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Article

Sports information processing and physiological condition monitoring system based on multimedia computer

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Abstract: Traditional sports information processing methods often rely on manual observation and recording. This method is not only inefficient, but also susceptible to subjective bias, which affects the accuracy and reliability of the data. In this paper, a sports information processing and physiological condition monitoring system based on multimedia computer is constructed, which deeply integrates multimedia technology, computer technology and biomedical sensing technology. Through the integration of advanced multimedia processors and a variety of biosensors, the system can collect, process and analyze the physiological data and sports trajectory information of athletes in sports events in real time, so as to achieve comprehensive and accurate monitoring of the status of athletes. Using data compression algorithms, each byte can store two bits of data, reducing the space occupied by system operation. In terms of functional implementation, this system not only provides a user management module to ensure the security authentication of user identity, but also is equipped with a sports information data analysis module, which can provide users with scientific training guidance and optimize training plans. Experiments show that the system constructed in this article is functionally tested and all functions meet the design expectations; within 500 m, the packet loss rate of the system is 0; when the number of users reaches 1200, the response time of this system is 3.62 s; under low-intensity exercise and high-intensity exercise, the average accuracy of monitoring and early warning of users in this system is 90.44% and 95.11% respectively. The sports information processing and monitoring system can not only accurately and quickly collect and process various sports information, but also monitor and analyze the physiological data of athletes with high precision.

Keywords: multimedia computer; sports information processing and monitoring system; sports information data analysis; physiological status monitoring; biomedical transducer

1. Introduction

Sports plays a vital role in human culture and has an unignorable impact on the development of many aspects. However, the processing of sports information has been limited by traditional manual observation and recording methods, which are inefficient and susceptible to subjective bias, thus greatly reducing the accuracy and reliability of the data. The lack of efficiency of traditional methods has led to slow data collection and processing speed, making it difficult for coaches and athletes to grasp key training data and physiological indicators in a timely manner. This delay in information not only hinders the immediate adjustment of training plans, but may also allow athletes to fall into a state of overtraining or undertraining without understanding, thereby weakening the effectiveness of training and even increasing the risk of sports injury. The system also deeply integrates cutting-edge technologies in the fields of biology and medicine, and can collect and process information about the physiological status of athletes in sports activities in real time, such as heart rate, blood pressure, and blood oxygen saturation [1,2]. This information is essential to assess the health of athletes, prevent sports injuries, and develop personalized training plans. At the same time, traditional methods are also susceptible to interference from subjective factors, which affect the accuracy and reliability of data. In the process of data observation and recording, coaches or recorders may deviate due to personal experience, subjective judgment or mood swings. This kind of deviation will not only mislead the formulation and implementation of the training plan, but may also mask the true physical condition and training feedback of the athletes, causing the coach to be unable to accurately assess the health level and athletic strength of the athletes.

The sports information processing and physiological condition monitoring system based on multimedia computers integrates multiple disciplines such as sports, computers, biology and medicine, bringing unprecedented solutions to sports events and athlete training. The system relies on computer technology to efficiently process and analyze complex data from multiple channels, while using radio frequency identification and heart rate sensing technology to collect athletes' physiological information in real time. Through the use of data compression algorithms, the system reduces the pressure on data transmission, further improves the processing efficiency, and enables the coaching team to obtain key information more quickly, so as to make more scientific decisions. In terms of biology and medicine, the system can continuously and accurately monitor the physiological condition of athletes through equipment such as heart rate sensors, which provides strong support for health management and training adjustment. In the field of sports, the application of this system has promoted the scientific and intelligent development of sports. Whether it is the organization of large-scale events or daily training, the system can provide comprehensive and accurate data support. In general, the construction of this system is not only a major innovation in the traditional sports information processing methods, but also an inevitable choice to adapt to the development of the times and meet market demand.

Sports information monitoring system is a comprehensive system based on modern information technology. It can collect, process, store, and analyze various types of information in sports activities in real-time, and effectively promote the scientific and intelligent process of sports training [3,4]. In professional team sports, collecting and analyzing athlete monitoring data is common. Thornton Heidi R believed that the athlete monitoring system should be based on appropriate data analysis and interpretation and be able to convey and display important information to coaches and improve athlete performance [5]. Comprehensive information systems in sports have the potential to improve the efficiency of data management. Varmus Michael believed that data is collected from national sports databases and other relevant sources. When the implementation of sports information systems is inefficient in terms of cost and technology, it is necessary to achieve transparency, automation and strategic planning of sports information system implementation [6].

Han Zhenyong used the advantages of adaptive algorithms and combined wireless transmission wearable sensor devices to build a sports monitoring system. He used the system to detect athlete heart rate and extract sports information from interference sources [7]. Xu Doudou designed a sports monitoring system based on Unity3D and inertial sensors, which can provide effective data analysis for application fields such as sports training and limb rehabilitation training [8]. Yang Maolin analyzed psychological barriers in sports by using mobile intelligent information systems in wireless communication networks and combined computer vision to summarize multimodal learning in human-computer interaction comprehensively [9]. Many professional sports organizations are currently looking for or have used sports information systems to integrate data from different information and measurement systems. Blobel Thomas created a catalog of 164 review items to define the relevant characteristics of sports information systems and conducted semi-standardized interviews with product representatives [10].

