as the reference segment point, and the upper arm and lower arm of the arm are, respectively, fixed with a posture measurement unit to estimate the posture angles of the elbow and wrist segments. The two attitude measurement units send data to the central section point through the RF module. The central section point is responsible for receiving the data and sending it to the upper computer for processing through the serial port. And it can communicate with computer through serial port.

3.4. Experimental Analysis. When the system starts to operate, the central node collects the posture solution data of the two posture detection nodes and then transmits the unified solution to the computer through the unit. The computer

TABLE 2: CGQ7080 sensor initialization content.

Register address	Name	Function	Efficient
0*11	DIV	Gyro sampling rate	2.5 s
0*2X	CON	Low-pass filter frequency	3.5 s
0*2Y	G-CON	Gyro measuring range	4.1 s
0*2Z	AC-CON	Acceleration measurement range	9.5 s
0*35	INT-E	A/D conversion complete interrupt	4.5 s

TABLE 3: Single-byte write timing and multibyte write timing.

Single byte	Start	1-7	8	9	1-7	8	9	1-7	8	9	Stop
Master	t	XW	D	1	EX	0	0	DATA	0	1	Q
Slave	0	1	0	XZG	0	0	XZG	1	1	XZG	1
Multibyte	Start	1-7	8	9	1-7	8	9	1-7	8	9	Stop
Master	T	XW	D	0	EX	1	DATA	0	DATA	0	Q
Slave	1	1	1	XZG	1	0	XZG	0	XZG	1	XZG

TABLE 4: CGQ7080 sensor read content.

Register address	Name	Describe	Read speed
0*3Y-0*38	ACCEL	Three-axis acceleration data	1.5 m/s
0*40-0*46	GYRO	Three-axis gyroscope data	2.0 m/s
0*40-0*33	XYZ	Three-axis data	2.3 m/s
0*25-0*51	OUT-HL	Three-axis human body data	1.7 m/s

TABLE 5: NRF working mode configuration.

Mode	P-u	P-r	Ce
Send mode	0.5	0.1	0.5
Receive mode	0.5	0.5	0.5
Standby mode I	0.5	-	0.1
Standby mode II	0.5	0.1	0.5
Power down mode	0.1	-	-

is judging and distributing, so as to timely present the posture tracking results of human aerobics on the interface. Fix the attitude measurement unit 2.5 cm closer to the wrist and elbow sections, keep other parts of the body stationary, the position of the shoulder section can be similar as the fixed position, as the starting value of the position, and the acquisition frequency of the sensor parameters is 30 Hz. The detection accuracy of a detection module affects the posture tracking accuracy of the whole system. Firstly, the posture detection results of a single measurement unit on a single limb and the influence of the set point of the sensor on the posture measurement results are tested. Firstly, fix the sensor 2.5 cm away from the carpal tunnel and in the middle of the lower arm, keep the upper limb stationary, and the lower arm stretches and bends at a slower speed, repeat it for 5 times, and measure the action steps of the carpal tunnel, as shown in Figure 7.

It can be seen from Figure 7 that the movement of the upper limbs is about 90 degrees, resulting in an arc-like curve. The blue curve in the figure is the wrist-segment curve obtained by fixing the close-together segment, and the brown curve is the wrist-segment curve obtained by fixing it in the middle of the lower arm. The upper limbs move repeatedly within 90 degrees. It can be seen from the figure that the measured curve of the closed segment is basically the same as the actual curve. The curve is fixed at the middle position, and the curve deviates from the normal curve more. This is because the closer the fixed point is, the closer the curve is. Reduce the impact of arm tremor so that the measurement position is far away from the normal value. By selecting four sets of weights for position estimation, the error weights and deviations of the elbow pass and wrist pass are calculated, respectively, as shown in Figure 8.

It can be seen from Figure 8 that the analysis shows that the average deviation of the four groups of experiments is within 0.9 cm, which correctly represents the estimated position of the pass. The standard deviation and standard error show that the error fluctuation is very small, which meets the stability requirements of the motion tracking and recognition system.

