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Retraction

Retracted: The Design of the Exercise Load Monitoring System Based on Internet of Things

Wireless Communications and Mobile Computing

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1].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.

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] K. T. Zhao and W. J. Liu, "The Design of the Exercise Load Monitoring System Based on Internet of Things," *Wireless Communications and Mobile Computing*, vol. 2022, Article ID 8011124, 11 pages, 2022.

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Research Article

The Design of the Exercise Load Monitoring System Based on Internet of Things

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Exercise is of great help to human health, and exercise load monitoring is also to ensure the physical and mental health of athletes. Therefore, this paper designs an exercise load detection system based on Internet of things technology. We introduce the design of heart rate acquisition part, mobile application part, and web server in detail. There are many places to weigh and consider in the design process. The design idea of the system is introduced step by step, and the hardware system deployment architecture and the overall software architecture of the system are designed. In particular, the monitoring of exercise heart rate is very suitable for the system requirements studied in this paper. The system design in this paper can achieve the effect of human sports load detection.

1. Introduction

With the rapid development of Internet technology, Internet of Things technology, and big data analysis technology, vital sign monitoring technology is changing rapidly [1]. Heart rate is an important physiological parameter and is the key object of vital sign monitoring, so the research on heart rate monitoring and analysis has received much attention [2]. Exercise makes people healthy and strong, and people want to improve their physical fitness through exercise. Exercise training in the forms, exercisers can choose their own exercise that suits their functional state. Exercise is risky. If the intensity of the exercise load is too high or the amount of exercise exceeds the ability of the exerciser, then it can cause exercise injury or exercise fatigue [3]. Exercise is the need for long-term adherence, the effect of exercise requires the accumulation of multiple exercise quantitative changes. The effects of exercise need to be accumulated quantitatively over a number of exercises before they can be seen. Exercise can be monitored [4], by monitoring the heart rate to adjust the speed of exercise, we can ensure that human life will not be endangered due to excessive exercise. Telemedicine aims to improve diagnosis and medical care, reduce medical expenses, and provide medical services that meet the health care needs of the general public [5]. The level of development of telemedicine is uneven, with Europe and the United States having been far ahead of other countries in this field for more than 40 years. The initial telemedicine technologies were telephone remote diagnosis and television monitoring [6]. With the rise of Internet technology, telemedicine has developed to the use of high-speed networks for the integrated transmission of digital, image, and voice and to achieve real-time voice and high-definition image communication, thus completing remote monitoring [7]. The Internet of Things (IoT) technology has received widespread attention worldwide after the "Smart Planet" was first proposed by American business leaders. IoT technology collects all kinds of information needed for monitoring, connecting, and interacting with any object or process in real time through various information sensing devices and combines with the Internet to form a huge network. At present, IoT technology is widely used in telemedicine projects, such as the "IoT-based mobile health monitoring common platform" of Jiangxi Huitian Technology Co. [8].

In this paper, we study the relationship between heart rate and exercise and use it as the basis to implement a heart rate collection device that can collect real-time heart rate in combination with current IoT technology [9]. The filtering of heart rate values is done in the heart rate acquisition device. The device implements the control of the heart rate acquisition device through Bluetooth low power technology and communicates with the mobile device using Bluetooth low power technology. These works will provide reliable and valid data for the later services and applications. In this paper, we propose a personalized maximum heart rate assessment model by monitoring the heart rate of exercisers over a long period of time and based on the heart rate characteristics of individual exercisers, which can greatly reduce the errors caused by using a fixed formula. The heart rate monitoring and analysis system designed in this paper can assist exercisers to monitor their exercise status at any time, so as to ensure the exercise effect and exercise safety. This paper assists exercisers in developing and completing their own exercise programs through long-term monitoring.

2. Related Work

Foreign research on vital sign monitoring technology is early, and there have been a large number of achievements in heart rate monitoring. Now, there are already wearable devices that fully or partially support real-time heart rate detection and analysis, such as Polar H7 Bluetooth heart rate band with low power consumption, fast connection, and good real-time performance. There are now wearable devices that fully or partially support real-time heart rate detection and analysis, such as Polar H7 Bluetooth heart rate band with low power consumption, fast connection, and good real-time performance [10], Runtastic heart rate band that supports IOS, Android 2.1, WP 7.5, and even many models of BlackBerry, Mio Alpha heart rate watch that uses dual-beam photoelectric devices to monitor user's heart rate, and Mio Link bracelet that also uses photoelectric monitoring module and tells users the current heart rate range by the color of LED lights. The Mio Link bracelet, among others, uses a dual-beam photoelectric device to monitor the user's heart rate. Heart rate monitoring is a very valuable thing, and researchers have used different methods to monitor heart rate from different perspectives, from ECG-based to pulse wave-based to light-transmitting finger-based [11–13]. Heart rate monitoring devices have evolved from fixed monitors to portable devices and are now taking a big step toward wearable devices. Relatively cutting-edge is heart rate telemetry technology, which can measure heart rate directly from images without contact.

In recent years, with the maturity of mobile Internet technology, mobile medical technology has emerged, and a large number of mobile medical applications have emerged in domestic and international markets. At present, vital signs monitoring technology is also developing in the direction of remote mobile monitoring, and there are two key technologies for vital signs remote monitoring system—data acquisition middleware and communication methods. Data acquisition middleware generally consists of information acquisition, information storage, information processing, and information service components [14–16]. Communication methods are classified as wired and wireless, and the common wireless communication methods for remote monitoring are Bluetooth, infrared, Zigbee, Ant, GPS, WiFi, etc. The Android remote ECG monitoring system based on Bluetooth 4.0 transmission implemented in [17] is typical of this type of system in terms of the architecture and technology used [18].

