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Research Article

Quantitative of Badminton Practice Based on Wireless Sensor Network

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In recent years, badminton sports have attracted the public and the majority of young students. Badminton training has received extensive attention in the field of sports. However, there is currently no effective and accurate method for effective analysis of badminton training. In order to solve this problem, this paper combines the training teaching theory and the representation training theory and applies the fuzzy algorithm to construct the fuzzy evaluation model based on the analytic hierarchy process. After the experiment, the test scores of the sports quality of the two groups of badminton special students were improved. Through the screening of the seven functional modes of action, it was found that the special students' left and right symmetry differences were obvious, the lower limbs were not stable, the core area was weak, and the muscle control ability on both sides of the spine needed to be strengthened.

1. Introduction

In recent years, badminton [1, 2] has attracted the masses and young students. The popularization and development of badminton have aroused widespread concern in the field of teaching and training. Predecessors also discovered many novel and practical training methods in their exploration and practice. However, the current research on badminton teaching mainly focuses on professional sports team training and college badminton classroom teaching. There is a lack of research on teaching and training methods for the public and young people. Badminton is a good fitness exercise for young people, mobilizing the whole body cells, but there has been no systematic badminton training, and there is no good hardware facilities to capture athletes performing badminton training, so it is not very good. Therefore, it is an urgent task to research and determine effective youth education methods [3] to fill this gap. This is also a difficult task.

This article divides the participants into two classes: the experimental class adopts the core strength training method, and the control class adopts the traditional strength training method. The training content is arranged according to different groups before and after. After 12 weeks of training, the experimental class and the control class analyzed the sports quality of badminton students, strength quality indicators and special speed quality indicators, and analyzed the results using a fuzzy algorithm model.

The first section of the article outlines the areas covered in this article and explains the overall structure of the article. The second section is a review of related literature in the field of application of fuzzy algorithms and motion control. The third section is related theoretical methods and algorithm models involved in this article. The fourth section is the experiment, including data sources and experimental settings. The section part is the analysis and discussion of the experimental results. The sixth part is a summary of the innovative points of the article [4].

2. Related Work

Regarding motion analysis, many experts and scholars have conducted research and achieved fruitful results. In [5], the inertial measurement unit for whole body motion analysis was verified by using a photoelectric system. A large number of intelligent algorithms based on social intelligent behavior have been extensively studied and applied to various optimization fields. Previous inertial measurement unit validation studies were incomplete in terms of the joints being analyzed, the complexity of the motion, and the duration of the trial. Based on the motion of 12 participants, the root mean square error of the method was smaller compared to the biomechanical model. In [6], the authors surveyed the sports analysis of 85 players (U13-U15) from the Auckland Metropolitan League in two competitive football matches. The 5 Hz Global Positioning System (with interpolated 10 Hz output) unit was used to measure standing, walking, low intensity running, medium intensity running, high intensity running, and the time required [7]. The speed threshold for each match activity was determined by the average 10 meter flight sprint peak speed for each age group. Useful information was provided for the development of specific training programs for young football players and the development of a framework for age-based football simulation protocols. Little was known about the conventional head loading environment associated with rugby joint attacks. In [8], the authors focused on the analysis of ball head movement during a rugby joint attack without direct head contact. The head motion of the visually unaware ball carrier during real game processing of the upper torso without direct head contact was measured, and the kinematics was compared to previously reported shock events. Model-based image matching was used to measure the linear and angular velocity of the ball carrier. There was also a sports analysis study on the sport of rugby. In [9], the authors used a three-dimensional motion analysis system to capture the key kinematic differences of the four types of tackles studied. Through the 66 tackle movement capture experiments of 13 elite rugby players [10], the results showed that the kinematics of the low and contralateral legs are significantly different from the kinematics of the normal shoulder joints, which may affect the performance and possible contact of the tackle. In [11], the author analyzed the three official games of the Italian Serie A Beach Soccer Championship in order to investigate the physiological needs and technical and tactical performance of the Italian elite beach soccer team's wild players. It can be seen from the above that the equipment and means used by experts and scholars in various fields are different, in order to evaluate the state of motion as comprehensively as possible, so as to facilitate the follow-up scientific treatment of sports training. Sutradhar et al. pointed out that in this article, a new method of mixing two high-efficiency metaheuristic algorithms is proposed for energy system analysis and modeling based on water and heat in a single-objective and multiobjective environment [12]. Gavriil et al. pointed out that the best model is based on the 10-dimensional E 8 gauge theory, which reduces the additional use of Wilson flux mechanism on the near Khler manifold. Then, we propose the corresponding procedure when the extra dimension is considered as the fuzzy coset space, which is also the best model constructed in this framework. In both cases, the best model seems to be the Trinity GUT [13].

The algorithm based on fuzzy mathematics in fuzzy theory is very suitable for solving the problem with ambiguity. Fuzzy mathematics originated from reality, and its development can provide a solution for dealing with the ambiguous things encountered in life. Fuzzy algorithms are widely used in many fields. In [14], the author applied the fuzzy algorithm to medical image segmentation in image processing and realizes fuzzy clustering including spatial information, which made the algorithm robust to image artifacts and facilitates further refinement of segmentation results [15]. In [16], the author conducted induction motor diagnosis and fault detection based on electrical detection methods and fuzzy algorithms and evaluates the severity of motor faults through a fuzzy inference system. The proposed method not only diagnosed the type of motor fault but also evaluated the operating state of the motor. In [17], the author applied the fuzzy algorithm to subhealth assisted diagnosis. Based on rough sets and fuzzy mathematics, the training set was used to extract important features in different subhealth classifications and generate fuzzy weight matrices [18]. The results of the test set were achieved by the comprehensive calculation of the fuzzy weight matrix and the eigenvalues of the subhealth symptoms. In [19], the author applied the fuzzy algorithm to the fault analysis of the transmission system of heavy commercial vehicles manufactured by TATA. The key components of the system under consideration were determined based on the number of risk priorities, providing a reliable guarantee for subsequent system maintenance. In [20], the authors applied fuzzy algorithms to groundwater quality assessment in the quaternary loose sedimentary basin near the Pi River to assess the sustainability of groundwater for drinking purposes. This method was more comprehensive and reasonable for assessing groundwater quality. The application case of the above fuzzy theory fully showed that the fuzzy algorithm had obvious advantages in dealing with nondeterministic complex problems. Therefore, the fuzzy algorithm can be considered for the quantitative analysis of badminton practice.

