

Retraction

Retracted: Sports Parameter Acquisition Based on Internet of Things and Wavelet Analysis

Security and Communication Networks

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This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret 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 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] H. Chen and J. Li, "Sports Parameter Acquisition Based on Internet of Things and Wavelet Analysis," *Security and Communication Networks*, vol. 2021, Article ID 1070221, 12 pages, 2021.

Research Article

Sports Parameter Acquisition Based on Internet of Things and Wavelet Analysis

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In this study, a sports parameter acquisition model based on the internet of things and wavelet analysis is studied to improve the accuracy and timeliness of human sports parameter acquisition. A motion parameter acquisition model including a sensing layer, transmission layer, and application layer is designed. The acceleration sensor and temperature sensor in the information acquisition node in the sensing layer are used to collect the motion parameter data, which are uploaded to the application layer by the network in the transmission layer. The received data are denoised by the wavelet analysis method through the data processing unit in this layer and then sent to the ZigBee coordinator for coordination. The results show that the model can achieve the effective acquisition of different sports parameters of different moving objects and analyze the actual movement of moving objects according to the acquisition results. In the acquisition process, the signal burr can be effectively removed, the signal noise can be reduced, the high signal-to-noise ratio signal can be output, and the accuracy of acquisition is improved. It has high timeliness, stable performance, and strong practical application, which can provide an effective guarantee for users to monitor sports parameter data in real time.

1. Introduction

Sports parameter acquisition is a key technology in computer-aided training system and computer motion analysis system. The data acquisition accuracy of sports parameter directly determines the results of auxiliary training and sports analysis [1]. With the development of modern science and technology, the application of information technology in the field of sports, from the original local, objective support, such as the provision of architecture, has gradually changed into active support (e.g., technical research based on sports, special sports equipment and equipment, sports training system, and computer-aided decision-making system) and then became the pillar force of sports development in an all-round way. This puts forward higher requirements for sports parameter data acquisition [2, 3]. The scientific sports training method considers that the factors for athletes to improve their performance are multi-faceted, emphasizes multidisciplinary synthesis, and completes

the skill evaluation and technical diagnosis of athletes in training and competition. Function evaluation can solve the problem of athletes' reasonable load and prevent overtraining or insufficient training; technical diagnosis can solve the problem of rationality of technical movements [4]. The modern training method emphasizes the application of technical means in technical diagnosis. With the rapid development of competitive sports to high, difficult, precise, and sharp, sports analysis and training system more and more rely on modern high-tech means. Therefore, it is an irresistible trend for information technology to penetrate into sports training. The research and development of digital sports analysis and training system are to introduce information technology into sports training, help athletes master the technical essentials of action as soon as possible in the training process, reduce blind repetition, improve training efficiency, and reduce the possibility of injury to athletes, so as to achieve the best training effect [5]. It is an important research topic of how to provide

convenient and fast monitoring service of sports parameters for sports players through high-tech means. At present, most of the existing measuring instruments of human motion parameter on the market only measure a certain parameter of the human body and generally adopt the nonreal-time mode of storage to complete the parameter acquisition or use the wired mode to transmit data. The parameter data acquisition is not timely, and the acquisition method is not convenient, which cannot meet the needs of more users [6].

With the development and application of sensor technology, modern network technology, and artificial intelligence technology, the internet of things technology is known as the third innovation of the information industry. The internet of things makes the material world, where people live, realize digitization and networking to a great extent and makes the objects in the world connect together in both sensing and intelligent ways [7, 8]. In China, the internet of things is listed as one of the five emerging strategic industries in the country and has entered a period of rapid development, which has been widely concerned by the whole society. The internet of things technology integrates the physical world with the virtual world and deeply promotes human society to the information age, providing people with intelligent life and environment. At the same time, the internet of things is widely used and has gradually penetrated into all areas of people's life [9]. In 2007, Su Lina et al. analyzed the behavioral characteristics of people when walking or running, used acceleration sensors to detect the acceleration of human movement, and obtained the algorithm of walking steps and the walking distance from the stride length; in 2012, Deng Xiaolei et al. proposed a mobile monitoring system integrated with GPRS, GPS, and ZigBee; in 2010, NeilZhao analyzed the characteristics of walking or running with acceleration as the relevant parameter and drew the relationship between each stage of the walking cycle and the changes in vertical and forward acceleration. The movement can be divided into H directions, which are X-axis direction, Y-axis direction, and Z-axis direction. Adxl345 is used to detect the acceleration in H directions. The designed full-function pedometer can identify and count steps and measure distance, speed, and even calories consumed.

Wavelet analysis is a milestone in the development of the Fourier transform. Its basic theory involves digital signal processing, signal and system, Fourier analysis, functional analysis, computer control, and other disciplines and fields [10]. At the same time, it has the dual significance of wide application and profound theory. It has been widely used in signal processing, speech processing, mechanical fault diagnosis, and application. Wavelet function has the ability to represent the local characteristics of the signal in the time domain and frequency domain and can reflect the characteristics of the signal in different frequency bands on the corresponding analysis scale. It is a new technology to realize all kinds of information acquisition and recognition. Wavelet is used to decompose and reconstruct the collected and identified signals, and the signals are clearly distinguished in the noise inundation. The signal acquisition and identification are well filtered, which provides a new technology for the development of sensor sensing node, realizes

the intelligent control of large-scale information acquisition and identification of sensor sensing node parameters, and effectively improves the overall efficiency of information acquisition accuracy [11, 12].