[19] explored whether the traditional maximum heart rate derivation formula HRmax = 220-age is applicable to sports college students and finally concluded that it is not appropriate to use 220-age to derive the maximum heart rate of sports college students, but HRmax = 208 − 0.7 ∗age formula can be used to derive it. [17] studied the load level indexes corresponding to heart rate, grasped the dynamic changes of heart rate according to the heart rate monitoring indexes, combined the RPE subjective perception corresponding indexes and the exercise heart rate to determine the percentage of exercise intensity for analysis, and formulated the best target heart rate calculation formula and the heart rate indexes corresponding to exercise load level.

3. Design of an Exercise Heart Rate Monitoring System

3.1. Basic Requirement Analysis of Exercise Heart Rate Monitoring System. The purpose of the research on exercise heart rate monitoring system is to help exercisers to monitor their exercise status in real time and for a long time and to adjust the exercise load according to the exercise heart rate in time, so as to avoid poor exercise effect due to insufficient exercise intensity or overexercise resulting in sports injuries, in order to achieve a good exercise effect.

Interpreting the objectives of the system research, we can get its basic needs are (1) monitoring real-time heart rate, which is requirements for heart rate sensor sensitivity and heart rate acquisition algorithm; (2) long-term monitoring of heart rate, which is the requirement for heart rate collection device data storage analysis and athletes adhere to the needs of heart rate monitoring; (3) can detect exercise heart rate, which is the demand for the portability or wearability of sports heart rate collection devices; (4) can view sports heart rate in real time, which is the demand for real-time display of the exercise heart rate monitoring system; and (5) timely adjustment of exercise load according to the exercise heart rate, which is the core demand. This is the core demand, this demand requires the system to give a reasonable exercise heart rate monitoring exercise, and this is the core requirement, which requires the system to provide a reasonable theoretical model and an operable solution for monitoring exercise load using exercise heart rate. The functional modules of the system are designed according to the system requirement analysis, as shown in Figure 1.

1. Heart rate acquisition module, heart rate acquisition module mainly completes real-time pulse rate acquisition, heart rate calculation and filtering, heart rate display, Bluetooth low-power communication. Heart rate display, Bluetooth low-power communication four functions.

(1) Real-time pulse acquisition, through the pulse sensor to collect the pulse. In this paper, according to the system requirements for heart rate acquisition, the

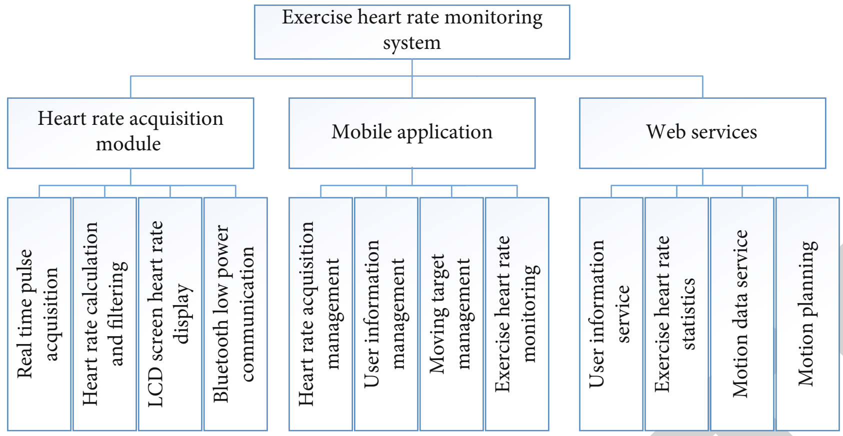


Figure 1: Functional structure of exercise heart rate monitoring system.

pulse sensor is used according to the needs of the system for the motion scenario of heart rate collection, and the pulse sensor output is the pulse wave signal. The pulse information collected in the pulse acquisition module is transmitted to the 80C51 processor through the GPIO interface

(2) Heart rate calculation and filtering, first, we have to obtain the time T used for each pulse according to the collected pulse information and calculate the heart rate according to the formula HR = 60/T and then use the adaptive hybrid filtering algorithm studied in this paper to numerically filter the heart rate

(3) The heart rate display on the LED screen simply shows the connection mode of the nodes of the acquisition device, the connection status, the heart rate of the three most recent consecutive acquisitions, and the three most recent consecutive heart rates

(4) Bluetooth low-power communication, using TI's BLE protocol stack, following the principle of low-power design and setting the relevant profile reasonably to realize the communication with the cell phone and complete the data transmission and the connection control of the acquisition device from the cell phone

In order to accomplish the research objectives of this system, the cell phone application should at least complete four submodules: heart rate acquisition management, user information management, sports target management, and sports heart rate monitoring [20].