Multimedia computers have demonstrated their profound application value in many fields [11]. In addition to processing conventional text and numerical data, it can also efficiently process diverse media information such as images and audio, making the presentation of information more vivid and diverse. To improve the accuracy of the picking robot's movements, Su Xianjun trained and optimized the picking robot's movements based on a multimedia database of sports training projects, and simulated the accuracy of the movements [12]. Orines Florilyn believed that the degree of utilization of multimedia-based teaching in sports and physical education teachers did not change when grouped based on profile variables, which helped to better determine the degree of utilization of multimedia teaching in sports and physical education teachers [13]. Sari Sri Indah conducted a study on sports youth based on computer-based management information systems, used a simple linear regression analysis method to analyze, and concluded that computer-based management information system variables had a significant impact on sports youth [14]. By analyzing the sports information service platform, Shao Guohua used the hierarchical analysis process and took the sports information dissemination model based on network technology as the premise to improve the connotation of the sports website operation model [15].

2. Requirements for sports information processing and physiological status monitoring system

2.1. Characteristics of sports information monitoring and processing system

Multimedia technology uses digital means to comprehensively process information such as sound, text, graphics, images, and videos, establish logical connections between these information, and thus create an interactive system [16–18]. The sports information monitoring and processing system cleverly combines multimedia and computer technology to build a system that comprehensively processes, transmits and retrieves sports information. This system can efficiently respond to multi-source information and meet various monitoring needs. With the help of multiple recording media such as cameras, microphones and sensors, the system can comprehensively record video, sound and text information, and realize computer storage through dedicated software and hardware to ensure comprehensive and efficient management of information. Faced with huge image, video and audio data, the sports information monitoring system uses large-capacity storage devices to lay a solid physical storage foundation. At the same time, data compression technology effectively reduces the amount of data, allowing many sports event videos and technical data to be efficiently stored and managed, significantly improving data processing efficiency [19–21].

2.2. System design goals

In modern sports, multimedia computer technology has become a core element for improving management efficiency and service quality. The sports information processing and monitoring system based on multimedia computers aims to comprehensively and accurately monitor, manage and analyze sports events and athlete data by combining multimedia technology and advanced computer management methods, and promote the pace of sports informatization. Its main design goals include: The comprehensiveness of system functions is ensured, covering all aspects such as data collection, processing, analysis and display; reasonable and efficient interfaces are built to achieve smooth integration and data interoperability with various related subsystems; multi-source data is effectively integrated to support data sharing and intuitive display in heterogeneous environments, providing a scientific basis for management decisions.

When designing a sports information monitoring and processing system, it is essential to establish specific and quantifiable performance indicators to ensure the stability and efficiency of the system in actual operation. The system should be able to support a certain number of concurrent user requests and maintain smooth operation even under high load conditions. The system should support at least 1000 concurrent users, process at least 10 MB of data per second, and ensure that the page loading time does not exceed 3.5 s, and the response time of data queries is controlled within 2 s. The setting of these indicators is designed to ensure that the system can still provide a rapid response and a stable user experience when processing massive amounts of data and requests. In addition, the system also needs to have the ability to operate stably under different user loads. As the number of concurrent users increases, the system should be able to dynamically allocate resources to maintain high throughput and low latency. Through load testing, we can simulate the usage scenarios of 1000, 5000 or even 10,000 concurrent users to verify whether the response time and data transmission speed of the system can still be stable when it is subjected to a large number of requests.

Sports information is of various types and comes from different sources. Therefore, the multimedia information processing system must have powerful comprehensiveness and data integration processing functions. The overall architecture diagram of the multimedia information processing system is shown in **Figure 1**. When studying the network structure, project team members need to rely on advanced technology, fully analyze the interface status, deployment distribution and business relationships, and follow the principles of security and reliability to improve the system's scalability and standardization.