Based on the above analysis, this study studies a sports parameter acquisition model based on the internet of things and wavelet analysis. By simultaneous interpretation of the parameters of the sports data from different sensors in the information acquisition node and transmission of the data to the data processing unit of the application layer through the network, the noise signal processed by the sensor is processed by the wavelet analysis method. The data are transferred to the ZigBee coordinator and then transferred to PC, intelligent terminal, and other devices via USB for storage and presentation. The acquisition of sports parameters is completed. Users can view or monitor their own and other people's sports situation in real time. At the same time, it can check our own sports history according to the sports parameters, adjust the amount and intensity of exercise in time, and improve the scientific and professional nature of sports. The study in [13] introduced the three-dimensional image analysis method to locate three-dimensional motion damage. The motion limit is calibrated by using the 3D simulation calculation process, which avoids the choice of process quantity and effectively changes the quantity, and finally realizes the information collection of motion damage attitude. The background of Reference [14]'s study is to use computer vision to evaluate the quality of motion gestures under noninvasive conditions, that is, without any body sensors. This study studies the estimation of table tennis motion parameters in a single-view video.

Our contribution is threefold:

- (1) A motion parameter acquisition model including a sensing layer, transmission layer, and application layer is designed
- (2) The results show that the model can achieve the effective acquisition of different sports parameters of different moving objects and analyze the actual movement of moving objects according to the acquisition results
- (3) It has high timeliness, stable performance, and strong practical application, which can provide an effective guarantee for users to monitor sports parameter data in real time

The remainder of this study is organized as follows. Section 2 introduces the sports parameter acquisition based on the internet of things and wavelet analysis. Section 3 discusses the experiment and analysis. Section 4 presents the conclusions of the study.

2. Sports Parameter Acquisition Based on Internet of Things and Wavelet Analysis

2.1. Design of the Overall Acquisition Model. This study designs a sports parameter acquisition model based on the internet of things and wavelet analysis. The overall architecture of the model is designed on the basis of the

hierarchical structure of the internet of things. It mainly collects the sports parameter information of the moving target. The model is divided into three layers, which are the perception layer (data acquisition layer), network transmission layer (network layer), and application layer (data processing and display layer). Through the acceleration sensor and temperature sensor in the ZigBee sensor node of the sensing layer, the parameter information of the moving target during sports is collected. After uploading to the application layer through the network transmission layer, the wavelet analysis method is used to denoise the uploaded sports parameter information. The processed parameter information is directly sent to the ZigBee coordinator through the mesh network, and the ZigBee coordinator is responsible for providing routing information for ZigBee sensor nodes [15]. After receiving and processing the collected motion parameter information data, the received information data are transferred to PC, intelligent terminal, and other devices through USB, and the motion parameter information data are stored through PC, intelligent terminal, and other devices and analyzed and presented according to user needs. The overall architecture is shown in Figure 1.

The first layer of perception layer mainly includes the ZigBee router and information acquisition node, which is also called the ZigBee sensor node, and is composed of an acceleration sensor and temperature sensor. The task of this layer is to complete the acquisition of sports parameter information, involving sensor technology and microprocessor technology [16]; the network transmission layer of the second layer needs to realize the transmission of the collected sports parameter information, that is, the wireless communication mode is used for data transmission, such as ZigBee technology, Bluetooth technology, and WiFi technology; the application layer of the third layer mainly includes data processing unit, information integration unit, and information presentation unit, in which the data processing unit is realized by wavelet analysis method, and the information integration unit is also known as information integration node, which mainly includes router node and ZigBee coordinator node, and information presentation unit includes PC, intelligent terminal, and other devices. The main task of this layer is to complete the noise reduction, integration, storage, and display of the uploaded information data. The specific implementation of the model is shown in Figure 2.

In the overall implementation process, the acceleration sensor in the information acquisition node is used to collect the acceleration data of human sports, and the temperature sensor is used to collect the temperature data of human sports; the microprocessor is mainly responsible for configuring the parameters of the sensor, controlling the sampling of the sensor, obtaining the data, and wirelessly sending it; the clock provides high transmitting frequency and stable working frequency for a microprocessor; the key can be used to realize function selection; power circuit supplies power for each node. The information integration node includes the coordinator node and router node. The router node is responsible for the routing and forwarding of data, which can increase the distance of data transmission.

The coordinator node acts as the gateway between ZigBee wireless network and the internet [17]; the microprocessor is responsible for the operation of the protocol stack, and the reception and integration of data and then sends it to the server through RS232 to the serial port.

2.2. Function Design of the Information Acquisition Node. In this model, the design of the information acquisition node is the key. The information acquisition node is mainly responsible for the acquisition of human sport-related data, including the acquisition and transmission of human sports information. It is divided into four parts: CC2530 microcontroller part, sensor part, power circuit part, and key part. The overall design of the information acquisition node is shown in Figure 3.

In Figure 3, the sensor part includes the acceleration sensor module, temperature sensor module, and peripheral circuit. The sensor collects the analog signal and converts it into the digital signal through an on-chip A/D conversion circuit; the microcontroller part reads data and sends it to the network, Mac, and transceiver through radio frequency according to the specified format; the key is mainly responsible for function selection; the power circuit supplies power for the node.

2.2.1. Overall Structural Design of the Sensor. The sensor part mainly includes the acceleration sensor module and the temperature sensor module. The acceleration sensor module is used to detect the acceleration data of human sports. The 3D acceleration sensor ADXL345 is used here. CC2530 is its main control chip, and the radio frequency transmitting circuit is integrated into the chip, so the composition of this part can be divided into ADXL345 and peripheral circuit, CC2530, key, and power supply circuit. The structure of the acceleration sensor module is shown in Figure 4.

