

Retraction

Retracted: Physiological Index Monitoring of Wearable Sports Training Based on a Wireless Sensor Network

Journal of Sensors

Received 3 October 2023; Accepted 3 October 2023; Published 4 October 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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1].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] Z. Lu, Z. Li, and L. Zhang, "Physiological Index Monitoring of Wearable Sports Training Based on a Wireless Sensor Network," *Journal of Sensors*, vol. 2021, Article ID 7552510, 10 pages, 2021.

Research Article

Physiological Index Monitoring of Wearable Sports Training Based on a Wireless Sensor Network

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Received 25 October 2021; Revised 10 November 2021; Accepted 22 November 2021; Published 6 December 2021

Academic Editor: Gengxin Sun

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According to the development needs of wireless sensor networks, this paper uses the combination of embedded system and wireless sensor network technology to design a network node platform. This platform is equipped with a sports training sensor module to measure the physiological indicators of the ward in real time. The network node sends the collected physiological parameters to a remote monitoring center in real time. First, according to the generation mechanism of the physiological index signal and the characteristics of the physiological index signal, the wireless sensor network analysis and processing method are used to denoise the physiological index signal, and the wireless sensor network package is used to extract the characteristics of the physiological index, indicating different types of respiration. The energy characteristics of the sound physiological index signals are different, which verifies the feasibility of the independent component analysis method for separating the physiological index and the physiological index signal of the heart sound. Secondly, the hardware system of physiological index signal acquisition is designed, and the selection principle of the hardware unit is introduced. At the same time, the system structure of the monitor is designed, and then, the wireless sensor network sensor node is researched, the hardware of the wearable monitor system is designed, and the hardware architecture and working mode based on the single-chip MSP430F149 are given. Finally, the wireless hardware platform includes the following main modules: sensor part, preprocessing circuit module, microprocessing module based on MSP430 low power consumption, wireless transceiver module based on RF chip CC2420, and power supply unit used to provide energy.

1. Introduction

The wireless sensor network (WSN) is composed of micro-sensor nodes deployed in the monitoring area. It is the result of a multidisciplinary development that combines sensor technology, wireless transmission technology, distributed information technology, and embedded technology. Processing technology can collect, process, and transmit object information to objects that need to be sensed [1–3]. The WSN has a wide range of applications, from environmental monitoring, industrial processing control to military applications; you can see the WSN [4]. The increasing demand for sports training and health care also requires continuous and real-time detection of human vital signs, integrating WSN technology into sports training, health care, diagnosis, and treatment and establishing a wireless sports training health

monitoring system, which will become the future research and application hotspot [5]. At the same time, with the continuous development of science and technology in recent years, there has been a situation of multidisciplinary cross integration, and the detection of vital signs parameters based on wireless sensor network nodes has become a new auxiliary and support method in the clinical diagnosis and treatment process. At present, most of the main wireless sports training monitoring systems are aimed at the detection of conventional human physical parameters, and the related monitoring of the physiological index system, which is one of the four major systems of the human body, is not very common [6–8].

Regarding wearable devices, almost all current researches focus on the wearability of the device itself, while there is almost no research on data transmission, resource

sharing, and remote command between human bodies wearing wearable devices. Therefore, research on wearable wireless sensor networks has important value and significance [9–11]. The methods of physiological index signal analysis are generally divided into a time-domain analysis method, frequency-domain analysis method, and time-frequency joint analysis method. In digital physiological index signal processing, frequency domain analysis can be divided into periodogram and autocorrelation methods based on Fourier analysis and modern spectrum analysis methods based on non-Fourier analysis. Mao et al. [12] aimed at the current application status of wearable technology in the field of rehabilitation and discussed the possibility of wearable devices in the field in the future and the main problems. Masè and Micarelli [13], based on the concept of a wearable computer, proposed the concept of a wearable wireless network and built a wearable wireless network model using Bluetooth and Zigbee technology. Zhang et al. [14] proposed a wireless sensor network using a wearable computer as an intelligent interface, elaborated the architecture of the wireless sensor network, and proved the feasibility of the wireless sensor network. Khundaqji et al. [15] take the energy efficiency of human motion capture in wireless wearable devices as the main line, and in-depth research and exploration of energy efficiency improvement strategies are used in wearable computing in a low-power constrained environment. Kong and Wang [16] studied the sensor data fusion algorithm with the background of wireless wearable sensor network. The above literature mainly focuses on a brief overview of wearable wireless sensor networks. It does not analyze the network characteristics of wearable wireless sensor networks and the specific transmission process of the network, nor does it study the characteristics of network node mobility and real-time data transmission. Therefore, it is necessary for us to study the network optimization and routing algorithm of the wearable wireless sensor network based on the characteristics of the wearable wireless sensor network to improve the real-time and reliability of data transmission in the network [17–19]. Some scholars have pointed out the various problems and challenges faced by the WBAN network routing protocol through the research and analysis of various existing routing protocols in the WBAN network. In this environment, effective on-body communication routing has a significant impact on the performance of wearable wireless sensor networks [20–22]. For example, the researchers put forward a new opportunistic and mobile-aware routing protocol by studying the problems related to link quality and routing performance in high dynamic wireless body area networks [23–25].

