Design of Golfer's Heart Rate Data Transmission System Based on Machine Learning

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Abstract. In order to better guarantee the training status and health of sports, a design method of heart rate data transmission system for golf players based on machine learning is proposed. The hardware structure of the system is configured based on the modern background. Based on nRF905 and AT89S52, a set of remote heart rate data transmission system is designed for golfers Finally, the experiment proves that the performance of the golfer heart rate data transmission system based on machine learning is better in the practical application process. The test results show that the designed system can effectively realize the expected function.

Keywords: Machine learning · Golfer · Heart rate data transmission

1 Introduction

With the rapid development of science and technology, all kinds of high-tech technology makes the traditional equipment more intelligent. Under the background of Internet of things, the concept of athlete heart rate data transmission system has attracted much attention [1]. Heart rate data transmission system mainly collects golfer information through sensors and other devices, and makes corresponding decisions through data transmission and processing. Its architecture is similar to the Internet of things. This paper uses machine learning technology to build a sensor data transmission system between heart rate data transmission and intelligent terminal and server, in order to solve the problem of insufficient computing, interaction and storage capacity of heart rate data transmission. According to the requirements of data transmission in heart rate data transmission system, the hierarchy of heart rate data transmission system is divided in the system, and machine learning technology is used The sensor data transmission system of heart rate data transmission is designed.

At present, the common heart rate data transmission system includes non-contact breathing and heart rate signal acquisition system. According to the mechanical characteristics of cardiac ejection contraction process, the piezoelectric ceramic sensor with high sensitivity and good stability is selected to collect the mechanical signal of cardiac shock. The signal is processed by de-noising, filtering and amplification, and the ballistocardiogram (BCG) is obtained by digital acquisition. Secondly, the respiratory signal is extracted by smoothing the cardiac shock, Fast Fourier transform

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(FFT) was used to obtain the respiratory signal frequency. Band pass filter was used to remove the respiratory envelope and high-frequency interference of BCG signal, and the J wave peak number per unit time of BCG signal was obtained to calculate the heart rate value. Finally, in order to verify the accuracy and consistency of the system, the respiratory and ECG signals collected by BIOPAC were compared, The results show that the error rate of respiration is less than 4.5%, and the error rate of heart rate is less than 9.7%; There is also a typical system to extract heart rate parameters from face video. In this system, the face video image tracked and recognized by KLT (Kanade Lucas Tomasi) algorithm is converted to YCbCr color space for skin detection, and at the same time, it is converted to CG color channel to extract high-quality photoplethysmograph (PPG) signal, Finally, according to the physiological characteristics of the heart rate signal, the pseudo point noise is removed and the heart rate parameters varying with time are extracted. The system completes the signal acquisition through face changes, the acquisition process is relatively simple, but the accuracy of the acquisition has some defects.

In order to make up for the shortcomings of the above methods, this paper proposes a design of golfer's heart rate data transmission system based on machine learning. In the hardware design of the system, the power consumption requirement of the heart rate data transmission system is studied, and the data transmission of the sensor is realized based on cc2540 chip. The data processing program in the system is added to the software design. According to different sensor data, the algorithm in each level is designed, and the sensor is used to transfer the relevant data to complete the design of the system. The experimental results show that the proposed system can quickly collect the heart rate of golfers.

2 Heart Rate Data Transmission System for Golf Players

2.1 System Hardware Design

The main functions of heart rate data transmission system are data acquisition, data transmission and data processing. Based on these three functions, the heart rate data transmission system is abstracted into hardware module, intelligent module and server module. In the hardware module, the power consumption requirements of the heart rate data transmission system are studied, and the sensor data transmission is realized based on the chip cc2540 [2]. In order to realize the data transmission with cc2540 chip, the system structure is studied, and the sensor data is received and processed. According to the performance requirements of heart rate data transmission system for data transmission and processing, the server module designs data transmission format scheme, server container scheme and a hierarchical software structure. Finally, the information exchange of sensor data among the three modules of the whole heart rate data transmission system is completed [3]. Heart rate data transmission system is usually powered by battery, which has a high requirement for power consumption. Due to the data

transmission system. The network scale of heart rate data transmission system is small, and intelligent terminal equipment is needed as its user interaction system. Therefore, machine learning technology is more applied in heart rate data transmission system [4]. Based on this, the hardware structure of the system is optimized, and the specific structure is shown in the figure below (Fig. 1).