Figure 1 is a block diagram of the wireless sensor network architecture:

3. Method

3.1. Quantitative Analysis Model Based on Applied Fuzzy Algorithm. Extend the binary logic {0,1} to [0,1], broaden the feature function to the membership function $\mu A(x)$ and let $\mu A(x) \in [0, 1]$, and use it to express the ambiguity of the intermediate transition of objective things. For the result of a certain thing, there are m single factor influencing factors, so the factor set: $U = \{u_1, u_2, \cdots, u_m\}$. Write the single factor evaluation fuzzy set $R_j = (r_{j1}, r_{j2} \cdots, r_{ji})$ of the jth factor, and then obtain the single factor evaluation matrix of m factors:

$$\mathbf{R} = \begin{cases} \gamma_{11}\ \gamma_{12} \cdots \gamma_{1n} \\ \gamma_{21}\ \gamma_{22} \cdots \gamma_{2n} \\ \cdots\cdots \cdots \cdots \\ \gamma_{m1}\ \gamma_{m2} \cdots \gamma_{mn} \end{cases}. \tag{1}$$

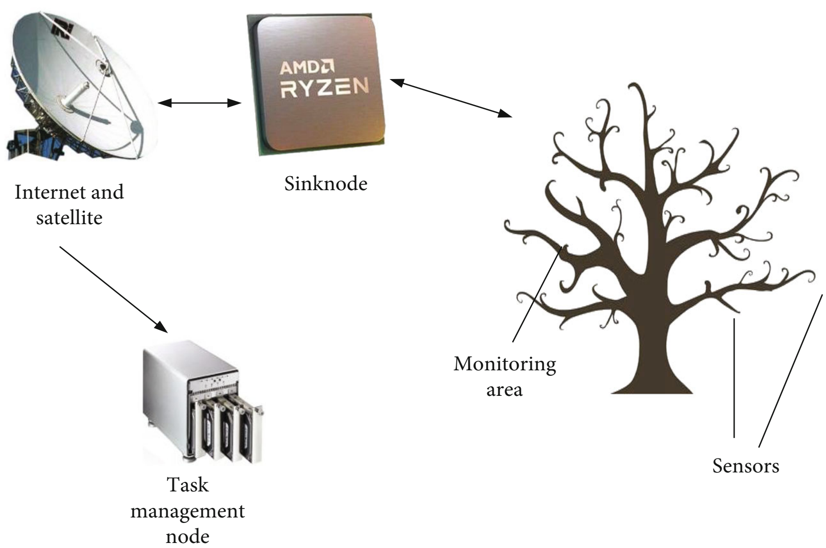

FIGURE 1: The block diagram of the wireless sensor network architecture.

Therefore, the fuzzy comprehensive evaluation set: $B = R * T$.

Suppose there are n factors, please sort by m experts. The result is a table of m rows and n columns; the numbers are $1, 2, \cdots, n$. The rank sum of the jth factor is represented by R_j. If T_j is used to represent the weight of the jth factor, the weight is calculated as:

$$T_j = \frac{2\left[m(1+n) - R_j\right]}{\left[mn(1+n)\right]} \quad (j = 1, 2, \cdots, n). \tag{2}$$

According to the weighted correlation theorem, there is always $\sum_{i=1}^{n} dij = 1$.

Once the analysis of the influencing factors increases, the complexity of the analysis increases, and the final result does not fully display the true value. The fuzzy design method, while focusing on multifactor analysis and weighting, can reflect the pros and cons of the design more comprehensively. On the other hand, the focus of the two is also different. The cross-impact analysis method focuses on the analysis of the factors themselves and their relevance. The focus of the fuzzy design analysis method is on the evaluation of the final result.

The flowchart of the proposed model is shown in Figure 2:

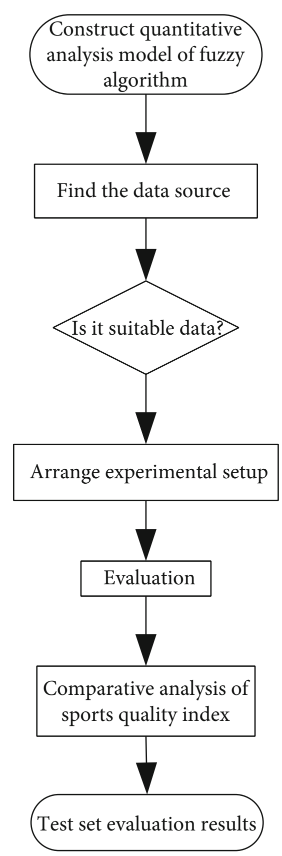

FIGURE 2: Flow chart of the proposed model.

3.2. Relevant Theoretical Concepts

3.2.1. Rosenthal Effect. The "Rosenthal Effect" actually allows a random selection of students to achieve comprehensive and significant progress through a series of emotions, language, and behaviors [21, 22] and finally achieve the expected experimental results. Students often turn passive into initiative in the process of learning, slowly change their position and mentality in the learning process, and stimulate the desire and pursuit of learning. This kind of benign interaction between teachers and students just confirms the scientific nature of the Rosenthal effect.

3.2.2. Training and Teaching. Training and teaching refer to the educational process in which the coaches teach students the physical knowledge, motor skills, physical development, and physical fitness according to the training plan and the physical education syllabus under the guidance of the coaches and the students. In the process of sports training and teaching, the training target is students, but the whole implementation process requires the participation of coaches and team members. The purpose of training is to improve the professional technical level of the players, increase their physical fitness, and achieve higher competitive or exercise requirements; second, toughen their will, and cultivate the spirit and character of the team members.

3.2.3. Representation Training Theory. The theory holds that representation training is achieved through the improvement of the understanding of the entire movement process. It believes that central activities are the basis for completing learning tasks, and muscle activities only play a supporting role, so the theory emphasizes the activities of the central center. The theory also believes that the representational training is mainly used in psychological internal activities. Through the improvement of attention, the reduction of exercise anxiety, and the improvement of self-confidence, a series of psychological skills are improved to affect behavioral performance. The suggestion of this theory shows that the representational training not only affects the mechanism of action learning but also regulates the mental state of using skills.