Based on the multiresolution characteristics of the feature extraction method of wireless sensor networks, this paper conducts localized feature characterization of physiological indicator signals to obtain parameters that represent the characteristics of physiological indicator signals, which can be used to classify and recognize physiological indicator signals. Although modern processing technology has made some progress in analyzing physiological index signals, the diagnosis of physiological index system diseases still adopts auscultation. It is necessary to establish a complete physio-

logical index collection, analysis, and recognition system and based on a wireless sensor network. This paper presents a research on the detection of wireless sensor network nodes that integrates collection, processing, and transmission of physiological indicators. At the same time, factors are selected according to the situation of this article to avoid the large prediction error caused by the incomplete consideration of input factors in the prediction model of this article. The key issue of this system is how to accurately collect, process, and short-distance wireless transmission of physiological index sounds. Physiological indicator signal pickup is to collect physiological indicator signals on the surface of the human body through the sensor; first, remove the interfering physiological indicator signals through the filter circuit; the processing module uses the microprocessor to analyze the physiological indicator signals on the basis of the collected physiological indicator sound physiological indicator signals. The collected and processed physiological indicator signals are transmitted to the next node or central station through short-distance wireless communication transmission technology, so as to provide diagnosis and treatment services for clinical sports training. Since the research in this paper is a wearable wireless sensor network applied to sports emergency scenarios, data transmission between human bodies should have a lower delay and a lower packet loss rate. The data aggregation in the physical communication network should be as energy-efficient as possible. Therefore, the research on the routing algorithm of On-Body network and B2B network in wearable wireless sensor network is very important.

2. Construction of a Wearable Sports Training Physiological Index Monitoring Model Based on a Wireless Sensor Network

2.1. Hierarchical Distribution of Wireless Sensor Networks.

The wireless sensor network is composed of a large number of randomly distributed sensor nodes with real-time perception and self-organization capabilities, which can realize the purpose of overall monitoring of a certain area. In the On-Body network, the capabilities of sensor nodes are limited. It needs to use less power to transmit the collected data from the sensor nodes to the coordinator node in order to achieve the purpose of energy saving. However, because WSN and WBAN have different architectures and applications run under different conditions, the routing protocols in traditional wireless sensor networks cannot be directly applied to our On-Body network. Figure 1 is the hierarchical framework of the wireless sensor network.

It can separate hidden components from multidimensional statistical data. For linear transformation, the physiological indicator signal to be measured is a physiological indicator signal that is linearly mixed by multiple independent non-Gaussian physiological indicator signals. The independent physiological indicator signal can be regarded as the basis of linear space. The ICA technology calculates the source physiological index signal from the physiological index signal to be measured under an unknowable advance

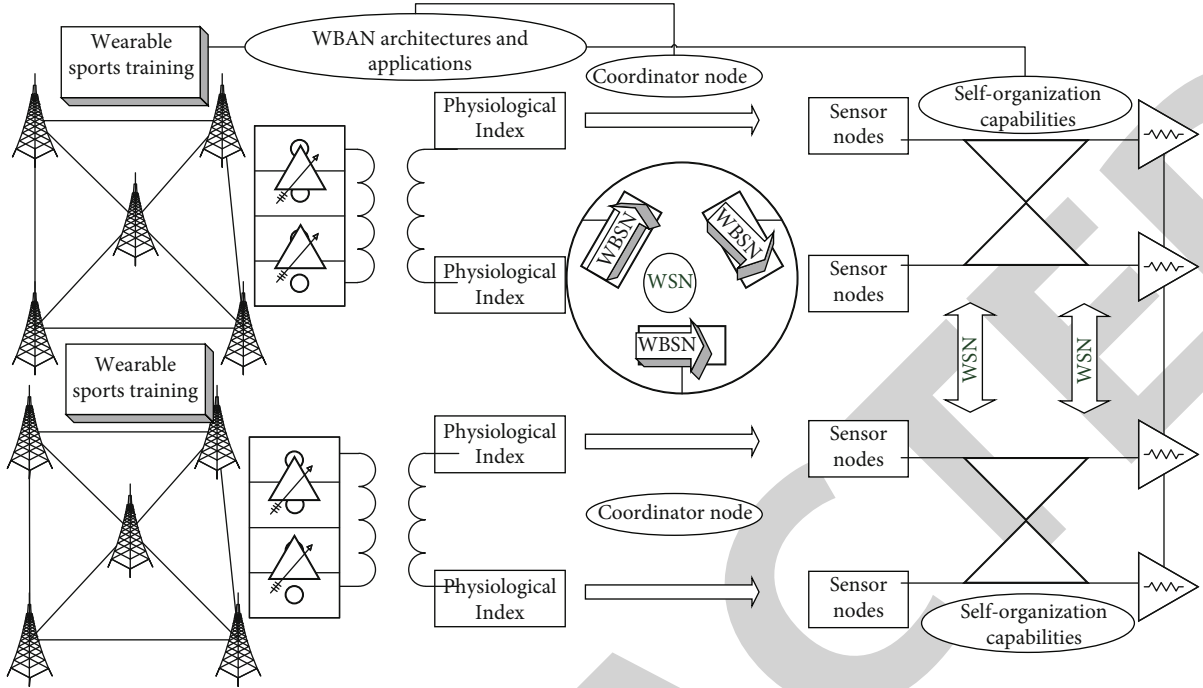


FIGURE 1: Hierarchical framework of wireless sensor network.

of the source physiological index signal and the linear transformation method.