(1) Heart rate acquisition management, including the connection of heart rate acquisition equipment, heart rate acquisition settings, initial processing and storage of heart rate data, and other functions

(2) User information management, including user registration, user login, user editing, and user rights management. In the registration part is a good time to collect the basic data of users

(3) Exercise goal management, the system assists users to specify exercise training plan, exercise goal management including the establishment of goals, goal query, and goal completion functions

(4) Sports heart rate monitoring, a key point of the sports heart rate monitoring system, is to monitor real-time heart rate to help athletes adjust exercise intensity in time to ensure exercise effect and sports safety. The exercise heart rate monitoring module includes maximum heart rate calculation, heart rate load index classification, and real-time heart rate display and alarm

Web service includes four submodules: user information service, exercise heart rate statistics, exercise data service, and exercise planning.

(1) User information service, with the authority and sportsmen and coaches can query the information of relevant sportsmen by conditions, system administrator can manage user information, and the system can provide simple user data to the public

(2) Sports heart rate statistics, sports heart rate monitoring system by long-term monitoring and saving the heart rate data of the sportsman, sports heart rate statistics can count the resting heart rate change, heart rate reserve change, heart rate recovery change, assist in adjusting the maximum heart rate, statistical sports average heart rate change, calculate the exercise volume change, etc., is a specific function of this paper to provide long-term sports heart rate monitoring service [21]

(3) Exercise data service, the exercise data service of this system is used to guide exercisers and coaches to specify exercise plan, users can check their detailed exercise data in the exercise data service module, and according to their users can check their detailed exercise data in the exercise data service module and complete the improvement of some index data according to their exercise goals

(4) Exercise planning, i.e., setting long-term exercise training goals, planning exercises by time and exercise form and exercise volume, and finally, the system can be used to check the exercise data

Through the analysis of each module of the exercise heart rate monitoring system, the communication process of each part of this system, as shown in Figure 2.

Based on the requirements description of the exercise heart rate monitoring system, the scope of work for the system design was determined. With a basic grasp of the system with a basic grasp of the system design, it was then found that some of the current popular IoT architectures have one can meet the basic requirements for the overall system architecture of the exercise heart rate monitoring system [22].

3.2. The Overall Architecture of the Exercise Heart Rate Monitoring System

3.2.1. IoT Architecture. The IoT architecture referenced in this paper can be divided into three layers: the sensing layer, the network layer, and the application layer. The sensing layer consists of various sensors and sensor gateways, including carbon dioxide concentration sensors, temperature sensors, humidity sensors, QR code tags, RFID tags and readers, cameras, GPS, and other sensing terminals; it also includes heart rate meters, blood pressure meters, blood glucose meters, and other vital signs collection terminals. The role of the sensing layer is equivalent to the nerve endings of human eyes, ears, nose and throat, and skin, etc. It is the source of IOT to identify objects and collect information.

3.2.2. The Overall Architecture of the System in This Paper. In this paper, the exercise heart rate monitoring system uses "Pulse Sensor + TICC2540" as the sensor node in the sensing layer. The Android cell phone is used as the sensor gateway. The Android phone is used as the sensor gateway, and the Android phone communicates with the heart rate acquisition device through Bluetooth and with the web server through HTTP protocol [23]; the Android application for exercise heart rate monitoring and the website for exercise heart rate monitoring are used as the application layer. The outline of the architecture is shown in Figure 3.

Exercise heart rate monitoring system involves embedded, Android, Web application, and other related technologies, and to make each part organically combined into a coordinated system, together to complete the exercise heart rate monitoring service. From the overall perspective, the system is divided into three parts: heart rate acquisition module, Android application, and Web service. Next, the overall operation of the system is described from the perspective of the overall data flow, and the partial data flow is shown in Figure 4.

3.3. Design of Heart Rate Acquisition Module. To complete the real-time heart rate acquisition, the heart rate acquisition device first acquires the pulse information and then obtains the pulse information from the pulse information. The heart rate filtering algorithm is used to numerically filter the collected heart rate information, and finally, the filtered data is sent to the cell phone through Bluetooth communication with the smartphone.

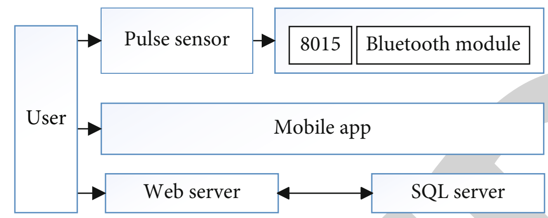


Figure 2: Communication of the exercise heart rate monitoring system.

The heart rate acquisition device is designed with both hardware and software components. The pulse sensor used in this system is a foreign open source hardware sensor, which has been introduced into China in recent years, and it can realize the sampling of human finger blood flow light environment, the pulse data is obtained by sampling the pulse analog signal with the AD converter controlled by 80C51, and the heart rate is calculated according to the pulse period T [24].

4. Heart Rate Filtering

4.1. Heart Rate Filtering Problem Analysis. Heart rate acquisition devices are inevitably affected by some disturbing signals from the system itself, and the data acquisition process is inevitably affected by periodic and nonperiodic interference signals from the system itself and the external environment, such as user breathing, muscle jitter, and baseline. The data acquisition process is inevitably affected by periodic and nonperiodic interference signals from the system itself and the external environment, such as user breathing, muscle jitter, baseline drift, and industrial frequency interference. Currently, there are two ways to deal with interference signals, hardware filtering, and software filtering.