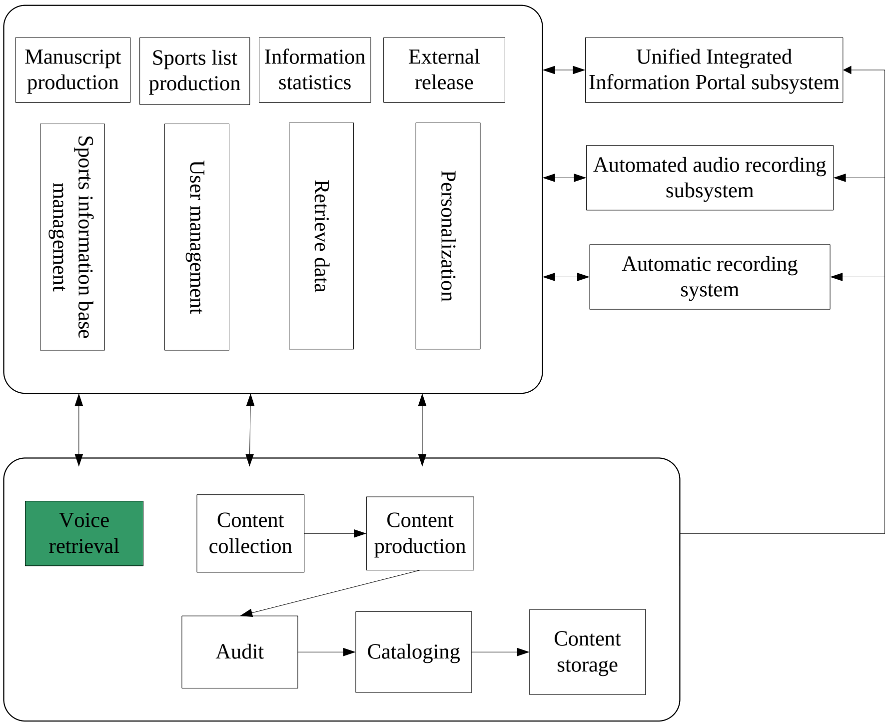

Figure 1. Overall architecture diagram of the multimedia information processing system.

2.3. System biological data collection section

2.3.1. Multimedia computer

The sports information processing and monitoring system based on multimedia computers is mainly responsible for computing and control work. The system includes data acquisition, preprocessing, early warning, and other links, aiming to collect and process multimedia data related to sports events in real-time, and provide efficient analysis, monitoring, and response capabilities. The multimedia computer is the core component of the sports information processing and monitoring system. With its excellent data processing capabilities and diversified information display methods, it provides a strong support for the stable operation of the entire system. The computer can efficiently process diverse information such as text, sound, images, and video, thus ensuring that the system can capture various data of athletes in training and competitions in all directions. In the system, multimedia computers play an important role in data processing and display. They are responsible for receiving and processing raw data from sensors and camera equipment, while generating intuitive and easy-to-understand monitoring charts and reports to provide coaches and athletes with accurate data feedback. In addition, it also has user management functions to effectively ensure the security authentication and permission allocation of system users.

2.3.2. Data compression algorithm

By integrating image sensors, audio capture devices, and temperature and humidity sensor nodes, the system can collect a variety of data from athletes and competition scenes in real-time. These data are transmitted to the system through the interface for preprocessing to ensure data quality and accuracy. The preprocessed multimedia information is transmitted by the processor through the Digital Signal Processing link protocol for encoding and decoding. The encoded data is stored in the audio and video data buffer pool for subsequent use. At the same time, the system can also perform motion detection and scheduling analysis on the collected video data to realize event triggering and alarm processing.

Wireless data network communication adopts a token-like network model. Among them, the data base station sends polling signals to the data acquisition terminal and data transfer node in the network in turn. This signal is called a token [22,23]. Only when the data acquisition terminal receives the token can it send data. After the data is sent, the terminal adds an end mark at the end of the data packet. Whenever the data acquisition terminal receives the token distributed by the base station, it compares the batch number of the last batch of successfully received data attached to the token with the batch number of the last data sent by the local machine. If the two are inconsistent, the terminal determines that the last batch of data is lost during the transmission process, so it sends the last saved data together with the current data to be sent. To improve the efficiency and stability of wireless transmission, a data compression algorithm is applied in this protocol. This algorithm allows each byte to store two bits of data. The specific implementation method is to divide each byte into two parts, and each part uses a four-bit binary coded decimal code to represent a number. This method can reduce the length of the card swipe data by half. If the number of digits in the user number is an odd number, an F is added at the end to make it complete.

The data compression algorithm mainly reduces the amount of data by simplifying the data representation method, thereby relieving the pressure on data transmission. During the transmission process, the size of the data has a direct impact on the transmission speed and bandwidth consumption. When traditional methods process large-scale data, they often face the problems of long transmission time and large bandwidth consumption. The data compression algorithm can effectively compress these data to a smaller size, ensuring data integrity while significantly improving transmission speed and efficiency. Data compression algorithms are divided into two categories: Lossy and lossless. In video compression, by omitting unimportant image details and color changes, the volume of the video file can be greatly reduced without affecting viewing. Lossless compression ensures that the data remains intact, that is, the compressed data can be completely restored to its initial state. This is essential in situations where the accuracy of data needs to be strictly guaranteed, such as the transmission of key information such as athletes' physiological data or competition results. The algorithm uses redundancy and statistical characteristics in the data to simplify data expression. The principle of the data compression algorithm is simple and easy to understand, that is, the compression and restoration of data are realized through the encoding and decoding process.