$$L(x, y) = \sqrt{\sum [C_a(x, y) - C_b(x, y)]^2},$$

$$g(x, y) = \frac{|k(x, y)|^2}{t} \times \exp\left(-\|k\|^2 \times \frac{(x+y)}{2t}\right). \quad (1)$$

It remains unchanged for reversible linear transformations. Obviously, compared with the entropy that remains unchanged for the orthogonal transformation, the conditions for negative entropy are more relaxed. In ICA, this property makes it possible to take edge negative entropy and then find a linear transformation to maximize it.

$$R_A = \frac{X_A X_A^T}{|X_A X_A^T|},$$

$$R_B = \frac{X_B X_B^T}{|X_B X_B^T|}. \quad (2)$$

Because the Zigbee protocol uses a layered architecture similar to the OSI seven-layer model, each layer completes certain functions, and the layers and connected layers can call the functions of the layer each other. This layered structure is similar to the stack structure, so we also call it the protocol stack. Mutual information (MI) is a basic criterion used to measure the independence between random variables. Mutual information can be expressed in the form of K-L divergence. The mutual information between multiple random variables is defined as its joint probability density

function between the products of each edge density function.

$$\begin{cases} F_1 = \frac{f_{11}}{\|f_{11}\|}, \frac{f_{12}}{\|f_{12}\|}, \\ F_2 = \frac{f^1}{\|f^1\|}, \frac{f^2}{\|f^2\|}, \\ F_{1,2} = \{F1, F2\}, \end{cases}$$

$$\exp \sum_{i=1}^n x(i) \times f(s, t) = \exp x(1) \times f(x) + \dots + \exp x(n) \times f(x),$$

$$g\{w(i) | w(i-n+1), \dots, w(i-1)\} = \frac{P[w(i-n+1), \dots, w(i-1), w(i)]}{P[w(i-n+1), \dots, w(i-1)]}. \quad (3)$$

Each layer provides services to its neighboring layers. These services are completed by two service entities: a data service entity and a management service entity. The former provides data transmission services, and the latter provides management and other services. These service entities all provide interfaces for their neighboring layers through service access points (SAP). The function functions defined by each layer can only be called by the functions of the layer or its connected layers, thus ensuring a clear hierarchical structure of the protocol.

2.2. Physiological Index Monitoring Module. The transmission of each sensor is scheduled in a synchronous manner, so that each sensor can efficiently transmit the collected data to the coordinator node. As we have introduced before, compared with other sensors, the coordinator node is

generally considered to be a more resource-rich device; it has less power constraints and is usually compatible with multiple standards and multiple communication modes. The coordinator node wirelessly interconnects the data sensed by the sensor node on the body to the coordinator node on other human body or external network infrastructure (GSM, GPRS, 3G, LTE, etc.) through off-body communication. In the case of unavailability or out of range, coordinator nodes can expand the end-to-end network connection in a multihop body-to-body manner by cooperating with each other, thereby forming self-organizing and dynamic wireless body-to-body networks. Among them, the main functions of the PHY physical layer include starting and closing wireless radio frequency transmission and reception, channel energy detection, link quality detection, channel selection, idle channel evaluation, and data packet transmission and reception through the radio frequency module; the main functions of the MAC layer include beacon management, time slot management, sending and receiving frame structure data, and providing appropriate security mechanisms; the network layer is mainly used for network connection, network information maintenance, data management, and network security.

According to the above summary and analysis of various sensor nodes, it can be seen that the transmission data rate of different sensor nodes is different, or even quite different. Figure 2 is a physiological indicator to monitor the transmission data rate. Therefore, in the subsequent simulation experiments, we need to consider the characteristics of different wearable sensor nodes and reasonably carry out location planning, speed setting, and initial energy setting. The classic theory of the central limit theorem in probability theory tells us that under certain conditions; the distribution of the sum of multiple independent distributions tends to be Gaussian. From the perspective of network topology, nodes can be divided into coordinator device nodes, router device nodes, and terminal device nodes. Among them, in addition to its own monitoring information, the coordinator node is also responsible for network formation, network related configuration, management of other network members, and link status information management. The terminal node only needs the functions of collecting data and sending and receiving data. Usually, the coordinator device node and the router device node are generally FFD nodes, and the terminal device nodes are RFD nodes.

2.3. Wearable Network Design. The wearable wireless sensor network is a self-organizing network based on the human body wearing the wearable device. Wearable wireless sensor networks can not only quickly network but can also accurately collect various physiological indicators of the human body and surrounding environment information in real time. At the same time, sports personnel can also collect information and data sensed by other sensor nodes on their bodies through the wearable node and conduct information interaction between each sports personnel and the command center in a single/multihop manner for accuracy. This not only saves lives and monitors the real-time health status of rescue team members and victims but also helps combat

commanders make the best decisions in sports operations. Therefore, the wearable wireless sensor network plays an important role in the emergency sports system and has far-reaching significance for the development of the existing Public Safety Network (PSN). In order to reduce the interference of the electrode contact impedance on the detection result, the double-electrode impedance method is selected in the specific circuit for the detection of physiological index signal parameters. It borrows the chest monitoring electrode for measuring the PWM and adopts the PWM method integrated with the controller MSP430.