The wireless sensor network provides the infrastructure for the centralized training of badminton. Figure 3 is a flowchart of key technologies in wireless sensor networks:

3.3. Evaluation System Based on Analytic Hierarchy Process. The first step is to build a model for the evaluation index system of badminton players' competitive ability. Through the established model, the complex problems are organized and hierarchically processed. In this study, it is equivalent to the four levels of competitive ability—first level indicator, second level indicator, and third level indicator.

The second step establishes a pairwise comparison judgment matrix. Suppose you want to compare the n factors $X = \{X_1, X_2, \cdots, X_n\}$, set their impact on the target to H, and determine their percentage in H, taking 2 factors each time. If the matrix $A = (\alpha_{ij})n \times n$, satisfied

$$\alpha_{\imath j} > 0, \alpha_{\imath j} = \frac{1}{\alpha_{\imath j}} > 0, i \neq j. \tag{3}$$

Then, form a pairwise comparison matrix A (also known as a positive reciprocal matrix) as:

$$A = \begin{vmatrix} \mathbf{a_{11}} & \mathbf{a_{21}} & \wedge & \mathbf{a_{n1}} \\ \mathbf{a_{21}} & \mathbf{a_{22}} & \wedge & \mathbf{a_{n2}} \\ \mathbf{M} & \mathbf{M} & \mathbf{O} & \mathbf{M} \\ \mathbf{a_{1n}} & \mathbf{a_{2n}} & \wedge & \mathbf{a_{nn}} \end{vmatrix}. \tag{4}$$

The third step calculates the weight vector. The feature vector and the maximum eigenvalue of the judgment matrix are calculated. Its calculation formula is

$$W_i = \frac{\left(\prod_{j=1}^{n} aij\right) 1/n}{\sum_{n=1}^{n} \left(\prod_{j=1}^{n} aij\right) 1/n}, i = 1, 2, 3, \Lambda, n. \tag{5}$$

It is generally considered that when CI < 0.1, it is logical that the calculated weights can be recognized. The consistency index CI is calculated as:

$$\mathrm{CI} = \frac{\lambda \max - n}{n - 1}, \quad \lambda_{\max} = \frac{1}{n} \sum_{i=1}^{n} \frac{a_{ij} \times w_i}{W_i}. \tag{6}$$

Generally, when CR < 0.1, it means that the consistency test passed; when CR ≥ 0.1, it means that the consistency test failed.

$$\mathrm{CR} = \frac{\mathrm{CI}}{\mathrm{RI}}. \tag{7}$$

Introduce the concept of location error:

$$\text{location\_error}_i = \sqrt{\|\tilde{x}_i - x_i\|_2} \quad i = 1, \cdots, N. \tag{8}$$

Introduce the concept of average error:

$$\text{average\_error} = \frac{\sum_{i=1}^{N} \text{location\_error}_i}{N} = \frac{\sum_{i=1}^{N} \sqrt{\|\tilde{x}_i - x_i\|_2}}{N}. \tag{9}$$

The standard deviation of the position error represents the consistency of the positioning accuracy of the algorithm:

$$\text{standard\_deviation} = \sqrt{\frac{1}{N} \sum_{i=1}^{N} (\text{location\_error-average\_error})^2}. \tag{10}$$

Use the Global Energy Ratio (GER) to measure the positioning accuracy of the algorithm:

$$\mathrm{GER} = \frac{\sqrt{\sum_{i<j} \left(\left(\mathrm{dist}_{\mathrm{est}}(s_i - s_j) - \mathrm{dis}_{\mathrm{true}}(s_i - s_j) \right) / \mathrm{dist}_{\mathrm{ture}}(s_i - s_j) \right)^2}}{N(N-1)/2}. \tag{11}$$

According to the principle that the RF signal attenuates with the propagation distance, sampling and fitting are used to obtain the function relationship with the distance. The commonly used RF signal attenuation model is

$$P(d)[dBm] = P(d_0)[dBm] - \eta 10 \lg \left(\frac{d}{d_0} \right) + x_\sigma. \tag{12}$$

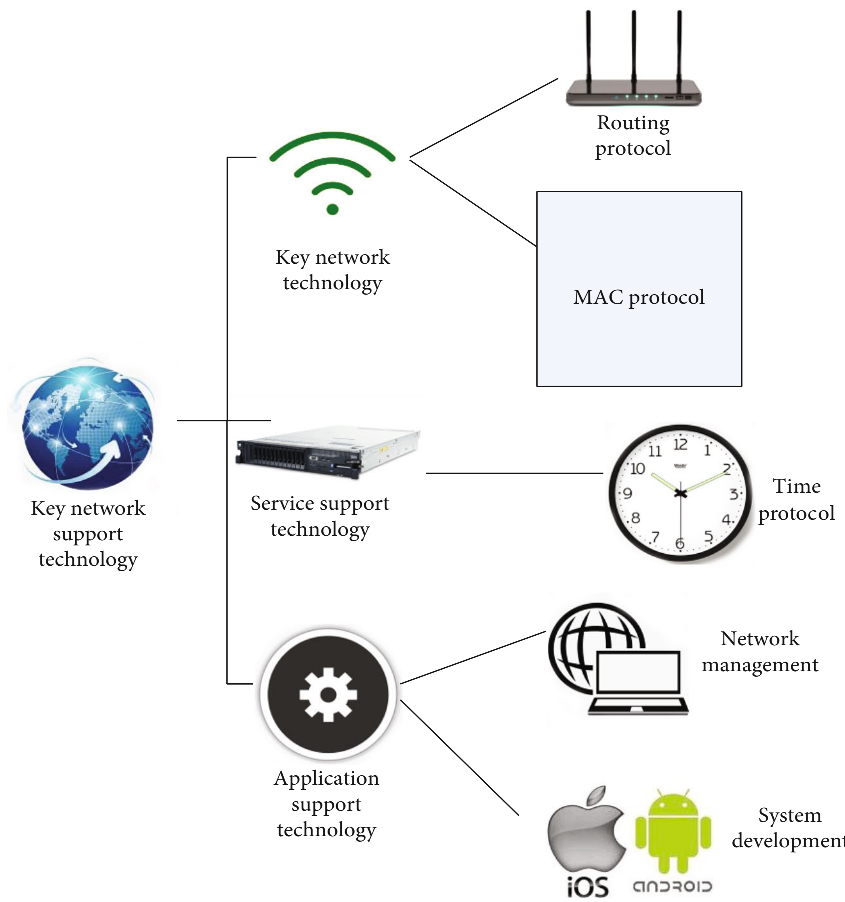

Figure 3: The flowchart of key technologies in wireless sensor networks.