2.4. Systems biomedical data processing section

2.4.1. Heart rate sensor

Data acquisition is very important in sports information processing and monitoring systems based on multimedia computers. Its main task is to collect various data about athletes and the environment from sensor networks and camera devices. Through the synergy of multiple sensors and camera devices, the physiological state, movement trajectory, and surrounding environmental parameters of athletes can be monitored in real-time to ensure the integrity and accuracy of the collected data. Among them, the heart rate sensor is a device that uses the principle of light reflection to measure the human heart rate. When the heart contracts, the peripheral blood volume reaches its peak, resulting in maximum light absorption. At this time, the detected light intensity is the weakest; when the heart relaxes, the situation is just the opposite, and the detected light intensity is the strongest [24–26]. The optical receiver captures this pulsating change in light intensity, which can accurately restore the user's heart rate data. The flow diagram of heart rate data acquisition is shown in **Figure 2**.

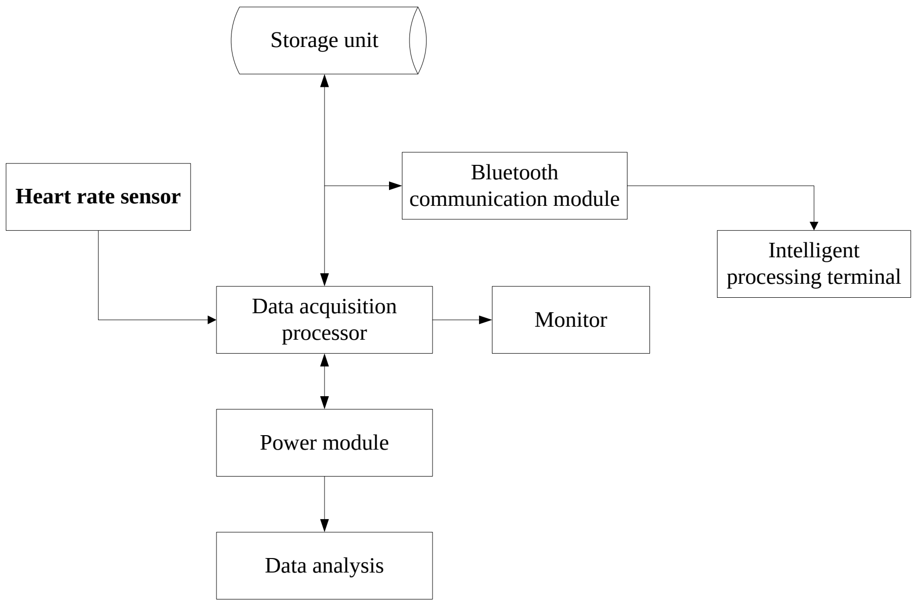

Figure 2. Schematic diagram of heart rate data acquisition.

Heart rate sensors play a vital role in monitoring the physiological state of athletes. It uses the principle of light reflection to accurately detect subtle changes in peripheral blood volume during heart contraction and diastolic, so as to accurately restore the athlete's heart rate data. In the system, athletes wear this kind of sensor, which can capture and transmit heart rate data in real time to multiple media computers for in-depth processing and analysis. The system can scientifically evaluate training intensity and fatigue based on heart rate fluctuations, and provide coaches with personalized training guidance.

2.4.2. Radio frequency identification (RFID)

The main function of data processing in sports information processing and monitoring systems is to clean and analyze the data collected from sensor networks and camera devices to extract valuable information to support decision-making. Radio frequency identification (RFID) technology plays an important role in data processing [27–29]. RFID technology uses radio waves to achieve contactless information exchange and storage, and combines wireless communication and data access technology to enable the system to achieve efficient two-way communication. Compared with traditional barcodes and QR (Quick Response) codes, RFID technology has stronger penetration and faster reading speed, and can automatically complete the identification process without manual operation. In sports information monitoring systems, the application of RFID technology is particularly important, especially during athlete training. By installing radio frequency identification tags on sports devices, RFID technology can help the system quickly and accurately identify devices and track athlete usage. Combined with the athlete’s login information, the system can accurately identify the athlete’s training items and record various detailed data, improving the efficiency and accuracy of data collection, and providing more personalized and scientific guidance for athletes’ training.

Radio frequency identification (RFID) technology, with its characteristics of non-contact automatic identification, plays a key role in sports information processing and monitoring systems. The technology uses radio waves to realize efficient exchange and storage of information, and is widely used in athlete identification and sports trajectory tracking. The RFID tag worn by the athlete contains its unique identity information. When entering the monitoring area, the RFID reader in the system will quickly read the tag information to achieve rapid and accurate identification of the athlete’s identity. At the same time, by cleverly arranging multiple RFID readers and readers, the system can also accurately track the trajectory of athletes and provide coaches with valuable real-time location information. RFID technology, with its advantages of fast reading speed and high recognition accuracy, ensures that the system can obtain athlete-related data in a timely and accurate manner, and lays a solid foundation for subsequent in-depth data analysis and training guidance.