Figure 3 shows the topology of a wearable wireless sensor network. Conceptually, the physical layer should also include a physical layer management entity (PLME) to provide a management service interface that calls the physical layer management functions; at the same time, the PLME is also responsible for maintaining the physical layer PAN information base (PHY PIB). The physical layer provides physical layer data services through the physical layer data service access point (PD-SAP) and physical layer management services through the physical layer management entity service access point (PLME-SAP). The network coordinator first sets itself as a cluster header and sets the cluster identifier (CID) to 0 and, at the same time, selects an unused PAN network identifier for the cluster to form the first network in the network. Whether a device can become a cluster member is determined by the network coordinator. If the request is passed, the device will be added to the neighbor list of the network coordinator as a child device of the cluster. The newly added device will add the cluster head as the parent device to its neighbor list. According to the central limit theorem, if the random variable X is composed of the sum of many mutually independent random variables, as long as the ink has a finite mean and variance, no matter what distribution it is; the random variable X is closer to the Gaussian distribution than the ink. In other words, S is more non-Gaussian than X . Therefore, in the separation process, the non-Gaussian measurement of the separation results can be used to express the mutual independence between the separation results. When the non-Gaussian measurement reaches the maximum, it indicates that the separation of the independent components has been completed. BSS refers to recovering an independent source signal only from the mixed physiological index signal to be measured (usually the output of multiple physiological index signals). In the actual environment, since there is no prior knowledge about the mixed system, it is required to infer the mixed physiological indicator signal from the physiological indicator signal to be tested and realize blind source separation.

2.4. Model Data Collection Factors. In a clustered structure, all human bodies wearing wearable devices form multiple clusters according to corresponding conditions. The cluster head of each cluster can manage all members in the cluster and can act as a gateway between clusters to realize all clusters. Finally, in a distributed structure, each human body wearing a wearable device is responsible for its own On-Body network communication and communicates with the surrounding On-Body network in a self-organizing form.

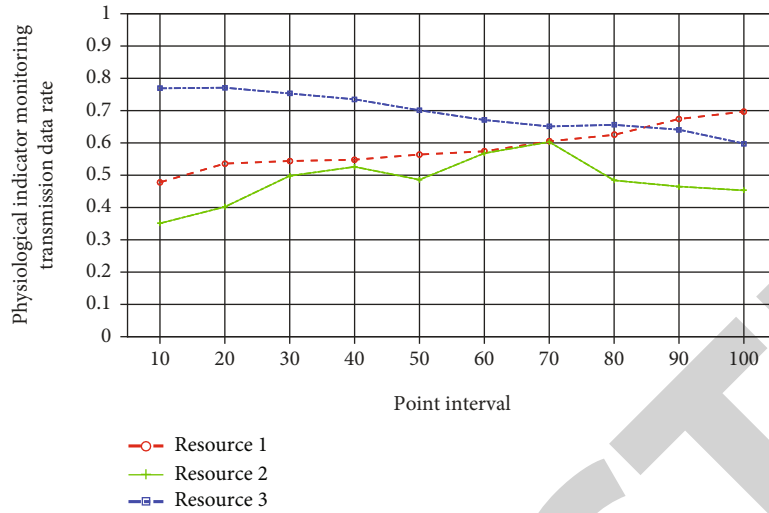


FIGURE 2: Physiological indicators monitor transmission data rate.

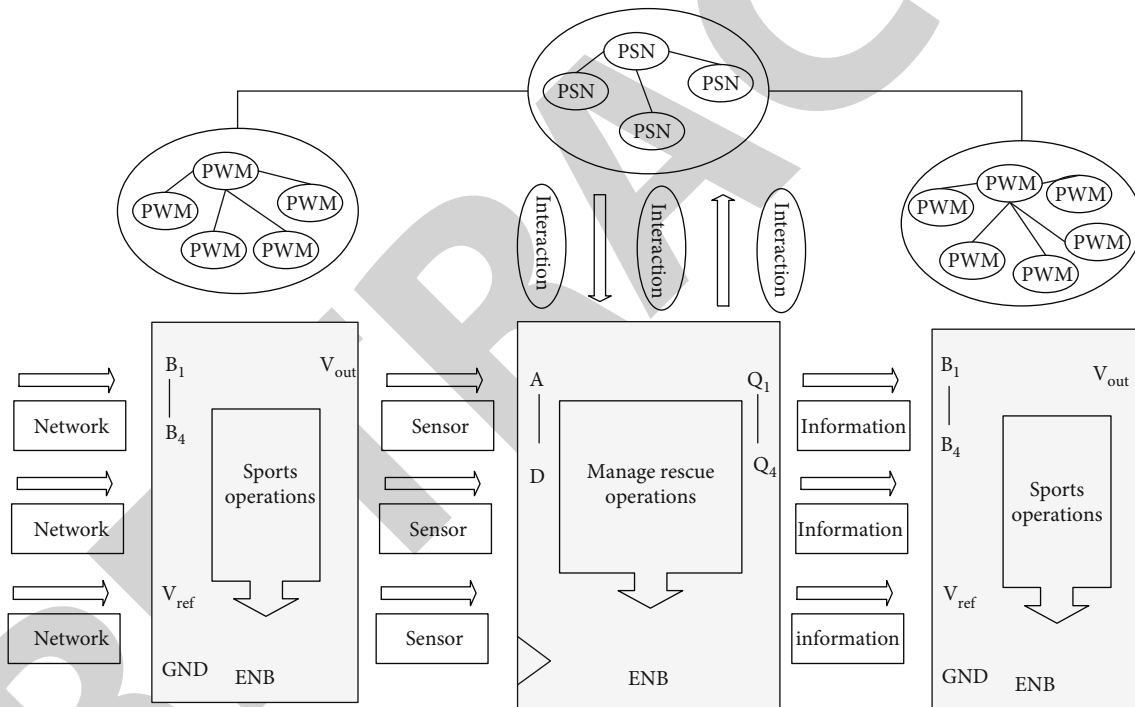


FIGURE 3: Wearable wireless sensor network topology.