Hardware filtering alone has the disadvantages of fixed cutoff frequency, unsatisfactory filter rectangular coefficient, and relatively poor accuracy. It cannot completely suppress the influence of the system itself and the external environment. Therefore, it is necessary to use effective software filtering algorithm to suppress or eliminate the influence of various signal disturbances in the signal acquisition process, so that the heart rate monitoring data can be more reliable. In order to monitor human heart rate data conveniently, quickly, and in real time, while considering the portability and low power consumption of the system, this paper designs a wearable heart rate monitoring device. In this paper, a wearable heart rate monitoring system is designed to monitor human heart rate data in real time. Based on the experimental tests and analysis, the adaptive hybrid filtering system is proposed [25].

Based on the experimental testing and analysis, the adaptive hybrid filtering algorithm is proposed to improve the reliability of the real-time monitoring system and realize the long-term real-time monitoring of exercise heart rate. The system can be used to improve the reliability of real-

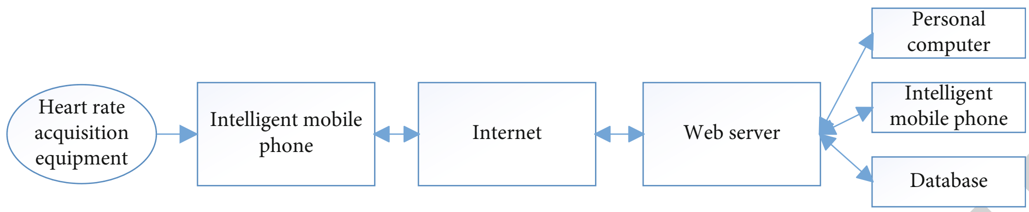


Figure 3: Overall system architecture.

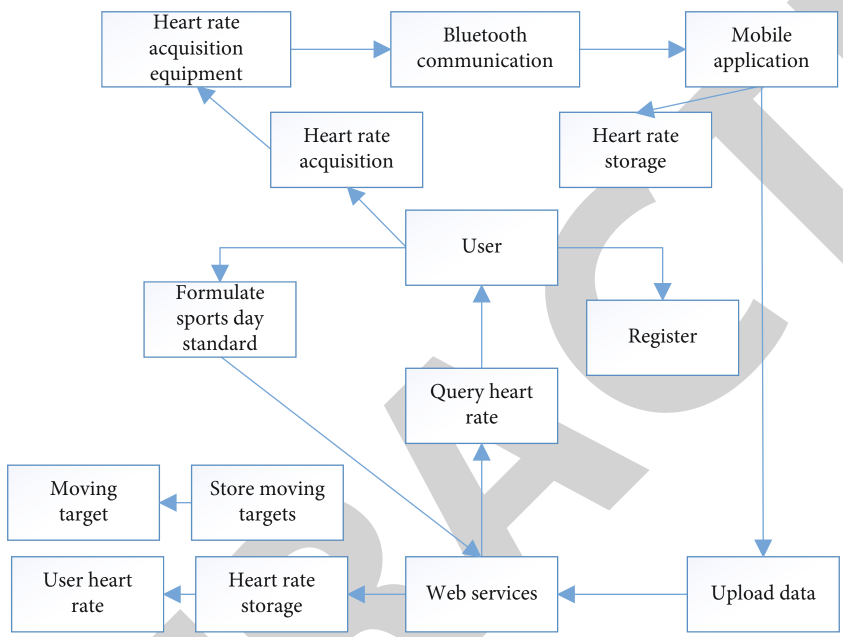


Figure 4: Data flow diagram of exercise heart rate monitoring system.

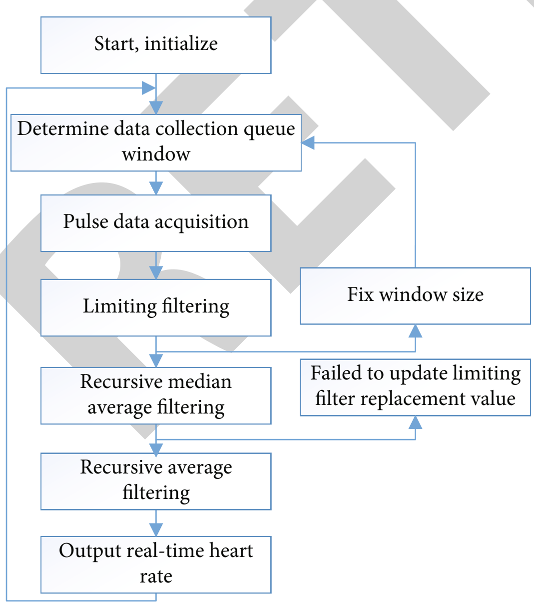


Figure 5: Flow chart of adaptive hybrid filtering algorithm.

time monitoring and achieve long-term real-time monitoring of exercise heart rate.

4.2. Adaptive Hybrid Filtering Algorithm. In the numerical filtering algorithm, different filtering algorithms are usually used according to the different characteristics of the interfering signal, in order to achieve better filtering effect. Among the commonly used numerical filtering algorithms: (1) amplitude limiting filtering method by setting a threshold value. By setting the threshold value, the sampling value is clipped so that it does not exceed the threshold range. It can effectively overcome the interference caused by chance factors. (2) Median averaging filtering method can suppress the occasional impulse interference and smoothness. The median average filtering method can suppress the occasional impulse interference and eliminate the deviation of the sampled value caused by it. (3) The recursive average filtering method is good for periodic interference.