3.5. Classifier Selection and Algorithm Research. The experiment process is divided into two parts: training and testing. This experiment selected 8 aerobics volunteers and completed the data of 6 postures independently of each other. Each of the six postures lasted for 1 minute. The rate is 55 Hz, and the steady state of the human body is generally about 2 seconds, so the sampling time window length is set to 1.2 s, and the repetition rate is 58%. A total of more than 250 samples of each type are formed, and 12% of them are taken as test samples and 88% for training samples, and cross-validation of the classifier is performed.

For the classifiers of the motion state, this study learned three classifiers. The factors that determine the effect of a classifier mainly include input feature selection, kernel function selection, penalty factor, and kernel function

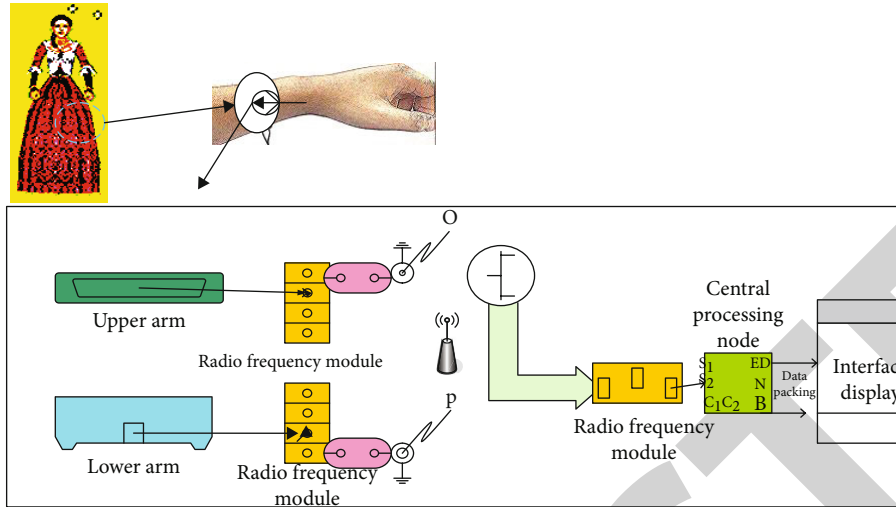


FIGURE 6: Schematic diagram of attitude tracking system.

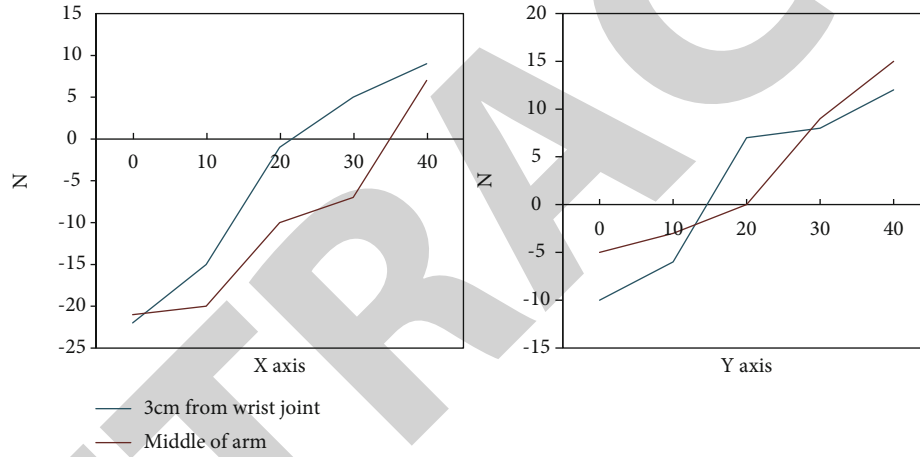


FIGURE 7: Wrist joint movement trajectory during arm bending.