The temperature sensor module is mainly responsible for detecting the body temperature data during sports, so it needs the temperature sensor TMP121, the same main control chip CC2530 as the acceleration sensor module, the power supply circuit, and keys, etc. The block diagram of the module is shown in Figure 5.

2.2.2. Design of Sensor Acquisition Process. The sensor part is used to collect acceleration data and temperature data during physical education. The main collection process of this part is as follows: starting the information collection node and initializing it, and scanning the communication channel to determine whether the beacon is received, and if the beacon is not received, it is scanned again. If the beacon is received, it is joined into the communication network and bound to the gateway; polling the OSAL event to determine whether there is an information collection event, if no information acquisition event is found, the OSAL event polling is implemented again. If the information collection event is found, the information collected is implemented and sent out; if the information sent is not responded several times, the information transmission will be judged as a

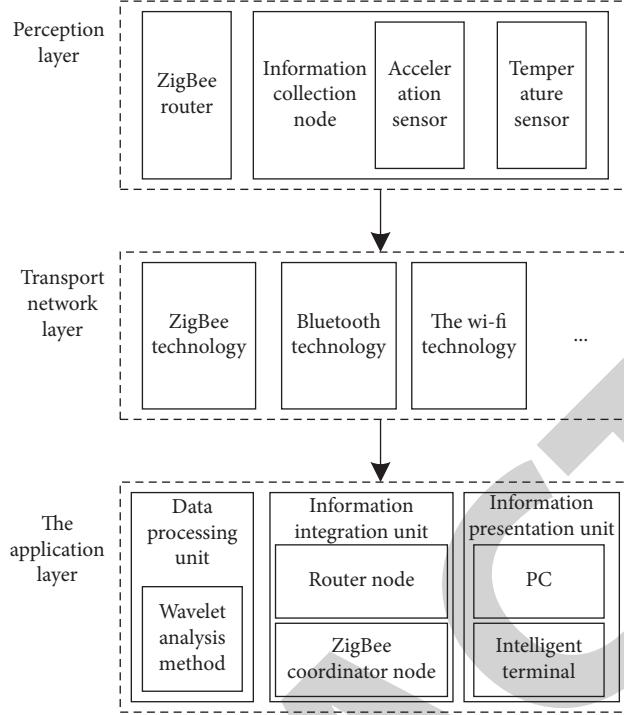


FIGURE 1: Overall architecture diagram of the acquisition model.

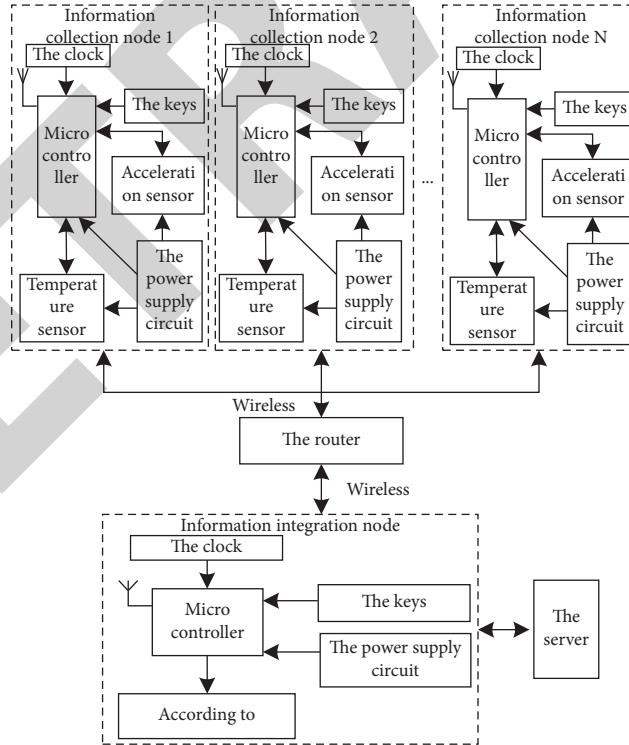


FIGURE 2: Overall implementation process design.

failure, and the bound gateway will be removed; if the information sent has a response, the information acquisition will continue and sent until the end as long as you think. The design of the acquisition process is shown in Figure 6.

2.3. Design of Data Processing Unit. In the practical application of acceleration sensor and temperature sensor in information acquisition node, the collected acceleration signal data and temperature signal data are inevitably

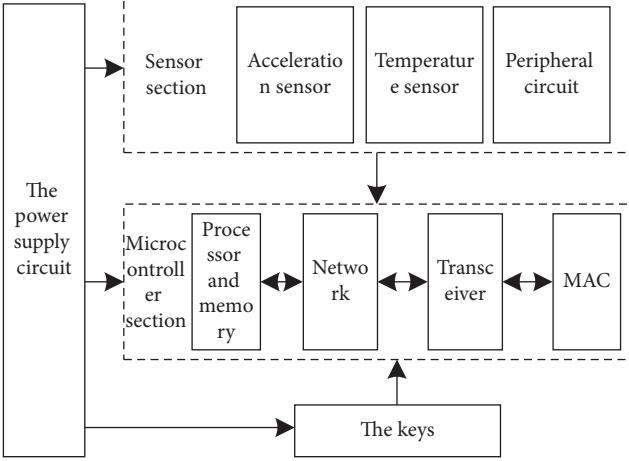


FIGURE 3: Structural diagram of information acquisition nodes.

affected by disturbance frequency noise, hardware circuit, transmission noise, jitter, and other factors, resulting in the output signal data often mixed with a lot of noise and other irrelevant signals [18, 19]. Before uploading the original signal data collected by the information acquisition node to the information integration node, the original signal data need to be smoothed and denoised to eliminate the noise of the original signal data. In this study, the wavelet analysis method is selected to remove the noise interference of the original signal on the premise of retaining the characteristics of the signal data, so as to obtain more accurate signal data, which is convenient for the information integration node to more efficiently and accurately integrate the collected data information and provide more accurate sports parameter data for users [20].