Amend equation (12) and propose an attenuation model:

$$P(d)[dBm] = P(d_0)[dBm] - \eta 10 \lg \left(\frac{d}{d_0}\right) - \begin{cases} nW \times WAF, nW < C \\ C \times WAF, nW \geq C \end{cases}. \quad (13)$$

Introducing the node distance, the two signal propagation speeds, and the signal arrival time, their relationship is as follows:

$$T_1 = \frac{d}{c_1}, \quad T_2 = \frac{d}{c_2}. \quad (14)$$

Identical deformation can be obtained:

$$d = (T_2 - T_1) \times S. \quad (15)$$

Table 1: Summary of body samples of experimental samples.

Body index	Experimental class	Control class	t	P
Age	21.03 ± 0.82	22.60 ± 1.07	0.937	0.361
Height	172.60 ± 3.75	173.6 ± 3.10	-0.650	0.524
Weight	69.70 ± 6.29	71.30 ± 4.32	-0.663	0.516

Get the matrix based on the least squares estimate:

$$A = 2 \begin{bmatrix} x_1 - x_n & y_1 - y_n \\ x_2 - x_n & y_2 - y_n \\ \cdots & \cdots \\ x_{n-1} - x_n & y_{n-1} - y_n \end{bmatrix}, \quad B = \begin{bmatrix} x_1^2 - x_n^2 + y_1^2 - y_n^2 + d_n^2 - d_1^2 \\ x_2^2 - x_n^2 + y_2^2 - y_n^2 + d_n^2 - d_2^2 \\ \cdots \\ x_{n-1}^2 - x_n^2 + y_{n-1}^2 - y_n^2 + d_n^2 - d_{n-1}^2 \end{bmatrix}. \quad (16)$$

TABLE 2: Comparative analysis of the strength and quality indicators between the experimental class and the control class after the experiment.

Test index	Experimental class	Control class	t	P
In-place badminton throwing away	8.86 ± 0.333	8.39 ± 0.337	3.16	0.005
20-second chest push barbell	28.9 ± 4.121	21.6 ± 1.429	5.291	0.005
60-second sit-ups	58 ± 3.4641	51.6 ± 2.22	4.918	0.012

Find the coordinates of the unknown node T:

$$\begin{cases} x_0 = \dfrac{(y_2 - x_2 \tan \alpha_2) - (y_1 - x_1 \tan \alpha_1)}{\tan \alpha_2 - \tan \alpha_1} \\ y_0 = \dfrac{(x_2 - y_2 \cot \alpha_2) - (x_1 - y_1 \cot \alpha_1)}{\cot \alpha_2 - \cot \alpha_1} \end{cases}. \tag{17}$$

The overlapping area where the unknown node is located is calculated as follows:

$$(x, y) \in [\max (x_i - l), \max (y_i - l)] \times [\min (x_i + l), \min (y_i + l)]. \tag{18}$$

Considering the influence of network topology and connectivity, the average hop count of neighbor nodes can be used to estimate the hop count of unknown nodes:

$$S_i = \frac{\sum_{j(nbrs(i))} h_j + h_i}{|nbrs(i)| + 1} - 0.5. \tag{19}$$

The position estimate of the unknown node can be calculated by the following formula:

$$\widehat{x} = \frac{1}{k} \sum_{i=1}^{k} a_i. \tag{20}$$

The weighted centroid algorithm (WCL) is as follows:

$$\widehat{x} = \sum_{i=1}^{k} w_i a_i. \tag{21}$$

Taking into account the distance d_i between the unknown node and the beacon node, the weight is

$$w_i = \frac{d_i^{-g}}{\sum_{i=1}^{k} d_i^{-g}}. \tag{22}$$

Construct coordinate points on multidimensional space:

$$f\left(p_{ij}\right) \approx d_{ij}. \tag{23}$$

In the MDS algorithm, the size of the stress coefficient (STRESS) is usually used to measure the degree of fit. The stress coefficient is defined as follows:

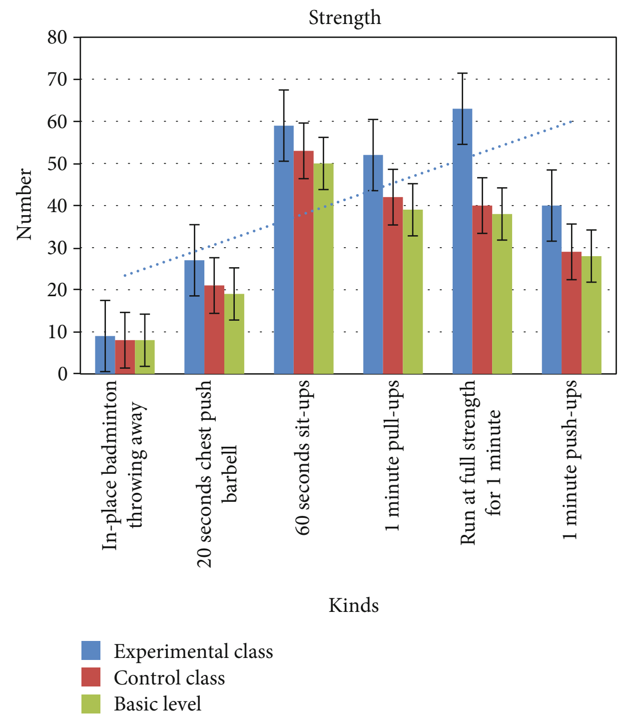

FIGURE 4: Comparison of the increase in the rapid strength index of the experimental class and the control class.

$$\text{STRESS} = \sum_{i,j,i \neq j} \left(f\left(p_{ij}\right) - d_{ij} \right)^2. \tag{24}$$

4. Experiment

4.1. Data Source. According to the data after the basic information of the experimental object and the sports quality data after the special student test, the subjects were divided into experimental class (group A) and experimental class (group B), 30 groups in each group. Let the experimental group and the control group achieve a more reasonable comparison; therefore, the actual age, height, weight, and data measured before the experiment are very small, as shown in Table 1 for details.