The B2B network studied in this paper adopts a distributed network structure, and each mobile node forms a centerless, mobile, and self-organizing network. It cannot guarantee that the predicted result is completely accurate. The difference between the predicted load value and the actual load value is the error of the load forecast. The Zigbee node is composed of four parts: sensor module, information processing module, RF radio frequency module, and power module. The sensor module is used to monitor external information and pass it to the information processing module; the information processing module is responsible for coordinating the work of each part of the node, and it also needs to process and save the information obtained by the

sensor module; the RF radio frequency module is responsible for sending and receiving of node data. Figure 4 is the distribution of physiological indicators of the wireless sensor network.

Reliable communication in sensor networks is very important. The communication requirements of different sports training sensors vary with the sampling rate, from 1 Hz to 1 kHz. One way to improve reliability is to perform signal processing of sensor physiological indicators. For example, feature extraction can be performed on an ECG sensor, and only information about a certain event (such as QRS features and the corresponding R peak time stamp) can be transmitted. For optimal system design, the balance

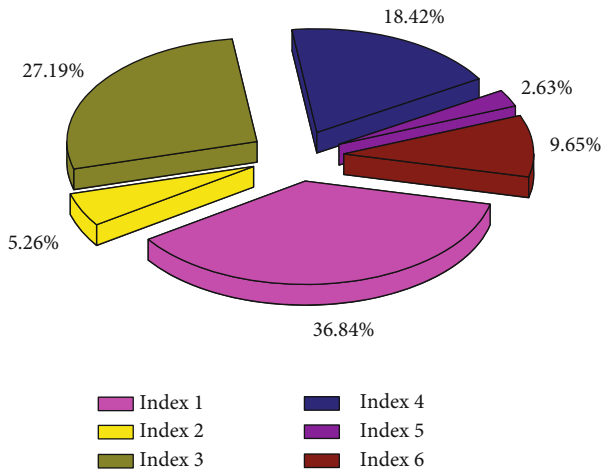


FIGURE 4: Physiological index distribution of wireless sensor network.

of communication and calculation is crucial. Based on the IEEE 802.15.4 protocol, the master node and each subnode together form a star network with simple structure, stability, and reliable operation. Once the network configuration is complete, the coordinator node manages the network and maintains channel sharing, time synchronization, data extraction and processing, and data fusion. Based on the synergy of information from multiple sports training sensors, sensor nodes display the user's health status and feed it back to the coordinator node through a wireless interface and then transmit it to the PC for further processing and storage of the collected data. If the user has an abnormal situation, an alarm will be sent on the sports training node and on the PC at the same time for the doctor to verify the user's status. The work flow of the information collection terminal mainly includes initialization, port configuration, communication module configuration, and main function loop functions. The initialization module includes data area initialization, parameter initialization, AD port configuration, and clock initialization. Port configuration includes network module configuration and Zigbee module configuration. The main functions include gas information collection, acceleration physiological index signal collection, pulse physiological index signal collection, body temperature physiological index signal collection, blood pressure physiological index signal collection, and Zigbee physiological index signal and network physiological index signal processing functions. The nodes work synchronously and at the same time transmit the received physiological indicator signals to the PC for processing and display.

3. Results and Analysis

3.1. Wireless Sensor Network Data Reception. This design uses the RC reset method to design the reset circuit, and the circuit adds a discharge loop. When the system power supply is stable, the circuit will cancel the reset physiological indicator signal. In order for the system to operate stably, after the system power supply is stable, the reset physiologi-

cal indicator signal must be cancelled after a delay to prevent the power supply jitter from affecting the system reset. According to the Zigbee protocol standard, Zigbee equipment has a transmission output power of 0-3.6 dBm and a communication distance of 30-60 meters and can detect energy and link quality. According to these detection results, the transmission power can be automatically adjusted to minimize the energy consumption of the equipment under the condition of ensuring the quality of the communication link. Both the selectivity and sensitivity index of CC2420 exceed the requirements of the IEEE 802.15.4 standard. CC2420 hardware supports CSMA/CA, and it integrates functional modules such as digital RSSI module, power supply monitoring, and channel conversion that can be used to realize node ranging function, including hardware MAC and CRC automatic verification processing. In order to further suppress the common-mode interference with physiological indicator signals, in the design of the entire acquisition circuit, this topic has designed a shielding drive circuit and a right leg drive circuit. By studying the causes of errors and analyzing the error values to improve the forecasting model, it can effectively reduce errors and improve the accuracy of forecasting. It can be seen that error analysis is very important for load forecasting. Connecting the shielding wire to the amplifier output can not only separate the shielding layer from the ground but also drive the shielding the layer's potential to have the same potential as the lead core wire; eliminating the distribution between the shielding layer and the lead core wires improves the input impedance and common mode rejection ratio. After the networking is successful, the reliability of the Zigbee network will be tested. Generally, the received physiological index signal strength index (RSSI) is used to measure the communication quality of the network, and the packet error rate (PER) is used to measure the receiving ability of the test terminal.