The wavelet analysis method is a kind of multiresolution analysis (MRA) method. In wavelet analysis, the selection of wavelet basis is an important problem, which determines the quality of wavelet analysis results to a certain extent. In use, it needs to be determined according to the characteristics of different wavelet bases and signals to be measured [21]. The implementation process of the wavelet analysis method is as follows.

A closed subinterval $\{V_j\}_{j \in \mathbb{Z}}$ in a defined space $L^2(R)$ is called an MRA in $L^2(R)$ if and only if $\{V_j\}$ satisfies the following conditions:

(1) Monotonicity:

$$\forall j \in \mathbb{Z}, \dots \supset V_{j-1} \supset V_j \supset V_{j+1} \supset \dots \quad (1)$$

(2) Approximation:

$$\begin{aligned} \bigcap_{j \in \mathbb{Z}} V_j &= \{0\}, \\ \bigcup_{j \in \mathbb{Z}} V_j &= L^2(R). \end{aligned} \quad (2)$$

(3) Linearity:

$$\forall j, k, a \in \mathbb{Z}, f(x) \in V_j \Rightarrow f(ax - k) \in V_j. \quad (3)$$

In equation (3), a represents coefficient; one of the elements of inner product space X is represented by x ; integer displacement is represented by k ; resolution series is represented by j ; and sports signal collected by information acquisition node is represented by f .

- (4) Existence of rise z basis: there exists $g \in V_0$, where g is an element of inner product space X , such that $\{g(x - k)|k \in \mathbb{Z}\}$ forms the rise z basis of V_0 .

Looking for wavelet in multiresolution analysis, for a sports signal f belonging to $L^2(R)$, the partial sum of its wavelet coefficients $\sum_{n=-\infty}^{\infty} f, \varphi_{j,n} \psi_{j,n}$, the difference between the two approximations of sports signal f in resolution 2^{-j+1} and 2^{-j} , and the approximation of the signal in different resolutions can be calculated in multiresolution. The orthogonal projection on different space $\{V_j\}_{j \in \mathbb{Z}}$ is calculated by the approximation definition of signal f on resolution 2^{-j} . A set of standard orthogonal bases V_j is found. Assuming that a space is described, only a set of bases need to be specified in the space.

A multiresolution analysis in $L^2(R)$ is defined as $\{V_j\}_{j \in \mathbb{Z}}$, which makes $\{\psi_{j,k}(x)|k \in \mathbb{Z}\}$ a standard orthogonal basis of V_j and has a unique function $\psi(t)$. The function can be expressed as follows:

$$\psi(t) = \sum_{k \in \mathbb{Z}} h(k) \psi(2t - k). \quad (4)$$

In equation (4), the low-pass impulse response is expressed as $h(k)$.

After translation and expansion, there are

$$\psi_{j,k}(x) = 2^{-j/2} \psi(2^{-j}x - k). \quad (5)$$

The function $\psi(t)$ is called the scaling function, and the scaling function needs to satisfy the equation in equation (4).

The low-pass impulse response $h(k)$ is a multiresolution analysis characterized by a set of orthogonal bases of each space V_j generated by the scaling function. Any scaling function is determined by a filter. Therefore, the design of the filter is one of the key points of wavelet analysis, and its frequency characteristics must meet the condition of accurate reconstruction [22].

$$|H(\omega)|^2 + |H(\omega + \pi)|^2 = 1. \quad (6)$$

In equation (6), the filter frequency is expressed by ω .

$\psi_{j,k}(x)$ is similar to the structure of the wavelet function $\varphi_{j,k}(x)$, and the wavelet function also corresponds to a filter; this is

$$\varphi(t) = \sum_{k \in \mathbb{Z}} g(k) \psi(2t - k). \quad (7)$$

In equation (7), $g(k)$ can be expressed as follows:

$$g(k) = (-1)^{1-k} h(1 - k). \quad (8)$$

That is to say,

$$G(\omega) = e^{-\omega j} \overline{H(\omega + \pi)}. \quad (9)$$

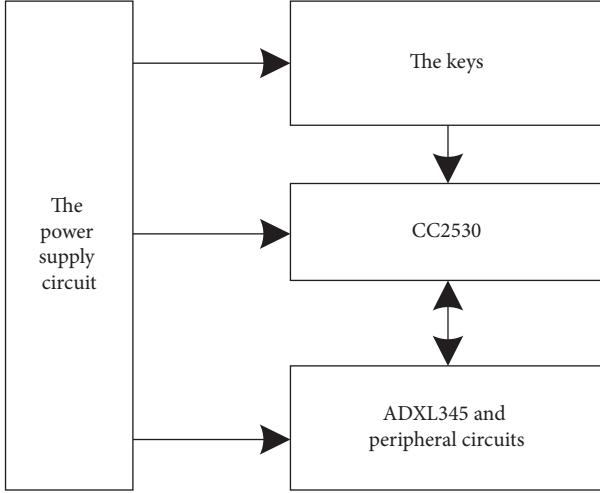


FIGURE 4: Structure design of the acceleration sensor module.