The average age of the participants in the experimental class was 21.3 years old, which was 0.5 years younger than the average age of the subjects in the control class. The average height of the subjects in the experimental class was 172.6 cm, which was 1.4 cm shorter than that of the control class. In terms of body weight, the average weight of the subjects in the experimental class was 69.7 kg, which was 1.3 kg

Table 3: Comparative analysis of speed and quality indicators between experimental class and control class after experiment.

Speed quality indicator	Experimental class	Control class	t	P
Action quality indicator	47.00 ± 5.29	41.10 ± 5.70	2.398	0.028
Response quality index	55.70 ± 5.46	47.30 ± 2.30	4.467	0.000
Mobile quality indicator	34.16 ± 1.42	36.64 ± 1.89	-3.326	0.004

higher than the average weight of the subjects in the control class. After statistical analysis, the two groups did not have significant differences in age, height, and weight, and the P values were all greater than 0.05. The impact of these three indicators on the experiment can be ignored in the experiment.

4.2. Experimental Setup

4.2.1. Control of Experimental Time. Subjects are required to participate in training on time. Under the guidance of a teacher, the experimental class will be trained in core strength training from 4 to 5 pm on Wednesdays. The control class will be under the guidance of another teacher on the afternoon of every Tuesday and Thursday. Practice from 4 to 5 using conventional waist strength training; monitor and measure exercise intensity data during this experiment. The student's heart rate is around 135 to 150 per minute.

4.2.2. Experimental Indicator Record Control. The indicators tested during the experiment were all recorded by the same person at the same site and at the same time. The experiment was started before and after the experiment to ensure that the experimental participants had a small difference in physical condition. In order to ensure the accuracy of the experimental data, the following requirements must be made: the experimental subjects must fully comply with the experimental requirements to ensure the quality of sleep; the subjects do not need to change their daily eating habits, thereby reducing the interference of other diets.

4.2.3. Operating Environment. For processor module hardware facilities, the processor module is the heart of the entire node and shoulders the burden of coordinating the work of the various modules of the entire node. Choosing the appropriate processor chip is very important in node design. According to the composition characteristics of the wireless sensor network, the processor chip of its node should meet the following requirements:

(i) Low power consumption working mode and support sleep mode

(ii) The peripheral integration is high, and there is basically no need to develop additional chips to keep the peripheral circuits effective and tidy

(iii) There are enough external I/O ports and communication ports

(iv) The running speed is relatively fast, and the event processing can be completed in a short time, so as to quickly enter the sleep state

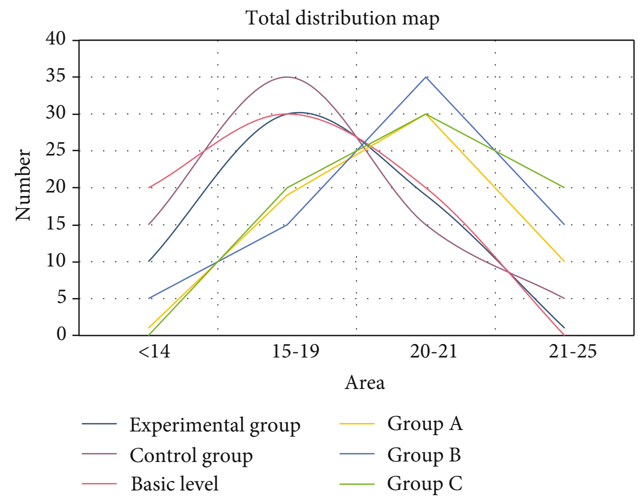

Figure 5: Total distribution map.

(v) The size is small, and the size of the processor basically determines the size of the entire node

(vi) The cost is low, and a large number of nodes need to be deployed. It is necessary to reduce the cost. At present, most nodes use high-end 8 or 16-bit microcontrollers as core processing units, such as ATMEL's ATmega128 series microcontrollers and TI's MSP430 series microcontrollers, which can meet the basic functions of wireless sensor network networking, routing, and data collection. This system design selects ATmega128 single-chip microcomputer as the core processor

4.3. Questionnaire Design and Distribution. This experiment evaluates the imaging ability using the "Sports Representation Questionnaire" (SIQ) developed by Masten. The scale is set up with four scenes. Each scene marks the four latitudes of the representation as visual, auditory, and kinesthetic. Each latitude adopts a five-level scoring method; that is, there is no representation of 1 point, the representation is unclear to 2 points, the degree of representation is generally 3 points, the representation is clear and vivid, and the representation is very clear and vivid. The four scene scores for each latitude are added to obtain a latitude score.

4.4. Evaluation Indicators

(1) First-level indicators: strength indicators; secondary indicator: rapid strength indicator; three-level indicators: badminton throw distance, 30S chest fast push barbell, 60-second sit-ups

Table 4: Results of each test action mode.

	Deep squat	Hurdle step	Inline lunge	Shoulder mobility	Active straight-leg raise	Trunk stability push-up	Rotary stability
Average	2.4667	2.0000	2.2833	2.7667	2.7000	2.2667	1.8833
Minimum	0.00	1.00	1.00	0.00	2.00	1.00	1.00
Maximum	3.00	3.00	3.00	3.00	3.00	3.00	2.00

(2) First-level indicators: speed quality indicators; secondary indicators: movement speed, reaction speed, movement speed; three-level indicator: 30-second fast swing, 60-second hanging Internet, speed running (30 meters), 30 seconds to hit the wall; 10 times to kill the Internet, "M" word fast movement (5 times)

(3) First-level indicators: sensitive quality indicators; secondary indicators: 30 seconds to hip jump, 30-second double shake, left and right touch (5 times)

(4) First-level indicators: endurance quality indicators; secondary indicators: 800 meters running, multiball running

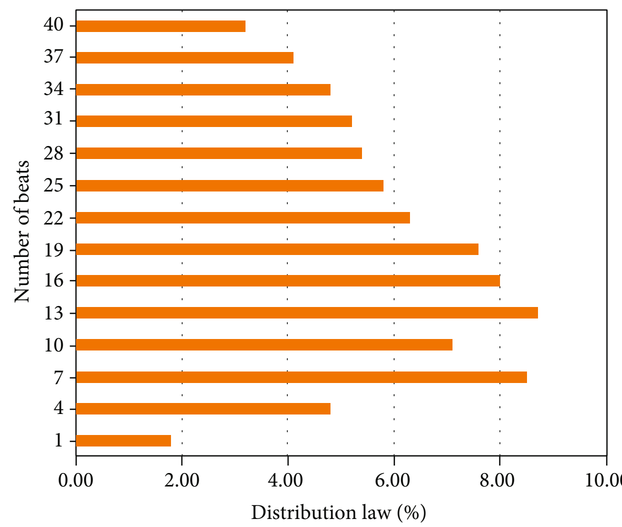

Figure 6: Beat distribution rate.