The method has good suppression effect on periodic disturbances, but poor suppression effect on occasional signal disturbances and high smoothing degree. In [49], the selection of the window size of the sampling value also affects the filtering effect in the median average filtering method and the recursive average filtering method. A large window

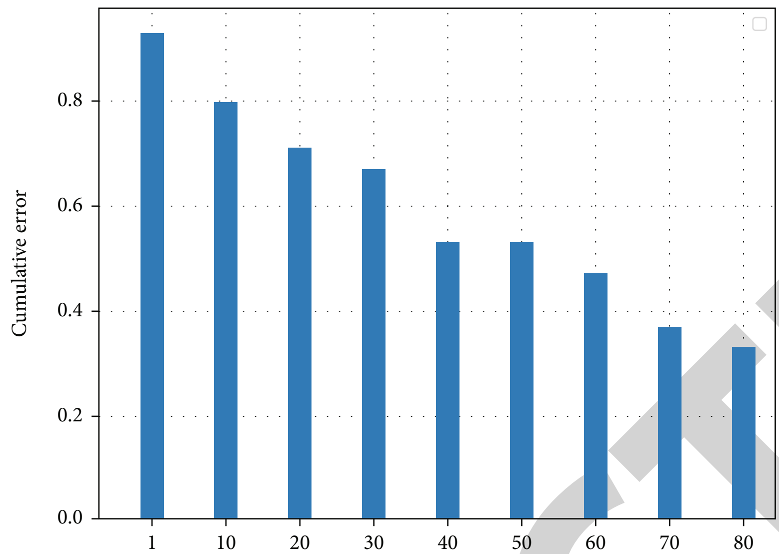


FIGURE 6: Error of preprocessed signal data under different iterations.

results in high smoothness and low sensitivity, while a small window results in poor smoothness and high sensitivity.

For the above analysis, the limit filtering method, the recursive median averaging filtering method, and the recursive averaging filtering method are used; the adaptive hybrid filtering algorithm is proposed for the influence of the sampling value window size on the filtering effect. It can effectively filter out the chance interference and suppress the periodic interference. The algorithm flow is shown in Figure 5.

In the adaptive hybrid filtering algorithm, W_n is the nth sampling queue window size. The adjustment of W_n value needs to be determined, and a W_n adjustment is performed when $n\%m = 0$ is satisfied. Where m is the W_n adjustment step set by the system. Under normal circumstances, the deviation of the previous sample value from the next sample value is small. Therefore, if the absolute value of the difference between two adjacent values in the sample queue is greater than the maximum sampling deviation value set by the system, an abnormal fluctuation is generated during heart rate acquisition [12].

$$C_i = \begin{cases} 1 & |S_i - S_{i-i}| > S_A, \\ 0 & |S_i - S_{i-1}| \le S_A. \end{cases} \quad (1)$$

In equation (1), 1 indicates abnormal fluctuation, 0 indicates no abnormal fluctuation, and S_A is the maximum sampling value deviation.

According to the number of abnormal fluctuations in the sampled value queue, the corresponding window size is adaptively adjusted. When the number of abnormal fluctuations is high, the queue window is increased to improve the smoothing effect and suppress the interference; when the number of abnormal fluctuations is low, the queue window to reduce the memory consumption and improve the operation speed.

$$E_n = \sum_{i=n}^{n-W_n-1} C_i, \quad (2)$$

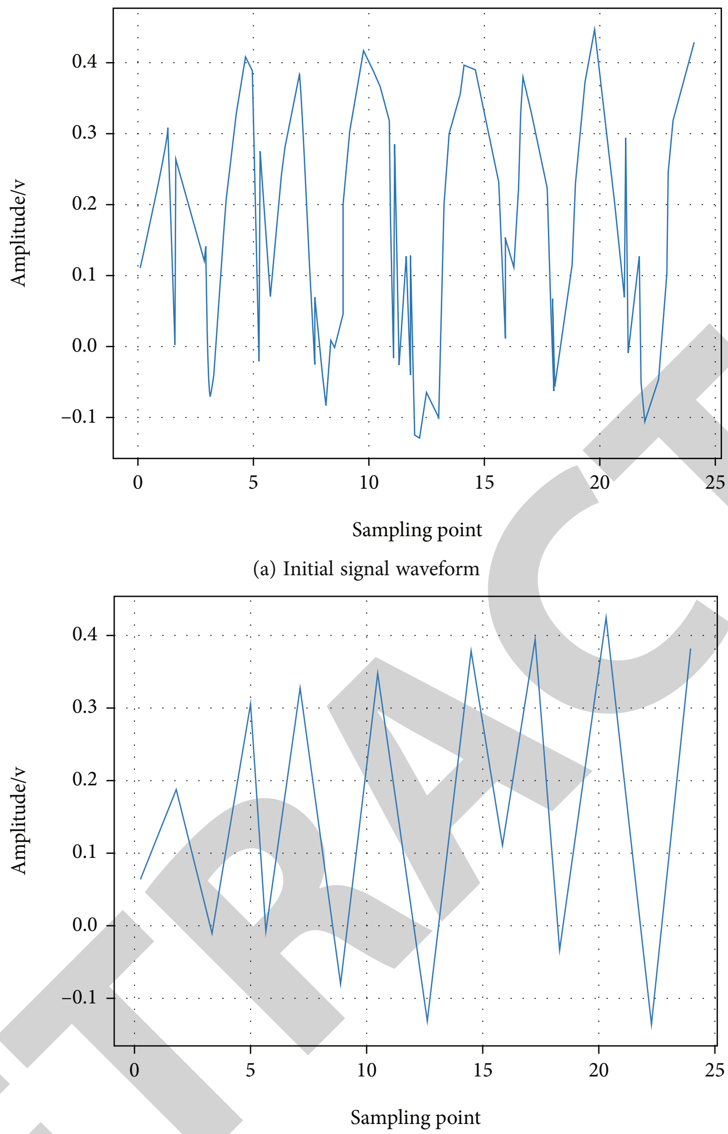
$$W_n = \begin{cases} P_1 & E_n \le \lambda P_1, \\ P_2 & \lambda P_1 \le E_n < \lambda P_2, \\ P_3 & E_n \ge \lambda P_2. \end{cases} \quad (3)$$