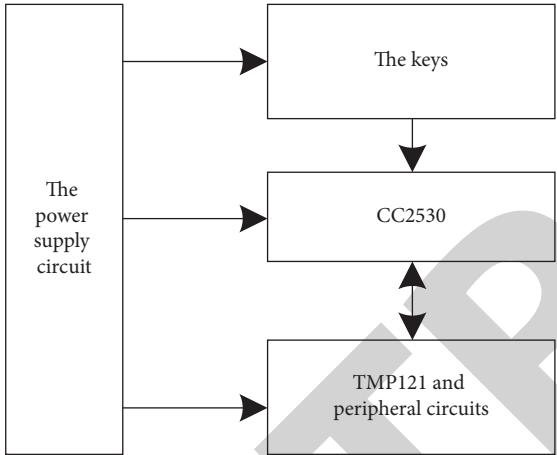


FIGURE 5: Structural design of the temperature sensor module.

The wavelet function $\varphi_{j,k}(x)$ constitutes the orthogonal basis of a subspace W_j of $L^2(R)$ space and a group of orthogonal bases in $L^2(R)$. The space V_j determined by the scaling function $\psi_{j,k}(x)$ and the space W_j determined by the wavelet function $\varphi_{j,k}(x)$ are related in this way. That is, W_j is the orthogonal complement space of V_{j-1} and V_j , and $W_j = V_{j-1} - V_j$. W_j describes the details, V_j describes the approximate part, and at this time j can take any real number. In two adjacent scales, the subtle differences of objects are observed.

To sum up, the multiresolution analysis in $L^2(R)$ is described by $\{V_j\}_{j \in \mathbb{Z}}$, $\{W_j\}_{j \in \mathbb{Z}}$, scale function $\psi_{j,k}(x)$, and wavelet function $\varphi_{j,k}(x)$. The above four elements are obtained, and the wavelet analysis of the signal is completed.

Let the smooth signal obtained by the signal $f(x)$ in scale j be

$$A_j^d f(x) = \langle f(x), \psi_{j,k}(x) \rangle = 2^{-j/2} \int f(x) \psi(2^{-j}x - k) dx. \quad (10)$$

The detail signal obtained by the signal $f(x)$ in scale j is as follows:

$$D_j f(x) = \langle f(x), \varphi_{j,k}(x) \rangle = 2^{-j/2} \int f(x) \varphi(2^{-j}x - k) dx. \quad (11)$$

The essence of the wavelet analysis method is not to do a complete analysis of the signal at each scale but to decompose the signal from fine to coarse and reconstruct it from coarse to fine. That is to say, $A_{j-1}^d f(x)$ is decomposed into $A_j^d f(x)$ and $D_j f(x)$, and the relationship is as follows:

$$\begin{cases} A_j^d f(x) = \sum_k h(k - 2n) A_{j-1}^d f(x), \\ D_j f(x) = \sum_k g(k - 2n) A_{j-1}^d f(x). \end{cases} \quad (12)$$

Equations (6) to (12) describe the wavelet analysis method of the one-dimensional signal. The wavelet analysis method of the two-dimensional signal can be described as follows:

$$\begin{aligned} A_{j-1} f(x, y) = & A_j f(x, y) + D_j^1 f(x, y) \\ & + D_j^2 f(x, y) + D_j^3 f(x, y). \end{aligned} \quad (13)$$

In equation (13), the low-frequency component is represented by A , and the high-frequency component in horizontal, vertical, and diagonal directions is represented by D . The wavelet decomposition of the two-dimensional signal is shown in Figure 7.

2.4. Functional Design of the Information Integration Node

2.4.1. Structural Design of the ZigBee Coordinator. Because the working time and workload of the ZigBee coordinator are the largest in the ZigBee network, it also needs an external power supply to ensure its stability and reliability. The composition of the ZigBee coordinator and information acquisition node is basically the same, but the sensor module is missing, and the USB interface is added to communicate with the host computer. The structural design of the ZigBee coordinator is shown in Figure 8.

2.4.2. Process Design of the Information Integration Node. The tasks of the information integration node include the following: first, to establish a ZigBee network, allowing other nodes (router nodes or information acquisition nodes) to access the network and bind; second, to receive the data collected by the information acquisition node after wavelet analysis denoising; and third, to send the received data to PC, intelligent terminal, and other devices. The process design of this node mainly includes device startup, system initialization (including hardware initialization and protocol stack initialization), channel energy detection, establishing a ZigBee network and allowing other nodes to access the network and bind, receiving the data collected by the sensor after wavelet analysis, and sending it to the computer through UART serial port. The flow of the information integration node is shown in Figure 9.