Figure 5 shows the receiving capability of the physiological indicator monitoring terminal. The frequency of the useful part of the ECG physiological index signal is mainly concentrated at 0.05 Hz. In the range of 100 Hz, since the existence of 50 Hz power frequency physiological indicator signals will interfere with useful physiological indicator signals, according to different situations, high-pass filtering, low-pass filtering, and band-stop filtering are used to process the collected physiological indicator signals. The ECG physiological index signal extracted from the human body surface contains a large amplitude DC interference physiological index signal. In order to enable the operational amplifier to work in the amplification area, the operational amplifier gain of the designed pre-amplifier circuit should not be too large. If it is too large, the DC stability of the circuit will decrease. In this design, a metal film resistor of 8.25 K is selected in the operational amplifier, which can increase the gain of the first-stage amplifier circuit by about 7 times. It is not enough to rely solely on the high common mode rejection ratio of AD620. The interference physiological indicator signal amplitude still reaches the physiological level. In the wireless network system of multipoint networking, the wireless platform based on ANT module has the advantages of low power

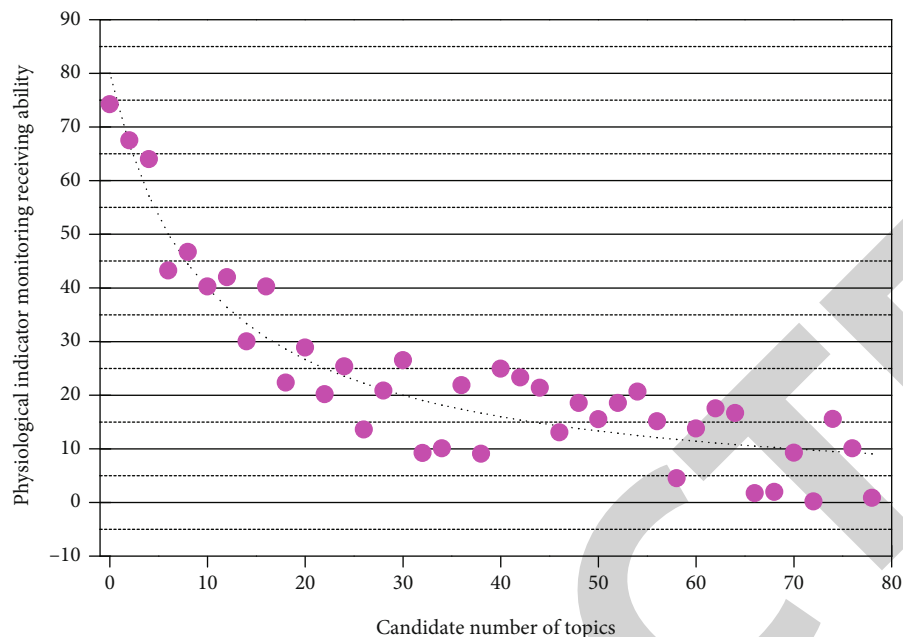


FIGURE 5: Receiving ability of physiological indicator monitoring terminal.

consumption, simple interface, convenient network protocol, etc.

3.2. Physiological Index Monitoring Model Simulation. The main part of a typical application circuit is to connect CC2420 to a microprocessor, with few external components such as crystal oscillator and load capacitors, input/output matching components, and power supply voltage decoupling capacitors. The single-chip microcomputer uses MSP430F149, which is a 16-bit low-power single-chip microcomputer with RISC architecture. It exchanges data with the personal computer through the serial port, receives the data of the sub-nodes in the cabin through the wireless module, and manages and coordinates the synchronization of the nodes in the cabin at the same time. When provided by the internal circuit, an external crystal oscillator and two load capacitors are required. The size of the capacitor depends on the crystal frequency and input capacitance and other parameters. For example, when a 16 MHz crystal oscillator is used, its capacitance value is about 22 pF. The RF input/output matching circuit is mainly used to match the input and output impedance of the chip so that its input and output impedance is 50Ω , while providing DC bias for the power amplifier and low noise amplifier inside the chip. Figure 6 is the result of the radio frequency input/output matching ratio of the wireless sensor network.

There are two passive filter circuits in the design, both of which consist of three components to form a T-type, which is called a double-T network. When the frequency of the physiological index signal is relatively low, increasing the capacitor impedance will increase the output and reduce the feedback. As the frequency of physiological indicators increases, the impedance of the capacitor gradually decreases, resulting in a decrease in output and an increase in negative feedback. When the frequency of the physiolog-

ical indicator signal reaches 50 Hz, the output value is the smallest. If the frequency of the physiological indicator signal continues to increase, the impedance of the capacitor will decrease successively, and the final output value will also become larger and larger. The collected data is transmitted to the coordinator node through the Zigbee wireless sensor network, and the coordinator transmits the data to the MCU of the information control terminal through the serial port for processing and display. The following figure shows the results after the measured temperature and pulse. The system test is divided into two parts: the first part is the test of the hardware part of the data acquisition module; the second part is the test of the background software system. In this system, the hardware part of the test is mainly based on the Zigbee development environment and the serial debugging assistant. Firstly, each submodule is tested separately, and then the output of the circuit and the communication connection between the modules are tested. Table 1 is the communication composition between wireless sensor circuit modules.