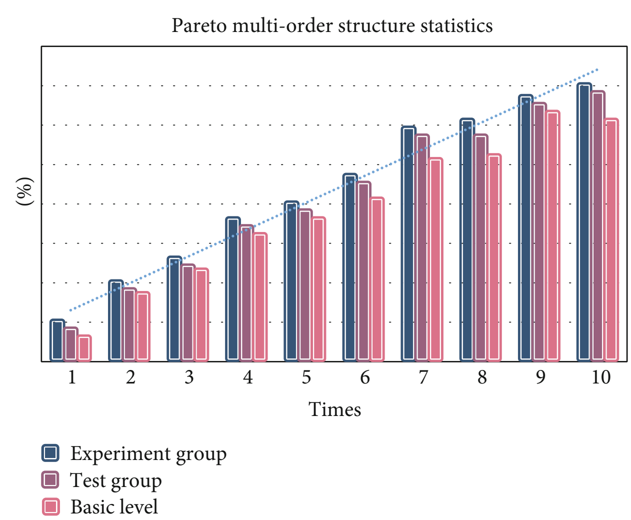

Figure 7: Pareto multiorder structure statistics.

5. Results and Discussion

5.1. Comparative Analysis of Sports Quality Indicators after Experiment

5.1.1. Strength Quality Indicators. Table 2 is a comparative analysis of the strength and quality indicators of the experimental and control classes after the test. Figure 4 is a comparison chart of the increase in the rapid strength indicators.

After 12 weeks of experiment, the results of the two groups of indicator test differences, the original badminton throwing far $t = 3.16$, $P = 0.005 < 0.001$, the original badminton throwing away, the test results between the two groups, significant differences, experiment after 60 seconds of sit-ups, and a 20-second chest push barbell P value of less than 0.001, the test results between the two groups showed a very significant difference.

The strength and quality of the experimental and control class members of the two groups of subjects were improved. The experimental class in-field badminton throws farther 9.12 meters than the control class increases 0.7 meters; 30-second chest fast push barbell times the experimental class increased 7.3 times than the control class; 60-second sit-ups experimental class increased the average increase compared to the control class 7.3.

The original badminton throwing index reflects the strength of the explosive force of the upper and lower limbs and the lower back. The experimental results show that the experimental class has improved more than the control class. In addition, the experimental results of the experimental class were higher than the control class, indicating that the experiment was effective in coordinating the explosive force of the hands, legs, waist, and abdomen. The experimental class members used the Swiss ball in training to control the body in an unstable state and perform elastic band training. Experiments have shown that training not only increases the strength of the surface layer muscle group but also enhances the control of the deep muscle group to the body.

5.1.2. Speed Quality. Table 3 is a comparative analysis of the speed quality indicators of the experimental and control classes after the experiment.

Before the experiment, the T test was carried out on the indexes of the experimental class and the control class. The P value of the test was greater than 0.05. There was no significant difference in the speed quality index structure of the

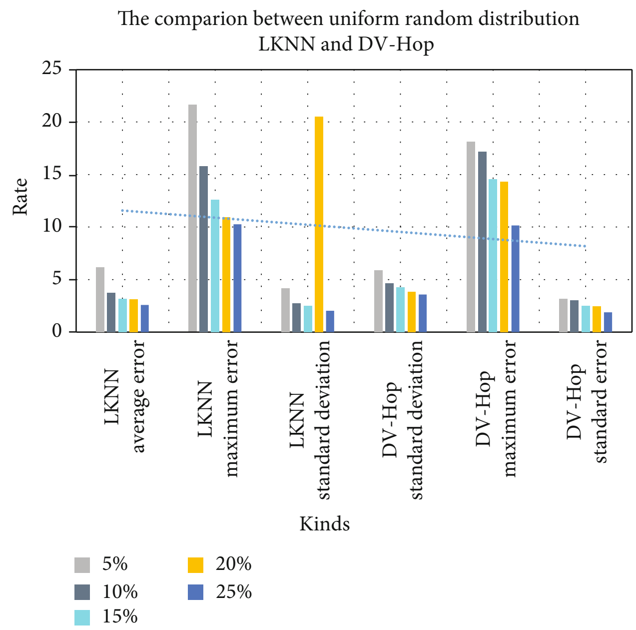

Figure 8: The comparison between uniform random distribution LKNN and DV-Hop.

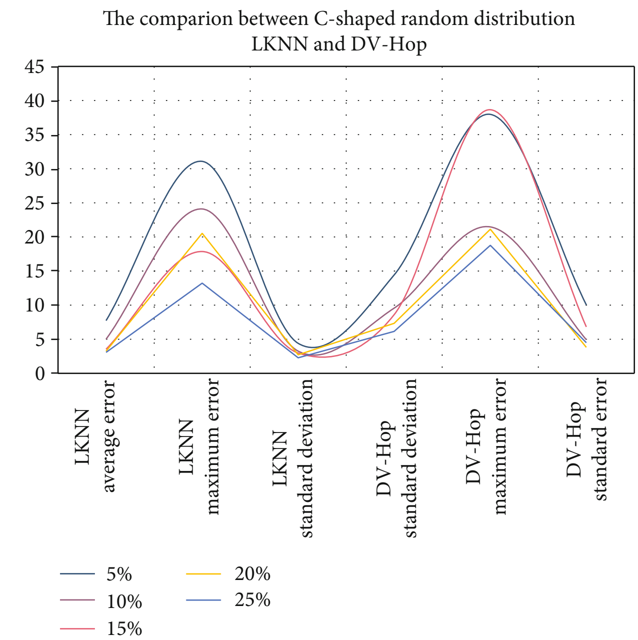

Figure 9: The comparison between C-shaped random distribution LKNN and DV-Hop.