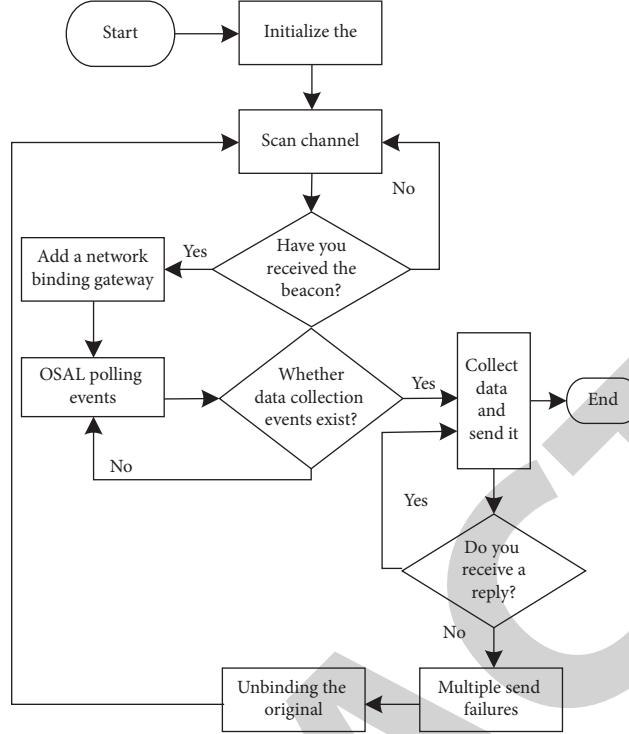


FIGURE 6: Sensor part of the information acquisition flow chart.



FIGURE 7: Wavelet decomposition of two-dimensional signals.

3. Result Analysis

Taking a sports university as an example, one student in the long-distance running major and one in the high jump major of the university are randomly selected as the experimental objects. The two experimental objects are men, of which the subject *a* is a freshman and the subject *b* is a sophomore. This study uses the proposed model to collect the parameter data of the two experimental objects in running and high jump, respectively, and make a detailed analysis on the collected results, test the acquisition performance, and noise reduction effect of the proposed model.

3.1. Acquisition Performance Test. Taking running and high jump as examples, this study uses the model to collect the acceleration value and body temperature value of two experimental subjects (*a* and *b*) in two kinds of sports and tests the acquisition performance of this model. The acceleration value changes in two experimental subjects in two kinds of sports collected by this model are shown in Figure 10, by taking Z-axis as an example.

It can be seen from Figure 10(a) that in the running process of two experimental subjects *a* and *b*, the Z-axis acceleration value of subject *b* relatively largely changes, and the fluctuation is not stable, while the Z-axis acceleration

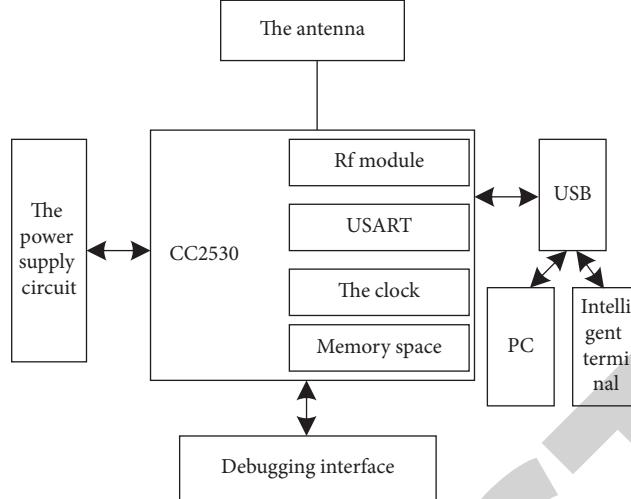


FIGURE 8: Diagram of the ZigBee coordinator structure.

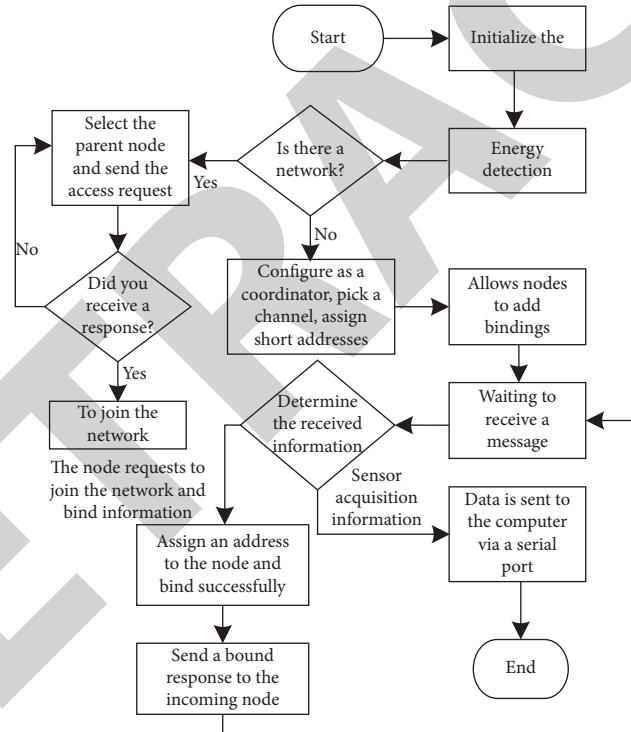


FIGURE 9: Information integration node flow chart.

value of the subject a relatively slowly changes, and the fluctuation is relatively stable. It can be seen that the pace of subject a is relatively stable, while the pace of subject b greatly fluctuates; in Figure 10(b), the highest acceleration value of Z-axis of subject a is lower than that of subject b, which indicates that the height of subject b is relatively higher. In conclusion, the performance of experimental subject a in running is relatively more stable, while the performance of experimental subject b in the high jump is better than that of the subject a. The proposed model can effectively collect different sports acceleration parameters of different experimental objects.

The changes in body temperature of subjects a and b during two kinds of sports are shown in Table 1.