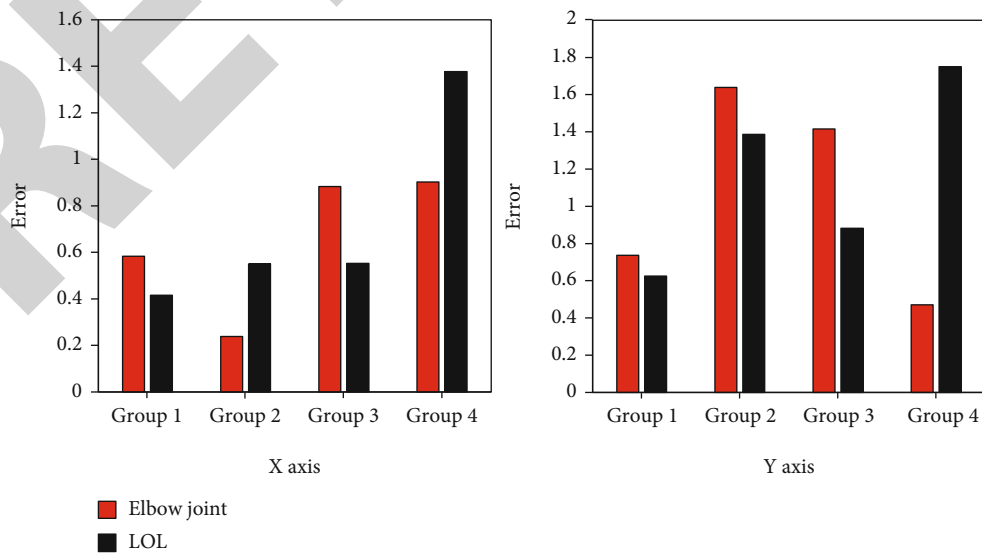


FIGURE 8: Comparison of joint position estimation errors.

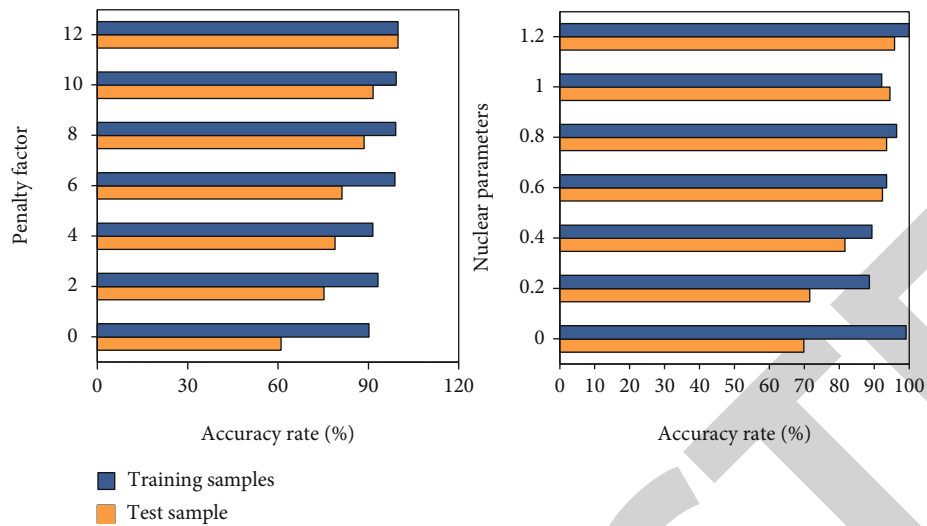


FIGURE 9: Accuracy of other classifiers with penalty factor and kernel parameter variation curve.

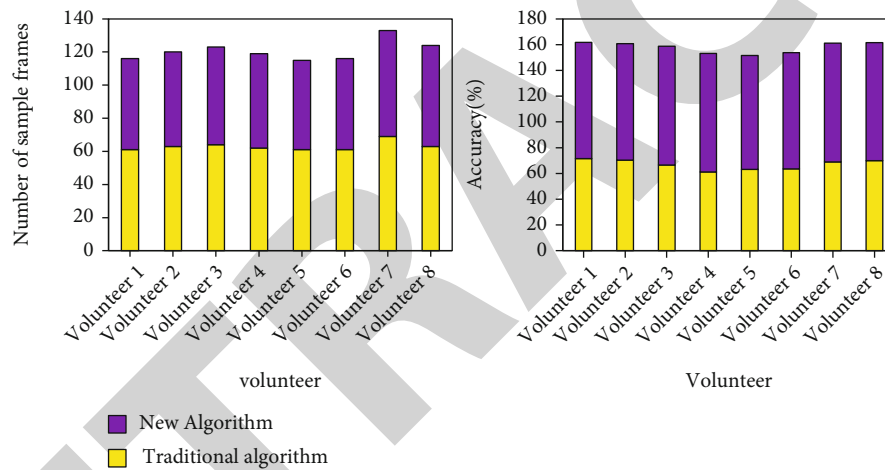


FIGURE 10: Test statistics table.

parameters. Due to the differences between each type of sample, the types and parameters of the three classifiers are different, so it is necessary to find the best classifier through experiment and certain comparative analysis. The experimental results can be seen in Figure 9.