2.4.3. Environmental sensor

Key data such as temperature and humidity collected by environmental sensors are effectively integrated into the data processing module. This integration helps the sports information monitoring system monitor the sports environment in real-time, and ensures that athletes can train under the most suitable conditions. Among them, the temperature and humidity intelligent sensor has demonstrated excellent stability and reliability with its unique acquisition technology [30–32]. The sensor cleverly integrates an 8-bit microcontroller, a capacitive humidity sensor, and a temperature measuring element, making it excellent regarding response speed and cost performance. In addition, the temperature and humidity intelligent sensor adopts a simple single-wire serial interface design, simplifying the system integration process, and significantly enhancing its anti-interference ability. Its signal transmission distance can reach more than 20 m, meeting the needs of various application scenarios.

Given that the data collected by wireless sensors is inevitably mixed with noise, wavelet transform is used to reduce the noise of the data [33,34]. A noise threshold β is set, and the calculation formula of the threshold is:

$$\beta = w(|w \geq H|) \tag{1}$$

w represents the signal-to-noise ratio of the posture data; H represents the carrier data's mean square error. The sample data is compared with the threshold β to determine whether the data needs noise reduction. If the data value exceeds the set threshold, the wavelet transform technology is used to smooth the data, thereby effectively removing the noise part in the original data.

2.5. System database

In the system studied in this article, database operation is the core link in processing user information and monitoring data. Each database in the system contains multiple data tables. Whenever a new user registers, the system automatically creates several new tables for it to ensure that the authority and security of information access are guaranteed. In particular, the sports monitoring and early warning table can efficiently process data beyond the normal range, making it convenient for users to query the date of the accident and related data, and providing convenience for subsequent analysis and research. The athlete user information table and the sports information monitoring and early warning table are shown in **Tables 1** and **2** for user reference and use.

Table 1. Athlete user information table.

Field name	Type	Field length	Primary key	Field description
Account	Varchar	20	Yes	User name
Password	Varchar	20	Yes	User password
Name	Varchar	20	Yes	User name
Age	Int	10	No	User age
Height	Int	10	No	User height
Weight	Int	10	No	User weight
YDXG	Int	50	No	Exercise habits
ZDXL	Int	20	No	Maximum heart rate

Table 2. Sports information monitoring and early warning table.

Field name	Type	Field length	Primary key	Field description
JCSJBH	Int	20	Yes	Monitoring data number
Name	Varchar	20	Yes	User name
Date	Varchar	20	No	Monitoring date
SSLX	Varchar	50	No	Event type
STZT	Varchar	50	No	Body status data
SMTZ	Varchar	50	No	Vital signs data
Location	Char	50	No	Recording location
CJSJ	Varchar	20	No	Record creation time

Table 1 is carefully designed to fully cover the key elements of athlete information. Among them, the Account field is used as the primary key to ensure the uniqueness of each athlete's account name, which provides a solid foundation for authentication and login in the system. The Password field is supplemented by the account name, which requires an accurate password when logging in. The Age and Weight fields record the age and weight of the athletes respectively. These two physiological indicators play an important role in physical fitness testing, health monitoring, and training program formulation. In particular, the YDXG field records the athletes' exercise habits in depth, including training frequency, exercise type and intensity, etc., providing the system with an in-depth understanding of the athletes' physical fitness and health status window. Finally, the ZDXL field stores the athlete's maximum heart rate, a key indicator that has indispensable reference value when evaluating physical fitness and formulating training intensity. In **Table 2**, the sports information monitoring and early warning table is an important tool for recording key health data of athletes in sports activities. The table ensures the uniqueness of each monitoring data through the JCSJBH field, which is convenient for the system to accurately track and query. At the same time, the Date field records the monitoring date, which helps to track health changes and evaluate the effectiveness of training. The SSLX field identifies health events or abnormalities, such as excessive fatigue, abnormal heart rate, etc., and is the core of the early warning system. The STZT and SMTZ fields store athletes' physical status and vital signs data, such as body temperature, blood pressure, heartbeat, etc., respectively, to facilitate the system to monitor and evaluate their health in real time. This design is designed to ensure the safety of athletes and to warn of potential health risks in a timely manner.

In the sports information processing and monitoring system, the data that needs to be stored covers the data of various users such as athletes, monitors, and administrators. Based on the system demand analysis, the entity connection diagram is used to model the system data of the sports information processing and monitoring system, and the relationship between different data entities is shown in detail, as shown in **Figure 3**.

Figure 3. Entity connection diagram of sports information processing and monitoring system.

As shown in **Figure 3**, the various data entities in the system and their connections are clearly shown, among which the sports record data is the core entity. When the athletes finish the game, they upload their sports records to the system, which are then safely stored by the system. The monitors can check these sports records when needed. At this time, the sports record data is presented in the most intuitive form, providing a convenient data analysis method for the monitors.