Through the analysis of Table 1, it can be concluded that the body temperature of the two subjects a and b in running and high jump has increased to varying degrees. In running, with the increase in running steps, compared with subject b, the rising trend of body temperature of the subject a is slightly lower, and the rising range is relatively stable, while the rising range of body temperature of subject b is higher in the early stage, and the changing range of body temperature in the later stage is lower. According to the acceleration value change of subject b in running in Figure 10(a), the reason for

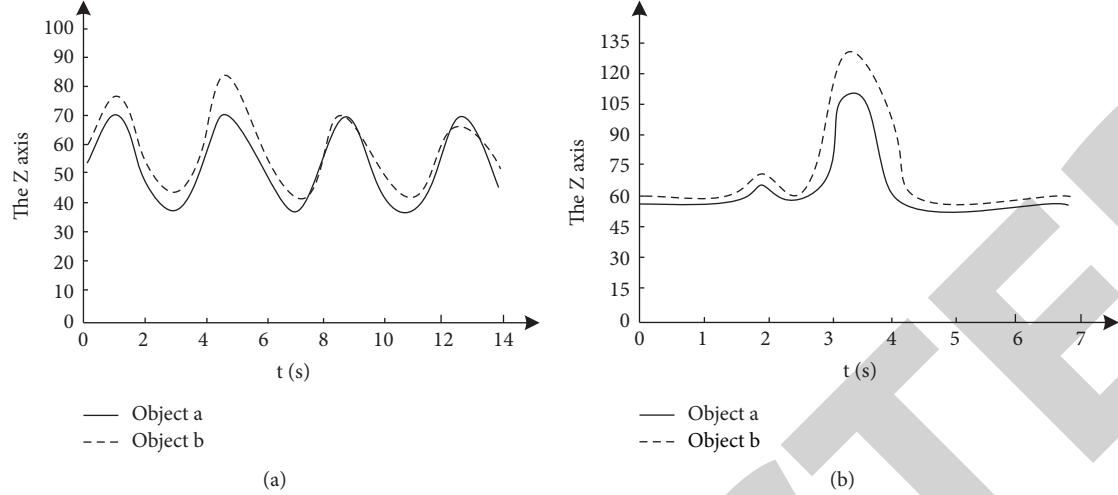


FIGURE 10: The acceleration values of two kinds of sports of two subjects were collected. (a) The acceleration values of the two experimental subjects a and b during running were collected. (b) The acceleration values of subjects a and b in the high jump movement were collected.

TABLE 1: Acquisition results of body temperature values of two subjects during two kinds of sports.

The subjects	Physical activity	Temperature value (°C)	
		The initial temperature	
Subject a	Running	Fifty steps	37.21
		100 steps	37.28
		150 steps	37.33
		200 steps	37.41
		300 steps	37.52
		1 time	37.75
		3 times	37.23
		5 times	37.31
		7 times	37.37
		10 times	37.45
Subject b	The high jump movement	The initial temperature	37.52
		Fifty steps	36.82
		100 steps	36.93
		150 steps	37.15
		200 steps	37.36
		300 steps	37.48
		1 time	37.71
		3 times	36.85
		5 times	36.91
		7 times	37.02
		10 times	37.13
			37.25

the higher temperature rise in the early stage is that subject b's pace greatly fluctuates in the early stage of running; in the high jump, with the increase in high jump times, the temperature change range of both is smaller, and the temperature rise range of subject b is slightly higher. It can be seen that the proposed model can effectively collect the temperature parameters of different sports of different experimental subjects. The results show that the temperature of subject b in running and high jump is relatively higher.

3.2. Noise Reduction Effect Test.

From the original acceleration signals of two kinds of sports collected by the proposed

model, two groups are randomly selected as the experimental objects of the noise reduction test. Through the noise reduction processing of the proposed model, the waveforms of the two groups of experimental acceleration signals before and after noise reduction processing are compared, and the noise reduction processing effect of the collected signals of the proposed model is tested. The comparison results are shown in Figure 11.

It can be seen from Figure 11 that after the noise reduction in the two groups of experimental acceleration signals by the model in this study, not only the original characteristics of the signal can be retained but also the burr on the signal can be eliminated, making the signal