From Figure 9, we can know that when the penalty factor is greater than 8.5, the test sample accuracy rate reaches a maximum of 99.8%, and the training sample accuracy rate reaches 100%. It shows that the recognition accuracy of this classifier is relatively high.

Based on the trained classifiers of each module, we combine them into a complete human pose recognition algorithm. This section will complete the algorithm test. This research needs to collect continuous motion state time series to test the algorithm. During the experiment, the data of 8 volunteers were collected, and the duration was more than 25 seconds. The aerobics volunteers should use all the postures that need to be tested, and each normal posture tried to maintain stability and lasted for about 6 seconds. If it is recognized as a turning state and the previous one is in a

motion state, the previous frame is extracted and feature extraction is performed, and finally, it is input into the recognition classifier for turning recognition classification. After the final experiment, the calculation result as shown in Figure 10 is obtained.

As shown in Figure 10, the statistical accuracy rate is 90.6%. It shows that the algorithm or the system designed in this paper has extremely high accuracy.

4. Discussion

This paper uses the particle swarm algorithm to optimize the key parameters to obtain the coincidence curve, then calculates the window similarity between different coincidence curves, and uses it as the distance measure of the g-neighbor algorithm. Finally, the g-nearest neighbor algorithm is used to identify six human postures. The experimental results show that the complexity of the formula of the algorithm in this paper is less difficult, and it can accurately recognize a variety of human postures.

Secondly, this article firstly defines the six common human posture actions of the human body and gives the corresponding actions of the control model. Based on the change characteristics of the posture angle, the six human postures are expressed and the recognition of these six human postures is given. In addition, the implementation process of the tracking recognition system based on the MFC framework and graphics library is introduced in detail, including the realization of data acquisition module, kinematics modeling, and display module.

This article also introduces the attitude measurement system, including attitude measurement unit, wireless sensor network, and host computer display interface. At the same time, the data collection and calculation of the human arm posture show that the human posture tracking effect is good based on the geometric constraints of the arm posture. Through the measurement of the posture measurement unit at different positions of the arm, it is concluded that the fixed position of the posture measurement unit will also affect the posture measurement result.

5. Conclusions

The wireless sensor network came into being with the continuous development of science. It integrates the technologies of a variety of complex disciplines and has great application value in positioning and tracking technology. In order to explore whether it is possible to make a real-time model of tracking and recognition when doing aerobics, we adopted a variety of scientific methods, such as system construction and platform simulation, to simplify the algorithm. There are a lot of experiments in this article, but only the choice of location is the most important, because a good location directly determines whether the results of this article are meaningful, and we finally found the best location, which is 2.5 cm from the wrist. The experimental results of the algorithm in this paper also prove its accuracy. Then, set the sampling time window length to 1.2 s and the repetition degree to 58%, forming a total of more than 250 samples for each class, and extract 12% of them as test samples and 88% as training samples for cross-validation of the classifier. As a result, when the penalty factor is greater than 8.5, the test sample accuracy rate reaches a maximum of 99.8%, and the training sample accuracy rate reaches 100%. It shows that the classifier selected in this paper has higher recognition accuracy. The shortcomings of this article are as follows: first, the hardware part needs to be tailored to make the wireless human body gesture recognition system more compact for the operator to use and to study the human body gesture recognition system fused with multiple sensors in order to recognize the operator's more complex human body posture. Secondly, when the posture of the static reference segment changes when the human body moves, the posture display interface will produce posture deformation. It is necessary to optimize the human body model and improve the posture relationship between the segment points. Combining these deficiencies, it is realized that in the next step of research, we should focus on the stability of the sensor segment and optimize the

hardware system, so that the tracking and recognition model in this article is not just a matter of paper and can be better.

Data Availability

No data were used to support this study.

Conflicts of Interest

The author declares that there is no conflict of interest with any financial organizations regarding the material reported in this manuscript.

Acknowledgments

This work was supported by the Shaanxi Social Science Foundation Project.

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