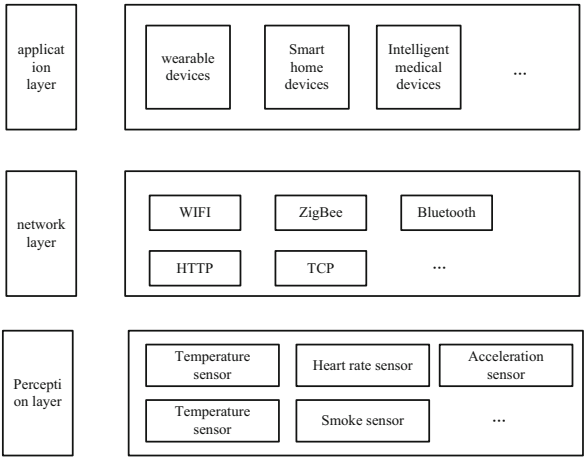


Fig. 1. System hardware structure

NRF905 and AT89S52 are selected. NRF905 is a new product developed by Nordic VLSI company in Norway. Before the formal start of the system design work, a series of studies on nRF905 and AT89S52 were carried out, mainly including: the specific structure of nRF905 [5]. The working principle of nRF905, the working principle of AT89S52 and its functions are introduced. The above work is the basis and premise to ensure the smooth development of the system design.

The basic design idea of remote heart rate data transmission system for golf players is as follows: to obtain the heart rate signal of golf players. The equipments needed are ECG electrode and ECG sensor [6]. The heart rate signal is sent by wireless way. At this time, we need to use the wireless signal transponder, which plays a key role is nRF905; to process the heart rate signal and obtain the heart rate data.

When processing heart rate signal, the main method is filtering. After that, the signals need to be stored and processed to facilitate relevant personnel to use the above signals [7]. In this system, the wireless data transmission device is essential. The device mainly includes three parts: transceiver nRF905, AT89S52 MCU and display structure.

The design of the system, in full consideration of the existing technology, uses physical fitness monitoring sensor, wireless network, a/D conversion and other modules [8]. The specific architecture design is as follows (Fig. 2):

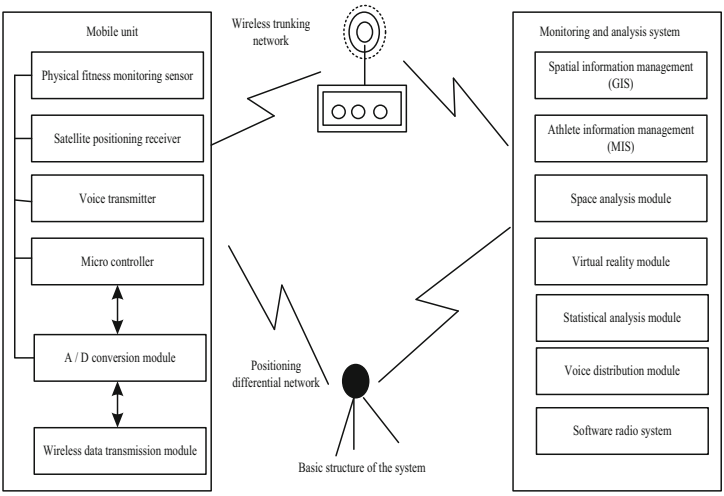


Fig. 2. Optimization of functional structure framework of equipment

The wireless network transmission in this system is designed by l-900/1800 module. The specific design idea is to use communication module to realize communication connection between MCU and computer through mobile communication technology. The specific process is to pack the data into IP data, and put it on the Internet. In the computer room, and send it to the communication module through the base station, then G transmits the IP packet to MCU, and obtains the corresponding processing results through the analysis of the central processor. In the practice design, the embedded 51 MCU system is selected, the remote data transmission adopts mobile network, and the MCU processor adopts the uspd3200 series [9]. It can be regarded as the interface of the whole data acceptance and information development, and the embedded system has good portability.