Compared with the existing research, this system has shown obvious innovation and improvement in data processing and analysis technology. In terms of data collection, by integrating a variety of sensors and high-definition camera equipment, the system can carry out comprehensive real-time monitoring of athletes and their surrounding environment, thereby greatly improving the completeness and accuracy of the collected data. At the data processing level, the system adopts advanced data reduction technology and radio frequency identification technology to ensure that data can be transmitted quickly, stored efficiently, and accurately identified. In addition, in the data analysis link, a professional sports information data analysis module has been introduced, which can make full use of optimized data resources to provide users with more scientific and accurate training guidance and feedback. These innovation and optimization initiatives do not exist in isolation, but are interdependent and progress together, so as to bring users a more efficient and personalized training experience.

3. Function realization of sports information processing and physiological state monitoring system

The system software is a comprehensive host computer system that integrates the functions of information management and data monitoring. Depending on the collected data, it can be widely used in various sports activities. Through the carefully designed software architecture, users can be helped to register quickly. Real-time collection, monitoring, storage, and analysis of various sports information data can be carried out, and intuitive real-time monitoring charts can be generated. The system automatically triggers an alarm when the data exceeds the preset normal range. In addition, data backup and restore functions are provided to ensure data security. Users can analyze data as needed, and support querying monitoring data by date, which is convenient for users to conduct more in-depth data analysis. The functional structure of the entire system is shown in **Figure 4**.

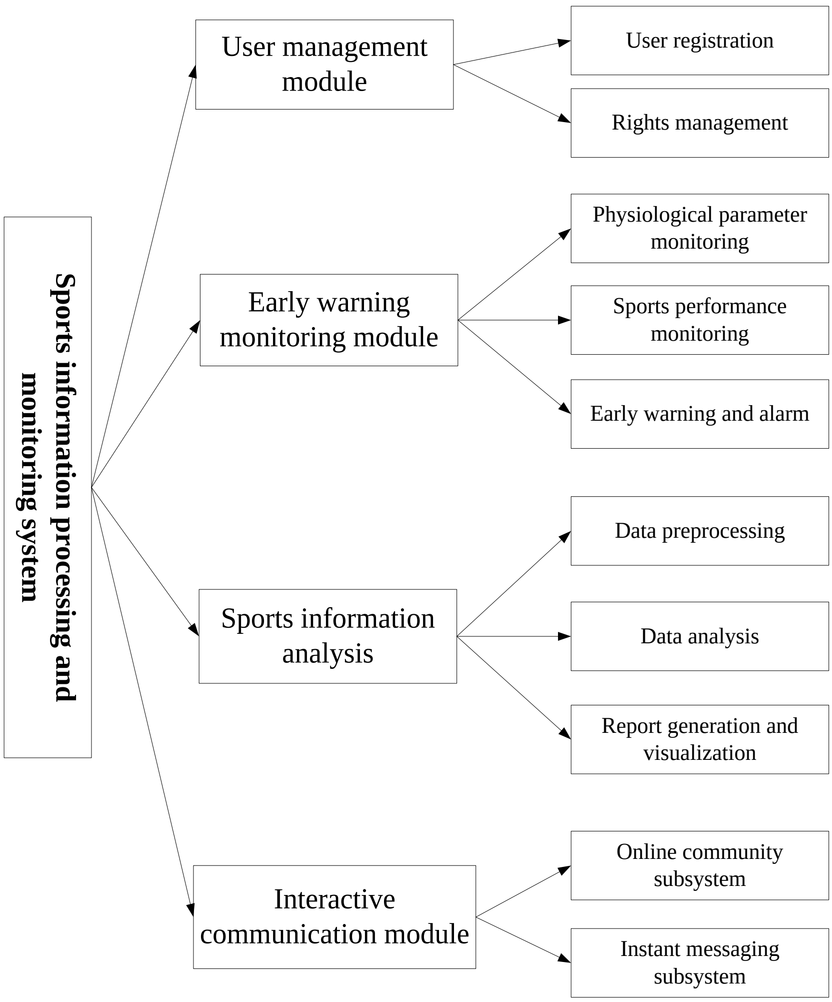

Figure 4. Functional structure diagram of sports information processing monitoring system.

3.1. User management module

The user management module is a vital part of the sports information processing monitoring system. It is responsible for the comprehensive management of the identity authentication, authority allocation and maintenance of personal information of all users. This module provides a flexible and secure user management mechanism to ensure that different users perform appropriate operations according to their authority. Whether it is athletes, coaches, administrators or other user roles in the system, this module can effectively manage their interactions with the system, provide users with customized services, and ensure data security and maintain the efficient operation of the system. When designing this module, the first consideration is how to properly store and manage user information. The system not only needs to save the basic information of users, but also manage professional data related to sports. To this end, a relational database is used to centrally store this information, and each user is identified by a unique account. To ensure the security of user information, the data is encrypted in the system to prevent illegal access or tampering during transmission and storage.