After sorting out and standardizing the original data, there are about 4500 pieces of original data. Since the data analysis in this article is based on system functions, the feature selection of training data is based on the selection of collection indicators in the front-end collection module of this system. The label of the data set is established based on the report results given by the doctor in the medical examination report. It can be seen from the model evaluation indicators that the model has a strong classification ability. The threshold can be adjusted by pressing the button. When the temperature or pulse exceeds the threshold, an alarm message will be sent to the preset guardian's mobile phone in the form of a short message. During the operation, the microprocessor can set the timer and interrupt program to make the two light sources alternately light up and to

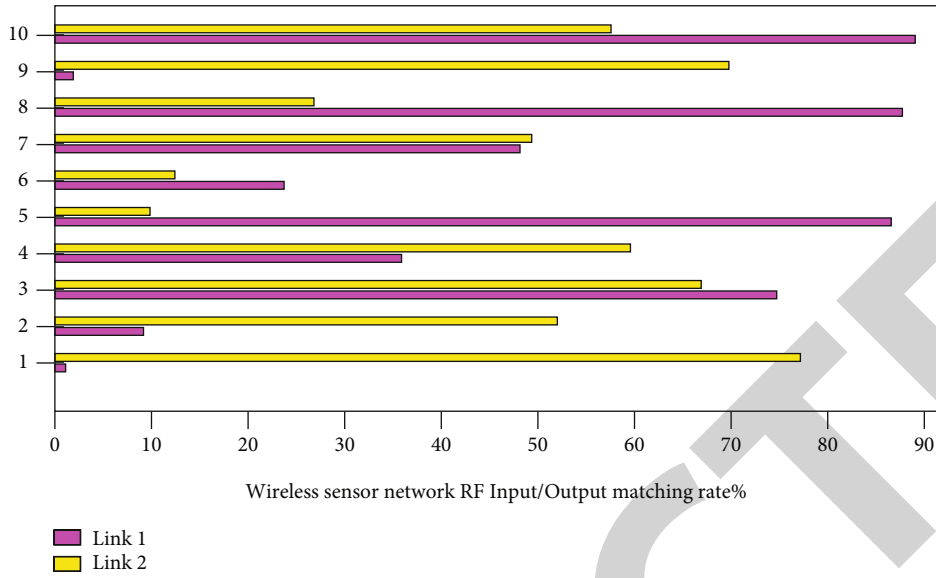


FIGURE 6: RF input/output matching rate results of wireless sensor network.

TABLE 1: Communication composition between wireless sensor circuit modules.

| Module | Working frequency (GHz) | Distance (m) | Transmission rate (Mbps) |
|--------|-------------------------|--------------|--------------------------|
| 1 | 2.5 | 0-1000 | 250 |
| 2 | 3.0 | 20-800 | 500 |
| 3 | 4.0 | 200-1000 | 300 |
| 4 | 5.0 | 50-500 | 40 |

ensure a fixed frequency, to ensure that the sensor can run at high speed and stably.

3.3. Analysis of Experimental Results. In terms of node hardware design, the sensor module part is mainly designed for the collection temperature physiological parameters; for the wireless communication module part, this article uses direct sequence spread spectrum on the FPGA development platform Quartus II 10.1. In terms of node software design, this paper considers the feasibility of the scheme and the rational use of hardware resources, designs the overall workflow of the node, and adopts a divide-and-conquer method to design separate software for individual functions, including overall node scheduling, physiological and physiological indicator data acquisition, and wireless communication program. The simulation experiment is carried out on MATLAB as the platform. The experiment is divided into two groups of unconsidered factors and considered factors. When the outside world sends a physiological indicator signal to the chip, the boot area that stores the BOOTROM.

For the allocation of training set and test set, in this paper, 60% of the experimental data in the data set is used as the training sample, and 40% of the experimental data in the remaining data set is used as the test sample. Figure 7 shows the statistical distribution of the deviation of the wireless communication transmission. The model

training experiment is implemented based on Python, and the support vector machine classifier SVC method is used to classify and train the data. The selection of the kernel function in the training method adopts the default Gaussian function, because it can obtain ideal results on most sample sets, and the support vector machine with Gaussian function as the kernel can usually show good performance. After the GPRS module is connected to the MSP430F149, the serial port will be initialized first, and then, the microcontroller will send the AT command to the GPRS module to make the module log in to the GSM network and establish a connection. After the configuration of the data transmission mode is completed, the data receiving function is used to the preset mobile phone in the form of short message. The temperature data obtained after DS1 8820 conversion is stored in the memory in the form of two-byte complement.