In this system, three kinds of communication are mainly realized, the first is GPRS and MCU communication, the second is to realize the communication between GPRS communication module and PC; the third is communication between PC and MCU. Based on this, the architecture of communication transmission information management system is optimized, and the specific structure is shown in the following figure (Fig. 3):

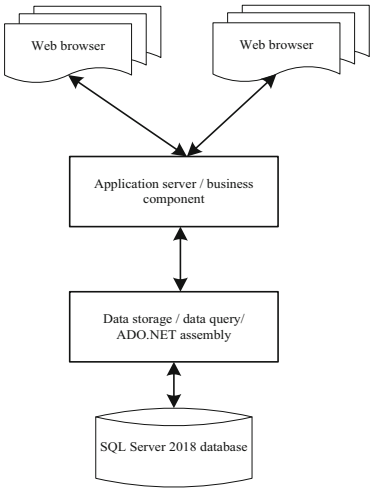


Fig. 3. Architecture design of communication transmission information management system

The system hardware design mainly includes: heart rate signal acquisition. When collecting the heart rate signal of golf players, there are two key devices, which are ECG electrode and ECG sensor. Among them, the main function of ECG electrode is to collect and process the heart activity signal of golf players, and further transmit it to ECG sensor. The main function of ECG sensor is to process a series of received heart signals, including increasing the original weak signal and filtering the signal. In addition, the ECG sensor can transmit the processed heart rate signal to the wireless signal transponder. The electrocardiograph electrode and electrocardiograph sensor used in this system have the following advantages: it can effectively resist the interference factors in the environment during the working process; the electricity required during the operation is not very much; when collecting the heart rate signal of golf players, the impact on the operators is relatively small, and the golf players can maintain the normal movement state.

The main component of preamplifier circuit is preamplifier, which is AD620 instrument amplifier. The main reason for choosing this component is: control the gain. If the gain is too large, it will cause the ECG amplifier to block, which will affect the normal operation of the system.

Generally speaking, the farthest distance that the heart rate sensor can transmit the heart rate signal is one meter, but in the field of remote monitoring, the monitoring range must exceed one meter, which puts forward new requirements for the transmission of heart rate signal. In order to solve the above problems, nRF905 is selected to meet the needs of remote monitoring with the help of wireless signal transponder. NRF905 also has the ability to receive signals, so in the design of wireless signal receiver, nRF905 is also selected. Generally speaking, in wireless data transmission, there are three types of systems, which are point-to-point system, point to multipoint system and multipoint to multipoint system.

2.2 System Software Process Optimization

In order to further optimize the data processing process of the heart rate sensor in the application layer, the main purpose is to increase the data processing program in the system. According to different sensor data, different algorithms can be designed in this layer. After processing, the data can be transferred to the presentation layer in the module or to the server through HTTP protocol. The data presentation layer is the top layer of the intelligent module in the heart rate data transmission system. Users exchange information with heart rate data transmission system through human-computer interaction. The sensor data can be transmitted to users in time, which can make the data produce the maximum value. The interactive mode of the system is introduced into the heart rate data transmission system. In the system, the screen is usually used to display sensor data. However, the information conveyed by simple graphical interface may be ignored by users. In the data presentation module, on the basis of providing a graphical interface to display sensor data, the multimedia technology of the system is designed to convey information. Based on this, the heart rate data acquisition and processing process is optimized as follows (Fig. 4):