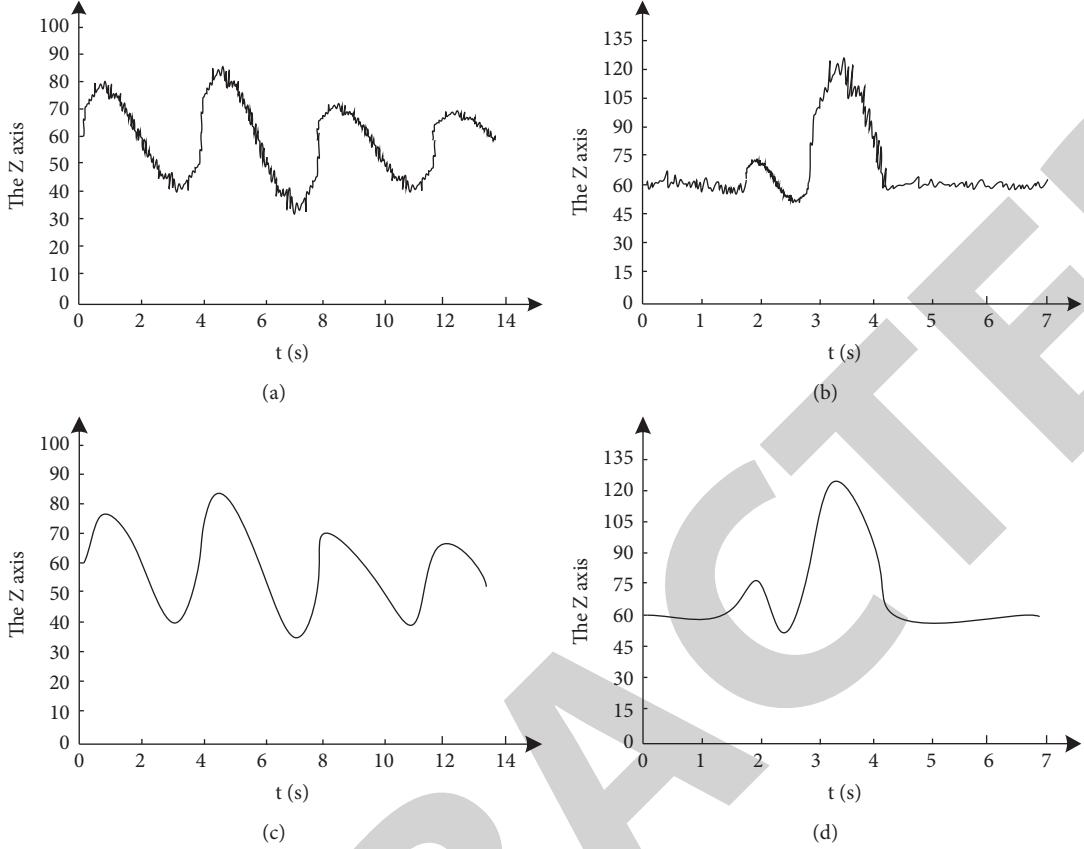


FIGURE 11: There are two groups of acceleration signal waveforms before and after noise reduction. (a) The first set of original acceleration signals. (b) The second set of original acceleration signals. (c) The first group of acceleration signals after noise reduction. (d) The second group of acceleration signals after noise reduction.

TABLE 2: Statistical results of SNR for 10 times of noise reduction in the model in this study.

The number of times	Signal-to-noise ratio (db)	Average signal-to-noise ratio(db)
1	92.3612	
2	95.1231	
3	92.5875	
4	98.1301	
5	91.5564	
6	92.3663	
7	97.5621	
8	96.1332	
9	95.6879	
10	94.3158	94.5824

smoother and the characteristics clearer, which can improve the accuracy of the final acquisition signal and lay the foundation for improving the accuracy of sports parameter acquisition.

The signal-to-noise ratio of the final output signal of the proposed model after noise reduction processing is tested, and the statistical results with 10 times random extraction are shown in Table 2.

It can be concluded from Table 2 that the signal-to-noise ratio of the final output collected signal after 10 times of noise reduction processing by the model in this study slightly fluctuates, and the signal-to-noise ratio is high. It can be seen

that the model in this study has a high noise reduction processing effect, stable noise reduction performance, high accuracy, and strong reliability of the final data, which can provide a scientific basis for athletes or coaches to view sports data at any time.

3.3. Acquisition Timeliness Test. The time consumption of each stage and the whole acquisition process in the model acquisition process is counted, and the timeliness of the data collected by the proposed model is tested. The test results are shown in Figure 12.

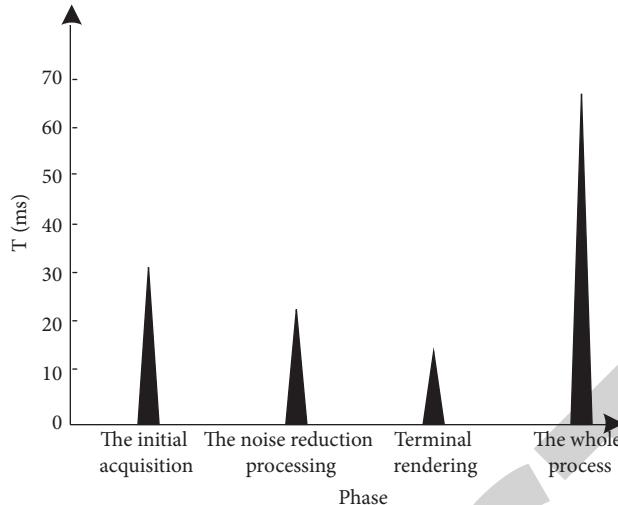


FIGURE 12: Time statistics for each stage of the model and the whole acquisition process.

As can be seen from Figure 12, the acquisition process of the model in this study takes less time, which can realize the real-time acquisition of sports parameters of athletes, and the collected data are more timely and have higher practical application value.

4. Conclusions

Sports parameters can directly reflect the actual movement status of athletes and can provide scientific reference for athletes to monitor their own movement status in real time or view historical movement data. In this study, the sports parameter acquisition model based on the internet of things and wavelet analysis is studied. By analyzing the internet of things technology and wavelet analysis method, a sports parameter acquisition model integrating sensor acquisition node and wavelet analysis denoising process is created. The real-time sports acceleration value and body temperature value data are collected, and the signal of collected data is denoised. The application results show that the model can improve the smoothness of the initial signal collected by noise reduction process, more clearly present the characteristics of the collected data, and improve the acquisition accuracy; according to the collected motion parameter data, it can analyze the various parameters of different moving objects; the acquisition process takes less time and has more timeliness, and it can collect real-time sports parameter data to avoid missing, and the overall performance is stable and feasible. In the future, this model can be applied to the sports monitoring system, and the actual application performance of this model can be further tested by testing the final monitoring effect after the application of this model.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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