Maximum heart rate, i.e., the number of rhythmic contractions of the heart per minute. The maximum heart rate is calculated using the international maximum heart rate metric. The heart rate is filtered by the maximum heart rate value and the minimum heart rate set by the system: if the measured value is larger than the minimum heart rate and smaller than the maximum heart rate, the sample value is valid. If the measured value is greater than the minimum heart rate and less than the maximum heart rate, the sampled value is valid [27]. If the sample value is greater than the maximum heart rate or less and if the sample value is greater than the maximum heart rate or less than the minimum heart rate, the sample value is invalid, the sample value is discarded, and the average value of the historical measurement is used as this the average value of the historical measurement is used as the measurement value this time. If the measurement value is invalid for 3 consecutive times, all operations are initialized and the measurement is restarted. The heart rate measurement with limit filtering is S_n:

$$S_n = \begin{cases} F_n & \mathrm{H}_{\min} \le \mathrm{F}_n \le H_{\max}, \\ F_c & \mathrm{F}_n > \mathrm{H}_{\max} \text{ or } F_n < H_{\min}, \end{cases} \quad (4)$$

$$H_{\max} = 220 - \text{age}. \quad (5)$$

In Eq. (4), F_n is the nth heart rate measurement, and F_c



(a) Initial signal waveform

(b) Signal waveform after preprocessing by this method

Figure 7: Comparison of the initial signal and the preprocessed signal waveform of this paper.

is the average of historical measurements. In Eq. (5), $H_{\min}$ is the minimum heart rate set by the system, $H_{\max}$ is the maximum heart rate, and age is the age of the test subject.

$$T_n = \frac{1}{W_n - 2} \sum_{i=0}^{W_n - 1} \left(S_{(n-i)} - S_{(n-i)\ \max} - S_{(n-i)\ \min} \right). \quad (6)$$

In equation (6), $S_{(n-i)}$ is the $(n-i)$th heart rate measurement after limiting filter, $S_{(n-i)\ \max}$, $S_{(n-i)\ \min}$ is the maximum and minimum of the cohort center rate measurement, respectively.

To further improve the stability of the heart rate acquisition system, the algorithm uses a second recursive averaging filter. The recursive averaging filtering is a low-pass filtering, which can be used several times to make the cut-off frequency smaller and filter out the high frequency signals with relatively low frequency.

$$H_n = \frac{1}{W_n} \sum_{i=0}^{w_n - 1} T_{(n-i)}. \quad (7)$$

In equation (7), H_n is the recursive average filtered output value, which is the final heart rate measurement.

5. Experimental Results and Analysis

In the experiment, ten gymnasts and divers with average ages of 18 and 20 were selected from a professional sports college, each of the 20 athletes completed three different sets of sports movements, and the six sets of sports movements were used as the experimental objects to reconstruct their sports trajectories. The overall performance and practical application value of this method are verified [16].