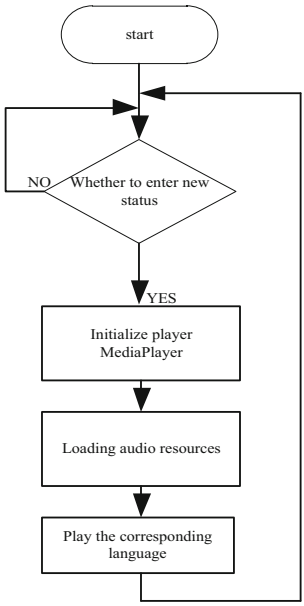


Fig. 4. Heart rate data acquisition flow

The first half of the data receiving process is the same as the sending process. In the second half, when the transceiver is enabled, if a data frame is received, the program will judge whether the data is overflowing, and then judge whether the data frame is too short, whether it is a response frame, if not If the data frame is too short or a response frame, the data frame will be discarded. In the process of building Okumura Hata

model, there will be data transition in the process of training data collection and intelligent data feedback of golfers in big data environment. In order to prevent data transition, it is necessary to modify the calculation process of golfers' training process. The specific correction methods are as follows:

$$\frac{\delta L_{\mathrm{m}}}{\delta \mathrm{i}}=\frac{(\mathrm{k}-\mathrm{k_m}-N_2)W_0(\mathrm{i})(\mathrm{k}-\mathrm{N_i})}{\mathrm{A}\ +\ \mathrm{w}_0(\mathrm{i})\pi}>0 \tag{1}$$

$$\frac{\partial^2 N_2}{\partial \mathrm{i}^2}=\frac{(\mathrm{k}-\mathrm{k_m}-N_2)W_0(\mathrm{i})}{\mathrm{w}_0(\mathrm{i})}>0 \tag{2}$$

In the formula, $\partial^2 N_2$ is the average weight coefficient of the intelligent customization system for training progress; $\mathrm{k_m}$ is the simulation index of the model data; $\partial \mathrm{i}^2$ is the weight process coefficient of the best operation; W_0 is the expression attribute of big data; A is the total display amount of the proposed process of the extreme data. In the correction process, the robustness of each module will be reduced, resulting in the increase of operation time. In order to solve this problem, the calculation process needs to be automatically adjusted and optimized. The total amount of the two pole limit data is equivalent to the limit value, and the maximum value and minimum value of the data need to be adjusted and optimized before standard confirmation can be carried out, which can be expressed by formula:

$$G_{\mathrm{f}}=E_P\frac{\delta L_{\mathrm{m}}}{\delta \mathrm{i}}\times\frac{\partial^2 N_2}{\partial \mathrm{i}^2} \tag{3}$$

In the formula: E_P represents the maximum critical value of the basic total amount; $\{\mathrm{h}_1,\mathrm{h}_2,\mathrm{h}_3\ldots,\mathrm{h_p}\}$ represents the ordered set that can be collected from the maximum value to the minimum value [10], from which the best optimization deviation of data can be calculated; $\{X_1,X_2,X_3\ldots X_P\}$ represents the ordered set composed of loss data in the model; through the above formula, the correction and optimization of the calculation in the intelligent customization of training progress are completed, ensuring the effectiveness of personalized training customization Effectiveness and applicability. Using machine learning technology, the software architecture is designed hierarchically, including view layer, business logic layer, controller layer and Dao layer [11]. MSP430 microcontroller of data acquisition node uses A/D unit to collect data from data acquisition module, which transmits data to CC2420 unit through SPI communication mechanism, and CC2420 transmits data through antenna [12].

In order to improve the efficiency of program transmission, the program is dynamically transmitted according to the language environment and morphemes. The principle of data processing is mainly divided into four stages, as shown in the figure (Fig. 5).