3.2. Sports information data analysis module

The sports information data analysis module is mainly responsible for the in-depth analysis of various data collected from sensors and cameras to reveal athletes' sports characteristics and performance. This module aims to provide coaches and athletes with accurate training guidance, optimize training plans, and improve athletes' competitive level and health through scientific data analysis. The module first receives real-time data from various sensors and cameras, which cover a number of athletes' physiological and sports indicators. The system collects and stores this data in real-time to build a complete dataset. The data analysis module cleans, processes, and converts this data into a standardized data format to eliminate invalid information and noise and prepare for subsequent analysis. During the analysis process, the athlete's physiological and sports data are processed by statistical analysis methods to obtain basic indicators such as average heart rate, maximum heart rate, and exercise intensity, helping coaches quickly understand the athlete's training load and physiological response. At the same time, the system sets corresponding thresholds according to different sports and individual characteristics of athletes, and automatically identifies abnormal data so that coaches and athletes can adjust training strategies in time to prevent sports injuries. In the sports information data analysis module, the performance analysis of athletes is focused on, and the performance trends and potential abilities of athletes to coaches can be revealed by integrating rich historical data with real-time data. The system can compare the results of athletes at different training stages and deeply analyze the progress of their physical fitness, skills, and tactical levels. Long-term data accumulation enables the system to draw a unique growth trajectory of athletes and accurately identify their strengths and weaknesses in specific sports.

3.3. Monitoring and alarm module

In the sports information processing and monitoring system based on multimedia computers, the main task of the real-time monitoring module is to track the physiological and athletic conditions of athletes in real-time to ensure their safety and health in training and competition. Once an abnormal situation is detected, the system immediately issues an alarm, prompting coaches and relevant personnel to take emergency measures to prevent athletes from being injured due to overtraining or other adverse factors. This module is the system’s core component, and its main function is to allow monitoring personnel to view athletes’ health data in real-time through the client or browser. When athletes have dangerous conditions such as high heart rate and low blood oxygen saturation, the system issues an early warning to monitoring personnel so that they can respond quickly and reduce the risk of injury to athletes. Before the start of a sports competition, athletes need to log in through the mobile client and join the monitoring group established by the monitoring personnel, while the monitoring personnel need to create their own monitoring group in advance. During the real-time monitoring process, the athlete client uploads health data every 5 s, and the system assesses its risk status based on the athlete’s maximum heart rate threshold and average blood oxygen saturation threshold. The real-time monitoring flow diagram is shown in **Figure 5**.

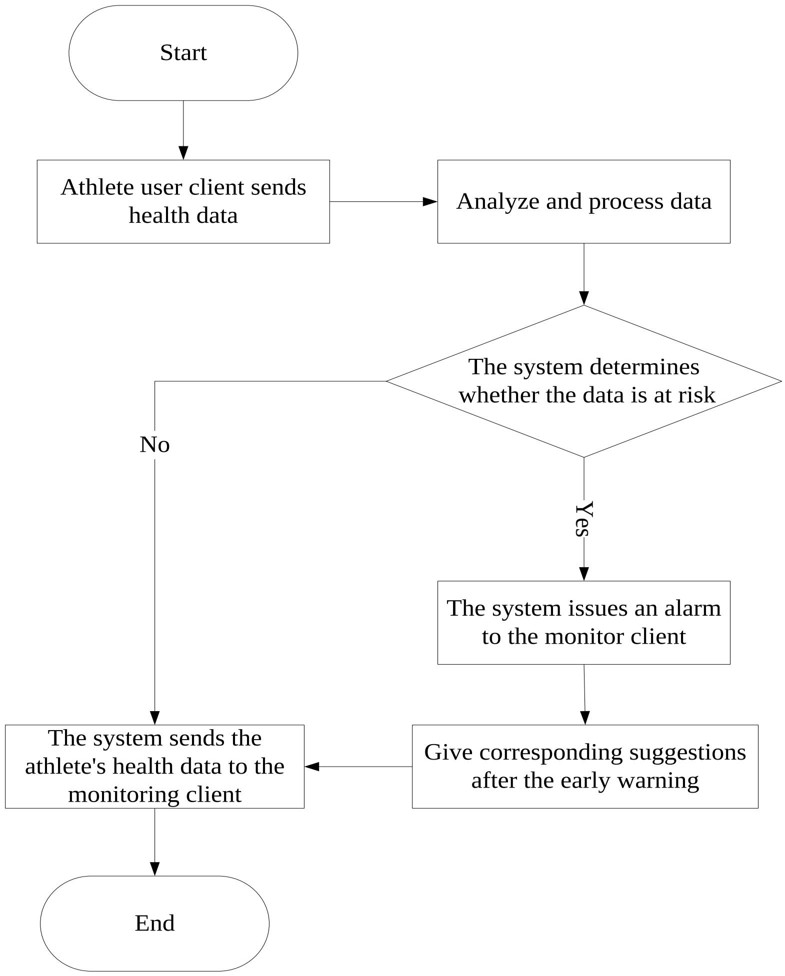

Figure 5. Schematic diagram of real-time monitoring flow.