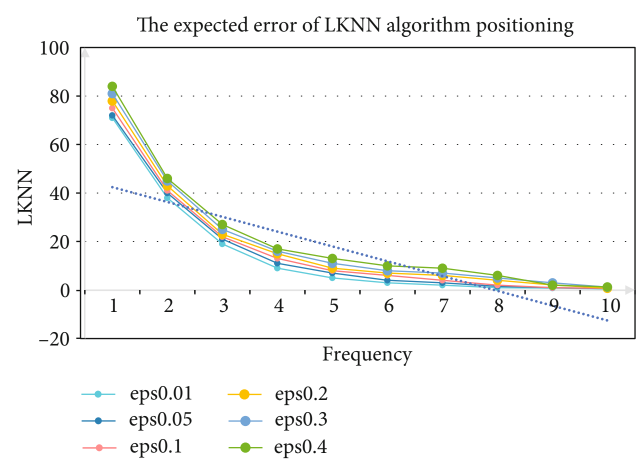

Figure 10: The expected error of LKNN algorithm positioning.

badminton special test before the experiment. The results in Table 3 show that there are significant differences in the results of the indicators between the two groups after the experiment. Movement speed indicators are as follows: 30-second fast swing, 30 seconds on the wall, and 60 seconds off the Internet through the independent sample t-test; P value is less than 0.01, including 30-second fast swing $P < 0.05$; three indicators after the experiment were a significant difference between the two groups. After the t-test, the P value was less than 0.01, and the results of the indicators of the two groups were significantly different after the three experiments. The results show that the response speed, movement speed, and speed of movement indicators have changed significantly through the training of the main strength training program for three months. Through the experiment, the indicators of the experimental class members are more obvious than the indicators of the control class.

5.2. Functional Action Analysis Based on Applied Fuzzy Algorithm Model. According to the statistical results, the total score of 10 students is ≤14 points, accounting for 16.7% of the total number. The scores of 50 people are between 15 and 19 points, and the percentage of the total number is 76.7%. Only one person with 20 points and 20 points is only 1.7% of the total. According to the table, it is not difficult to see that a total of 17 people had a total score of 17 points, accounting for 28.3% of the total number of testers (see Figure 5).

As can be seen from Table 4, the average score of deep squat for the 60 students tested was 2.47 ± 0.68, and the average score of the hurdle step was 2.00 ± 0.55. Average score was2.28 ± 0.72, shoulder mobility average score was2.76 ± 0.53, active straight leg raise average score was2.70 ± 0.46, trunk stability push-up average score of the trunk stability push-up was2.27 ± 0.58, and the average score of the rotary stability was1.88 ± 1.69. There were 0 points in both the top squat and the shoulder flexibility.

According to the previous analysis of individual test results, among the 60 badminton special test students involved in this experiment, only one badminton special student in the shoulder pain test performed the exclusion test after completing the shoulder flexibility action mode. The shoulders produced pain, and the shoulder flexion action score was 0.

5.3. Distribution Characteristics of the Basic Unit Competitive Process

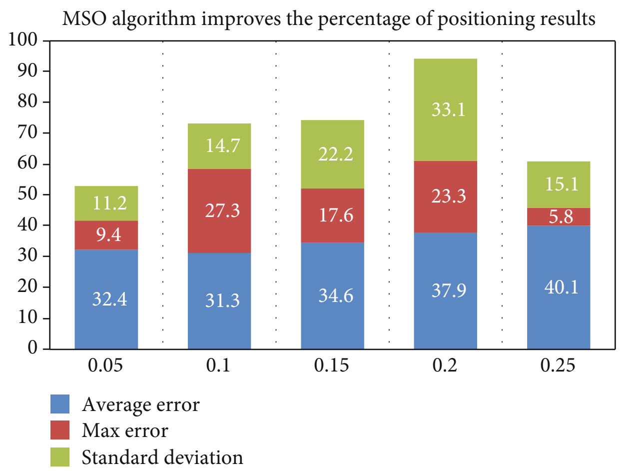

Figure 11: MSO algorithm improves the percentage of positioning results.

(1) Statistics and analysis of beat frequency

From Figure 6, we can see that in the single competition, the minimum number of shots of the two players is one, and the highest number of shots is forty-nine shots, but the latter situation is rare in many games, only once. 90% of the basic unit competitive process is mainly distributed within the 20-shot structure. According to the stage of the badminton basic unit competitive process, it can be known that the frequency of the launching phase consisting of one beat and two beats is the total number of beats. 6.7%, the three-shot and four-shot composition of the attack and defense stage after the transmission took up 15.74% of the total number of shots, while the five-beat and six-shot composition of the initial stage, seven beats and eight beats constitute the middle, and nine and nine shots frequency of the standing end of the composition is 16.79%, 14.02%, and 46.76% of the total number of times. Therefore, the distribution of the badminton women's singles from high to low is the end of the match, the initial stage of the match, the offensive and defensive stage after the launch, and the middle of the match. The highest rate of matching in the confrontation phase indicates that the athletes of both sides have completed at least 5 times and more than 5 hits, and the reason for the fewer occurrences in the launching confrontation phase is that the players in the top game have fewer errors in serving and receiving the ball, mainly for subsequent serve. After the serve, the attack and defense confrontation and the multishot are used as a foundation.

(2) Distribution characteristics of multiorder structure in competitive process

Using the Pareto data statistical processing method, the sum of the structural frequencies of all the beats of all basic units is limited to 90%, and the distribution rate of the auctions of each basic unit is from high to low. As can be seen from Figure 7, 90% of the basic unit competition process is mainly distributed between one and twenty beats. Among them, three beats, four beats, five beats, six beats, seven beats, and eight beats have the highest frequency, and the ratios are 8.62%, 7.12%, 8.75%, 8.04%, 7.70%, and 6.32%, respectively. 46.55%, therefore, the two sides serve the ball attack and defense stage; the first stage of the match and the middle stage of the match are the focus of the two sides of the badminton women's singles event.

Table 5: Measurement data of parameter A.