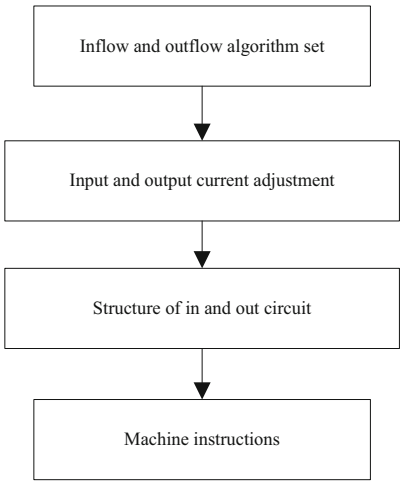


Fig. 5. Golfer heart rate processing steps

The program transmission of heart rate collection and transmission of golfers plays an important role in the programming. A layered and open dynamic transmission method is proposed. The method maps the programming language source representing the input and exit to specific technology, which fully reflects the basic operation sequence of electronic access. The input and output algorithm set, current adjustment and circuit construction in the figure are all carried out on the computer transmitter, and the machine instruction is executed on the simulator. The source program is written by advanced language, and can be programmed under complex data structure. The transmission of the input and exit algorithm set is represented by the source program to the middle of the input and exit quantity, and the middle part is encoded by the input and exit quantizer and the operation circuit; the current adjustment maps the source program to the equivalent, only contains one input and exit level, which is usually called the source program Assembler for access. The purpose of current adjustment is to produce high-quality assembly code. The circuit structure is optimized for the calculation of the input and exit with specific attributes.

2.3 Realization of Primary Transmission of Golfer's Heart Rate

Mysql database is used to store the heart rate sensor data sent by the intelligent terminal. In the heart rate data transmission system, a simple user system is designed and implemented in the server for different users to query personal data. In the design of database table, three entities are designed: sensor record entity, user information entity and account information entity. The sensor record entity has corresponding attributes to store data. The diagram of the three entities is shown below. One user information contains multiple heart rate sensor recording entities and an account information entity (Fig. 6).

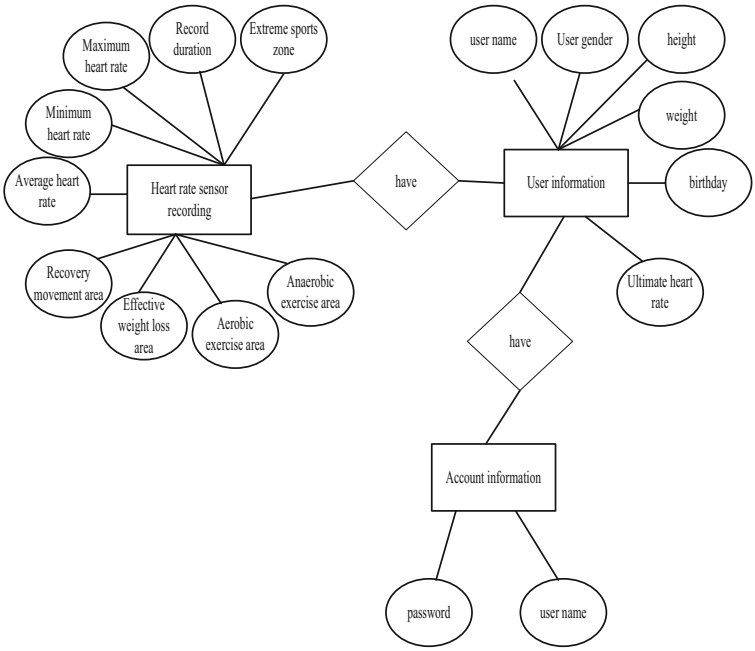


Fig. 6. Diagram of feature recognition of data to be transmitted

Power consumption is an important index of heart rate data transmission system. The heart rate data transmission system is designed based on low power machine learning technology. The system consists of three parts, including hardware module, intelligent module and server module. As shown in the figure, the three functions of the system can be summarized as data acquisition and transmission, real-time data processing and presentation, and data storage (Fig. 7).