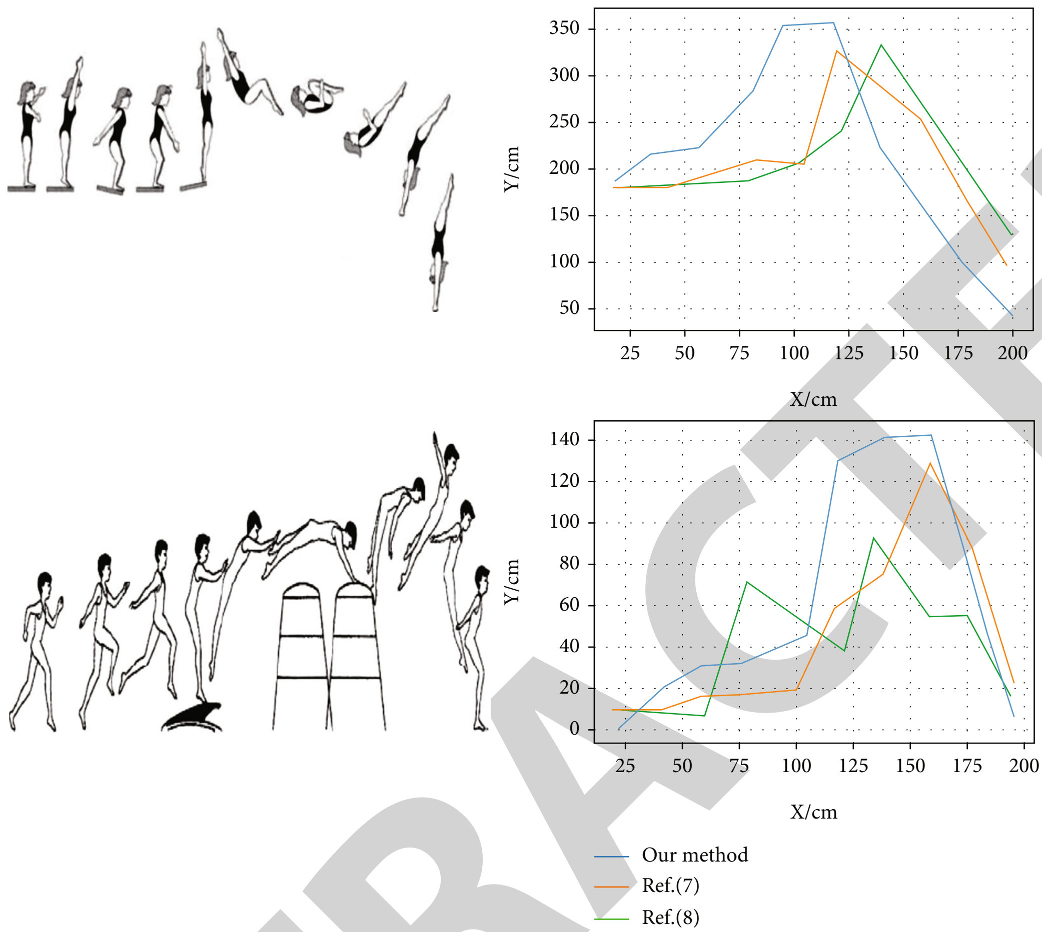


Figure 8: Trajectory of the actual motion and the reconstructed motion action of each method.

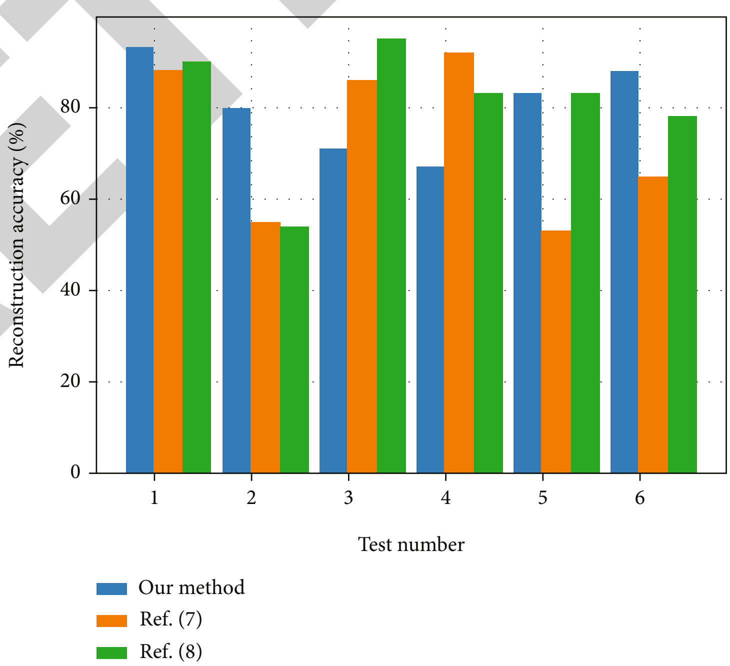


Figure 9: Comparison of accuracy of motion action trajectory reconstruction by different methods.

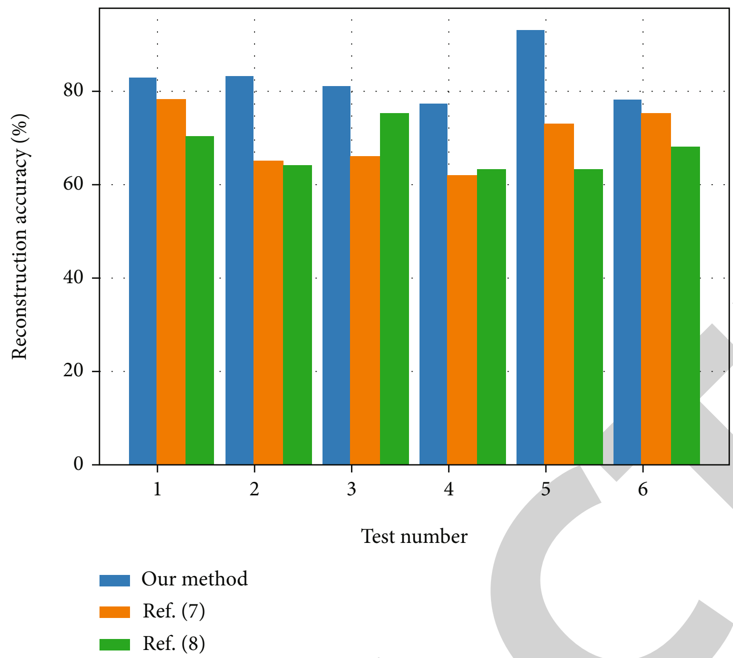


Figure 10: Comparison of reconstruction error of motion action trajectory by different methods.