Reference node orientation	RSSI	Average RSSI
Up	-44.36	
Down	-43.78	-42.97
Left	-43.18	
Right	-40.56	

Table 6: Measurement data of parameter N.

D(m)	RSSI (dBm)	D (m)	RSSI (dBm)
0.5	-39.00	3.5	-57.40
1.0	-42.97	4.0	-62.58
1.5	-46.01	4.5	-63.93
2.0	-49.73	5.0	-65.96
2.5	-54.62	5.5	-66.12
3.0	-55.84	6.0	-68.81

Table 7: The measured distance before and after compensation (group B).

Calibration distance (m)	Measured distance (m)	Compensated distance (m)
0.51	0.73	0.58
1.00	1.00	0.94
1.50	1.27	1.31
2.00	1.70	1.90
2.50	2.49	2.84
3.00	2.75	3.09

Table 8: The measured distance before and after compensation (group B).

Calibration distance (m)	Measured distance (m)	Compensated distance (m)
3.50	3.11	3.43
4.00	4.67	4.56
4.50	5.19	4.83
5.00	6.09	5.19
5.50	6.17	5.23
6.00	7.62	5.63

(3) The comparison between uniform random distribution LKNN and DV-Hop is shown in Figure 8

The comparison between C-shaped random distribution LKNN and DV-Hop is shown in Figure 9.

Table 9: Improved algorithm test results.

Real coordinates	Positioning coordinates	Absolute error	Relative error
(2.9, 3.6)	(2.576, 3.342)	0.413	9.039
(4.1, 2.4)	(3.298, 3.571)	1.419	33.451
(4.1, 1.2)	(4.628, 2.933)	1.812	35.109
(7.1, 3.0)	(6.399, 3.452)	0.833	15.523
(7.7, 4.2)	(6.588, 3.743)	1.202	20.341
(5.3, 6.0)	(5.132, 4.508)	1.500	29.064
(4.1, 5.4)	(5.076, 4.266)	1.496	31.924
(3.5, 4.2)	(3.621, 3.558)	0.652	15.071

Table 10: Test set evaluation results.

Number	TP	FP	FN	Precision	Recall	*F*-score
Slide A06	38	5	26	0.601	0.883	0.718
Silde A08	31	33	24	0.564	0.483	0.520
Slide A09	41	21	13	0.766	0.651	0.704
Slide A13	0	4	2	0	0	—
Slide A16	29	44	3	0.904	0.396	0.553

Table 11: Statistics of the number of data packets received by the node per second.

Number of concurrent connections	Persistent connection	Nonpersistent connection
1	6678	3610
5	24496	12168
50	92430	27326
100	112826	27862
500	116783	29156
1000	116164	28641

The expected error of LKNN algorithm positioning is shown in Figure 10.

The MSO algorithm that improves the percentage of positioning results is shown in Figure 11.

The value of A is the signal strength when the signal propagates 1 m. This article measures the unknown node by placing a reference node in the up, down, left, and right directions. The measurement data is shown in Table 5.

The value of n is the propagation loss coefficient of the wireless signal. This value has a direct relationship with the actual environment. The RSSI value corresponding to different distances needs to be measured and then obtained by curve fitting. In the determination of the value of n, the RSSI was measured multiple times at intervals of 0.5 m, and the average value was obtained to obtain a total of 12 sets of data from 0.5 m to 6 m. The measured data are shown in Table 6.

The measured distance before and after compensation is shown in Tables 7 and 8.

In general, the measured distance after compensation is closer to the calibration value than without compensation, which greatly reduces the error caused by the inaccurate measurement distance and improves the positioning accuracy of the system.

In the experiment of eight locations selected by unknown nodes, each location point is tested multiple times, and the average value of each data value is calculated as the final measurement data. Then, the measured data is converted into distance, and the coordinates of the unknown node are solved through the positioning calculation of the triangular centroid improvement algorithm. The positioning results are shown in Table 9. The absolute error in the table is the deviation between the result calculated by the RSSI triangle centroid improvement algorithm and the actual coordinates of the unknown node, and the relative error is the ratio of the absolute error to the true larger distance.

The test set evaluation results shown in Table 10.

The statistics of the number of data packets received by the node per second are shown in Table 11.

From Table 11, we can see that the different data transmission speeds in the three different modes will also affect the real-time data feedback of the experimental group and the control group of badminton.

6. Conclusion

By applying fuzzy algorithm, combined with training teaching theory and representation training theory, this paper constructs a fuzzy evaluation model based on analytic hierarchy process and analyzes the experimental group and the control group and draws the following conclusions.

Through the functional test of the flexibility and stability of the students in the badminton speciality, the weak links of the students in the badminton speciality have been found. Some students have weak core control skills, poor body balance, muscle stability, and joint flexibility. Through the screening of 7 functional action modes, it is found that there are obvious differences in left and right symmetry of the special longevity, the lower limbs are unstable, the core area is weak, and the muscle control ability on both sides of the spine needs to be strengthened. In addition to the methods used in this article, some of the most representative computational intelligence algorithms can be used to solve these problems, such as monarch butterfly optimization (MBO) [23], earthworm optimization algorithm (EWA) [24], elephant grazing optimization (EHO) [25], moth search (MS) algorithm [26], slime mold algorithm (SMA) [27], and Harris Hawks optimization (HHO) [28]. This article realizes centralized badminton training by studying the quantification of badminton training based on wireless sensor networks, improving the overall quality of athletes and the skills of playing badminton. The distribution characteristics of the basic unit shooting process of badminton are as follows: the basic unit game process is forward (leftward), and the peak forward deviation is 5 beats, which is the initial stage. The frequency of the confrontation phase consisting of one beat and two beats accounts for 6.7% of the total number of beats. The frequency of the offensive and defensive phases after three and four beats accounted for 15.74% of the total number of beats. Five and six beats constitute the end of the stage, including the first stage, seven and eight beats, and nine and nine beats. They accounted for 16.79% and 14.02%, respectively, accounting for 46.76% of the total number of shots. In the future learning method, the multiattribute decision-making algorithm of interactive Archimedes norm operation under Pythagorean fuzzy uncertainty can also be used. Extend the method to Pythagorean fuzzy uncertain environment.

Data Availability

No data were used to support this study.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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