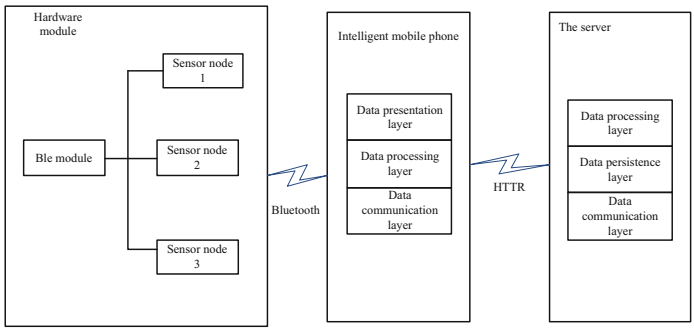


Fig. 7. Golfer heart rate data storage model

Because the designed ECG data wireless transmission system can be embedded in the heart rate transmission system, so in practice, the source of ECG data should be the data collected from the athletes' heart electrodes, which needs to be converted into digital signals through a/D conversion. Considering the design of ECG data wireless transmission system hardware, the control module of the system uses 16 bit MSP430 microcontroller, which contains 12 bit a/D, so the collected data is 12 bit, so it uses the 212 format used in MIT-BIH database, that is, three bytes to represent the two collected data, if the two adjacent ECG data collected are ox3f3 and oxf 3F is represented by three bytes: oxf3, oxf3 and ox3f, that is, the first byte is the lower 8 bits of the first data; the upper 4 bits of the second byte are the higher 4 bits of the second data; the lower 4 bits of the second byte are the higher 4 bits of the first data; the third byte is the lower 8 bits of the second data. These are the two data collected and transmitted in three bytes, as shown in the table below (Table 1).

Table 1. ECG data transmission format collected

Byte 1	Byte 2		Byte 3
Data 1 low 8 bits	Data 2 high 4 bits	Data 1 high 4 bits	Data 2 low 8 bits
0, 2, 4	1, 3, 5	6, 7, 8	9, 10

The transmission of psychological data based on the above table transmission format can better guarantee the operation effect of the system, and improve the security rate and timeliness of the system operation.

3 Analysis of Experimental Results

In order to verify the practical application effect of the golfer's heart rate data transmission system based on machine learning, the experimental detection is carried out. In order to ensure the experimental detection results, the experimental environment and parameters are set uniformly (Table 2).

Table 2. Experimental configuration parameters

Name	Describe
Libc	System C library
Media Fiame work	Multimedia Library Based on packetvideo
Surface Manager	Display system manager
FreeType	Font engine
SQLite	Lightweight relational database

The selected 20 different golfers were randomly divided into two different groups, the experimental group and the control group. And through statistical software for statistical analysis, through the t test, $P > 0.05$ (Table 3).

Table 3. Basic statistics of athletes

	Average age (years)	Training years (years)	5000m (min)
Experience group	19.9	5.8	16.27
Control group	20.2	6.1	16.14
T test	$P > 0.05$		$P > 0.05$

Through the above random selection, and the above-mentioned golfers for a month of training, in order to view the effect analysis of the system in the process of application. Using the electronic program design, the athlete's in and out can be input by one key, and the athlete's in and out will be displayed on the record sheet. This paper studies the influence of two kinds of program transmission, file structure and human-computer interface design on the program operation efficiency. In order to verify the efficiency of simultaneous interpreting of two programs in different transmission languages, the traditional program is compared with the program designed for the electronic intake and output (Fig. 8).