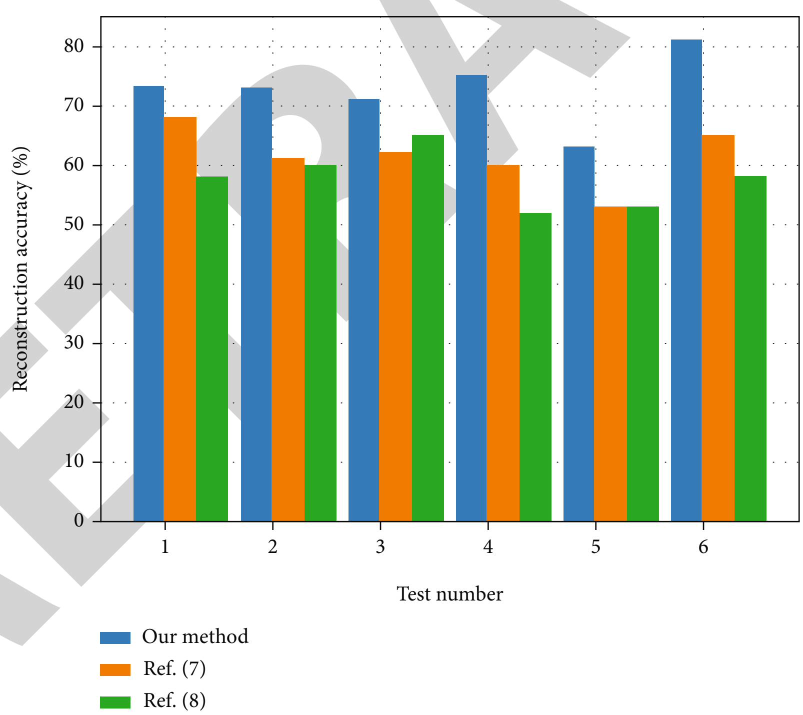


Figure 11: Comparison of reconstruction time of motion action trajectory by different methods.

5.1. Heart Rate Filtering Performance Analysis. The preprocessing effect of heart rate signal directly affects the accuracy of motion trajectory reconstruction afterwards, so the signal preprocessing performance of this method is mainly affected by the number of iterations, so the signal preprocessing effect of this method under different number of iterations is tested here. In order to select 5-80 iterations for this method, the initial signal is preprocessed, and the cumulative error results of the preprocessed signal are obtained under different iterations, as shown in Figure 6.

Analysis of Figure 6 shows that with the growth of the number of iterations, the cumulative error of the signal after preprocessing of this method gradually decreases, and when the number of iterations reaches 80, the cumulative error of the signal is reduced by 91.91% compared with 5 iterations, which shows that the higher the number of iterations the better the preprocessing performance of this method and the higher the degree of error reduction of the signal.

The signal preprocessing effect of this method is analyzed by presenting the waveform of a random group of motion action signals after preprocessing by 80 iterations and comparing it with the initial signal waveform before the implementation of preprocessing for this group of motion action signals. The comparison of the initial signal waveform with the preprocessed signal waveform of this paper is shown in Figure 7.

It can be seen from Figure 7 that the initial signal waveform has more burrs, and the signal waveform is not smooth enough. After preprocessing by this method, the coarse errors and general errors in the signal are eliminated, and the signal waveform is smoothed, which indicates that this method has a high signal preprocessing effect.

5.2. Refactoring Performance Check. The passive infrared sensor trajectory reconstruction method and the improved inverse distance weight interpolation trajectory reconstruction method are selected as the comparison methods of this paper, and the two methods are from the literature [7] and literature [8], respectively. The EC8M-SSD camera was used to shoot 6 sets of sports movements presented by 2 athletes, and 2 sets of the 6 sets of sports movements were randomly selected as the comparison objects. The actual shooting motion and the reconstructed motion trajectory of each method are shown in Figure 8.

From Figure 8, we can see that the two sets of motion trajectories reconstructed by this method are almost the same as the two sets of motion trajectories actually filmed, while the motion trajectories reconstructed by the other two methods have different degrees of deviation. It can be seen that the reconstructed motion trajectories of this paper are highly accurate and can better restore different motion trajectories, and the reconstructed performance is stable and reliable.

In order to quantify the effect of the three methods more clearly and prove the effectiveness of this paper, we continue to compare the methods of literature [7] and literature [8] with this paper, and the results of the accuracy of motion trajectory reconstruction of the three methods are shown in Figure 9.

The analysis of Figure 9 shows that the reconstruction accuracy of this method is higher than the other two methods, up to 99%, which shows the superiority of this method to a certain extent. Based on the above experiments, we continue to analyze the effectiveness of this method and compare the reconstruction error and reconstruction time of the motion trajectory of the three methods, and the results are shown in Figures 10 and 11.

Analysis of Figures 10 and 11 shows that, compared with the method of literature [7] and literature [8], the reconstruction error and time of motion trajectory of this method are lower, the reconstruction error is as low as 2%, and the reconstruction of motion trajectory can be achieved in a minimum time of 2.5 s, which further proves the superior performance of this method and has certain application value.

6. Conclusions

In this paper, we design the sports load detection system based on the Internet of things technology. According to the basic requirements of the system, we design the application software of the mobile terminal, including user information management to help athletes complete the maximum heart rate estimation. In addition, it can help athletes measure their maximum heart rate, add the function of viewing friend information in user information management, and provide a window for users of sports heart rate monitoring system to compare friends, so as to encourage exercisers to complete exercise goals.

Data Availability

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

Conflicts of Interest

The authors declared that they have no conflicts of interest regarding this work.

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