Since the data set contains continuous feature data with different value intervals, the data needs to be normalized. Normalization is to adjust the range of the data to the interval of $[0, 1]$ or $[-1, 1]$, eliminating the influence of different dimensions on the data. Figure 8 is a comparison of frequency measurement deviations of wireless sensors. The minimum-maximum normalization method is adopted for processing, and the value is mapped to the interval range of $[0, 1]$. Each group is divided into the BP neural network model, GABP neural network model, and PCA. The GABP neural network model was carried out by four groups. The acceleration movement amplitude in the vertical direction is greater than the lateral forward and backward movement, and the amplitude gradually increases from the head to the toe of the human body. In order to effectively reflect the motion state of the human body, this paper adopts the SMB38 three-dimensional acceleration sensor that measures the three-dimensional acceleration values of the front and rear, left and right sides, and upper and lower parts of the human body. For example, the uric acid value is generally three digits. The uric acid value is a single-digit value, which

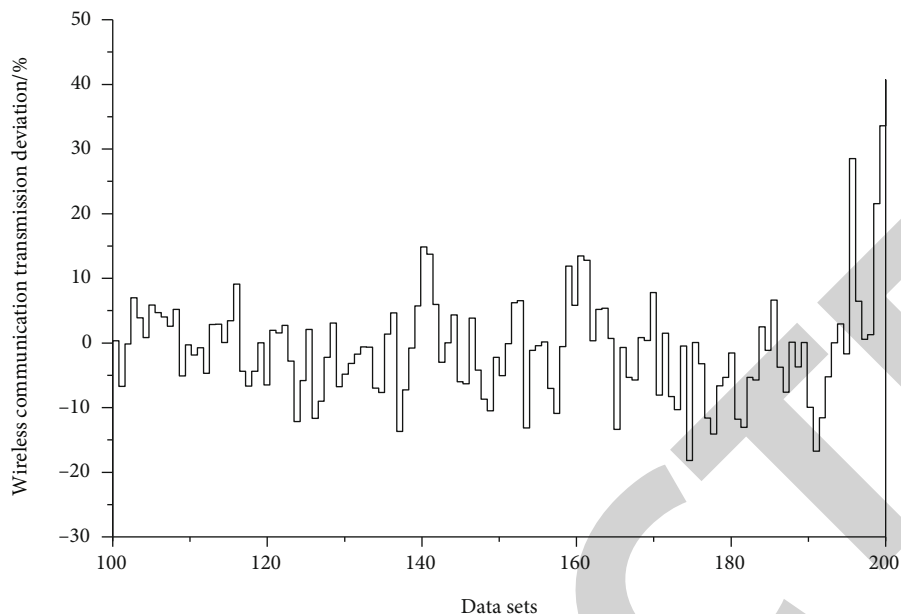


FIGURE 7: The statistical distribution of wireless communication transmission deviation.

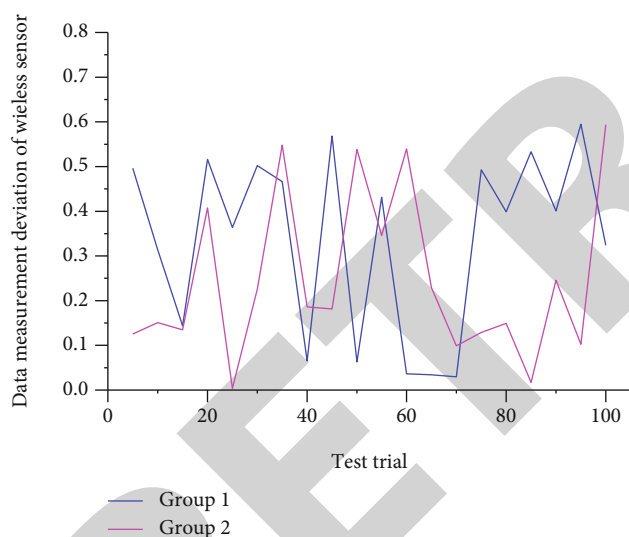


FIGURE 8: Comparison of frequency measurement deviation of wireless sensors.

is an abnormal value. The processing of outliers is to use the average value of the entire data set instead for correction. From the pulse test results, it can be seen that the pulse values of the three tested subjects are within the normal range, and there is not much difference between the test results of the medical pulse meter. It can be seen from the variance of the three sets of pulse test data that sometimes the result is not stable, but it can also be within the acceptable range. This is because the sensor element of the front-end pulse acquisition module is related to the circuit design. If there is a need for accurate measurement in the future, the pulse measurement module can be further improved and optimized.

4. Conclusion

According to the short-distance, low-complexity, low-power, low-cost, and high-stability requirements of wearable sports monitors, this paper chooses IEEE802.15.4 as the wireless communication protocol for a wireless sensor network. On this basis, the network structure, software, and hardware of the wearable sports monitor system are designed, and the technical difficulties and key points of implementing the monitoring device are analyzed and studied. The synchronization and coordination of the network carries out the collection and transmission of physiological indicator signals. The sensor module is responsible for the collection of physiological and physiological index signals and the conditioning of physiological index signals. In order to achieve a clear comparison effect, this paper uses the maximum relative error, the absolute value of the relative error, and the average relative error to do error analysis; we select the maximum relative error of the predicted load of 48 points. Each physiological and physiological index signal needs to be designed independently, based on different physiological physiology. For the reception and transmission of wireless data, this module mainly uses direct sequence spread spectrum technology for communication and uses FPGA development technology to complete the digital logic circuit of the direct sequence spread spectrum communication system to analyze and study the technical difficulties of wearable sensing detection and data collection of physiological and physiological indicator signals and design sensor nodes and coordinators by integrating these five detection circuits and radio frequency communication modules node. Through experimental verification, the physiological index signal denoising and feature extraction proposed in the paper have good effects and certain feasibility; the hardware system design scheme conforms to the principle of

miniaturization and low power consumption and can be applied to wireless sensors for physiological index signal detection.

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 known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

This work was funded by a grant from the National Key Research and Development Program of China (Grant No. 2020YFC2006200).

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