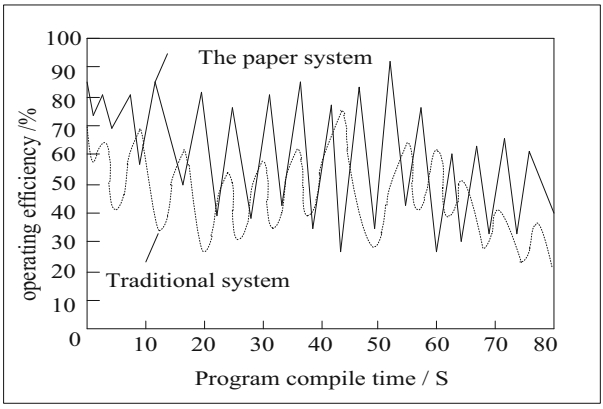
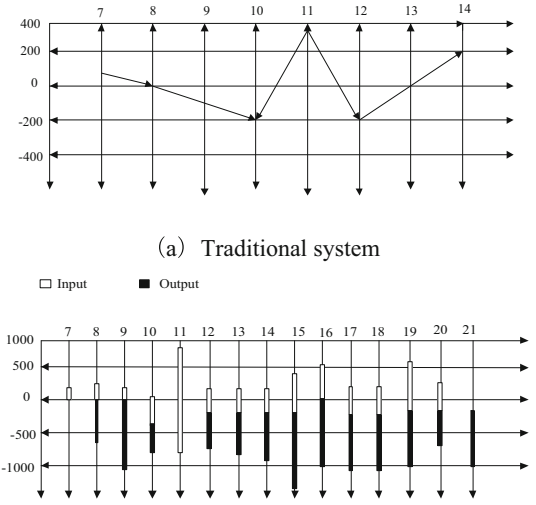


Fig. 8. Comparison of system operation efficiency

It can be seen from the figure that: the traditional program uses C language to transmit the program, and the running efficiency is in a curve state, while the program designed for electronic in and out volume uses the transmission with specific parameters, and the running efficiency is in a broken line state. The initial operation efficiency is more than 60%, which can meet the requirements of system preparation operation. When the transmission time is 10 s, the efficiency of the traditional program is 10%

higher than that of the electronic access program; when the transmission time is 20 s, the efficiency of the electronic access program is 60% higher than that of the traditional program; when the transmission time is 52 s, the efficiency of the electronic access program reaches the maximum, 92%, while the efficiency of the traditional program reaches the maximum The efficiency of the program is less than 60%. With the increase of transmission time, the running state of the two programs tends to be stable, but both of them are lower than the initial running efficiency. The final running efficiency of the electronic access program design is 45%, which meets the standard of 30% of the normal running efficiency of the system. Therefore, using specific parameters to transfer the program is more efficient. In order to count the in and out volume of the two programs in different environments, the traditional program is compared with the program designed for psychological transmission volume, and the results are shown in the figure (Fig. 9).



(a) Traditional system

(b) The paper system

Fig. 9. Comparison results of system data transmission

It can be seen from the figure that: the traditional system makes statistics on the data by manual means, and the in and out volume records are relatively rough, showing a broken line, while the in and out volume design program makes statistics on all data in the system memory unit, and the in and out volume records are more detailed, showing a column. According to the record results, the efficiency of the program is compared, and the results are shown in the table (Table 4).

Table 4. Running efficiency of two programs under different file structures

Experiment times/time	Traditional procedure	Electronic access program
1	60%	85%
2	55%	90%
3	65%	92%
4	55%	87%
5	72%	91%

It can be seen from the table that: there is a big difference in the operation efficiency of the two programs under the structure, the traditional design program can not accurately obtain the athletes' in and out value, and can only view the general trend, which leads to the decrease of the operation efficiency of the program; while the heart rate data in and out design program can accurately obtain the athletes' in and out value, and the operation efficiency of the program is higher. Therefore, it is more efficient to collect all the data in the system memory and retrieve the key heart rate data in and out according to the basic operation sequence. It is confirmed that the design method of golfer's heart rate data transmission system based on machine learning proposed in this paper has high application value and fully meets the research requirements.

4 Conclusion

A remote heart rate data transmission system for golfers based on machine learning is designed. The test results show that the system can achieve the expected function and provide remote heart rate data information. Better training for golf players to improve scientific guidance to ensure the training effect. In the hardware design of the system, the power consumption requirement of the heart rate data transmission system is studied, and the data transmission of the sensor is realized based on cc2540 chip. The data processing program in the system is added to the software design. According to different sensor data, the algorithm in each level is designed, and the sensor is used to transfer the relevant data to complete the design of the system. The experimental results show that the proposed system can quickly collect the heart rate of golfers.

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