4. System testing and experiments

System testing plays a vital role in the software development process. With the help of meticulous manual or automated testing methods, the various functions of the system can be comprehensively reviewed. In this process, the black box testing stands out for its independent focus on the functional interface, which is committed to ensuring the smoothness and accuracy of system operation from the user's perspective. The white box testing explores the system's internal structure in depth and verifies the correctness of its internal logic with a rigorous attitude [35–37]. These two testing methods complement each other and jointly build a solid quality defense line. They not only ensure that the external performance of the software can meet the expected standards, but also ensure that its internal logic is rigorous and correct. Therefore, system testing plays an indispensable role in promoting software quality to a higher level.

4.1. Functional testing

This article conducts a detailed and comprehensive functional test on the constructed sports information processing and monitoring system, aiming to ensure that the system's various functions strictly meet the initial project's requirements. By adopting various testing strategies and technical means, the system is comprehensively evaluated, and the specific test results are summarized in **Table 3**, showing the degree of compliance between the system performance and the expected goals, providing strong support for subsequent system optimization and iterative upgrades.

Table 3. Functional test table of sports information processing and monitoring system.

Serial number	Test module	Test results	Whether it meets expectations
1	Data collection	The system can normally collect and transmit data in real-time, with short delay time.	In line with
2	Data processing and analysis	The data processing is correct, the format is unified, and invalid data has been removed.	In line with
3	User login	The system can perform user authentication normally and log in quickly.	In line with
4	Motion analysis	The action analysis is accurate, and the feedback and suggestions are in line with the actual situation.	In line with
5	Monitoring and alarm	The system sends out an alarm signal in time when the physiological indicators are abnormal.	In line with
6	User interface	The interface is simple and intuitive, the data is clear, and there is no delay in operation.	In line with
7	System stability	The system is running stably, and the response delay is within an acceptable range.	In line with
8	Data storage and backup	The data can be successfully backed up, and no data is lost after recovery.	In line with

As shown in **Table 3**, all tests pass the inspection smoothly and no abnormalities are found.

In this system, data transmission between data forwarding base stations is implemented through the HTTP protocol, which can ensure the stability of data transmission. Therefore, the reliability of this system mainly depends on the wireless transmission packet loss rate between the data acquisition terminal and the data base station. The packet loss rate is a crucial indicator to measure the quality of the data link of the wireless sensor network, which is mainly affected by factors such as transmission distance and weather conditions [38,39]. A series of tests are conducted to evaluate the specific impact of these factors on the packet loss rate. In the test, the wireless transmission power is adjusted to the maximum. The transmission distances of 100 m, 500 m, 1000 m, and 2000 m are tested under sunny, cloudy, and rainy weather conditions, respectively. In each test, the packet loss rate data is recorded when the packet loss retransmission function is turned on and off. The test results are shown in **Table 4**.

Table 4. Packet loss rate test.

Turn off/turn on packet loss resend		**Weather**		
		Sunny	**Cloudy**	**Rain**
Distance	100	0%/0%	0%/0%	0%/0%
	500	0%/0%	0%/0%	0%/0%
	1000	0%/0%	0.1%/0%	0.5%/0%
	2000	0.2%/0%	0.3%/0%	1.15%/0.02%

As shown in **Table 4**, under sunny and cloudy weather conditions, regardless of whether the transmission distance is short or long, the packet loss rate after turning off or on the packet loss retransmission mechanism is extremely low, almost close to zero, showing excellent transmission quality. However, in rainy weather and when the transmission distance is long, turning off the packet loss retransmission mechanism causes the packet loss rate to increase significantly. However, it can be ensured that data is not lost within a transmission distance of 500 m, which meets the requirements of the design of this system.

4.2. Performance test

Response time is one of the key indicators to judge system performance. It specifically refers to the time it takes for the system to complete the processing and give feedback from receiving data. In athlete training and health monitoring scenarios, rapid response time is particularly critical. Once the system detects a sudden increase in the athlete's heart rate, if a warning can be issued immediately, the coach and medical team can quickly intervene to effectively prevent injuries caused by overtraining or emergencies. Accuracy is also a core element in measuring system performance. It reflects the accuracy of the system's collection and processing of data. In the field of athlete training and health monitoring, the accuracy of data is essential for the formulation and adjustment of training plans, as well as the assessment of athletes' health. Through the integration of a variety of sensors and camera equipment, this research system realizes real-time tracking and monitoring of athletes' physiological status and exercise trajectory, and uses cutting-edge data processing algorithms to significantly improve the accuracy and credibility of the data. In addition, in practical applications, the stability and reliability of the system cannot be ignored. The research system uses the HTTP protocol for data transmission, thus ensuring the stability of the data transmission process.

This article builds a sports information processing monitoring system based on multimedia computers. The system can analyze the motion data of system users well and provide feedback quickly, and the system delay is very low. Different results can be obtained by analyzing the movements of different numbers of users. To further study the response speed of this system, it is compared with other sports monitoring systems, and the sports monitoring systems based on sensors (system 1), video analysis (system 2), and multimedia (system 3) are compared, as shown in **Figure 6**.

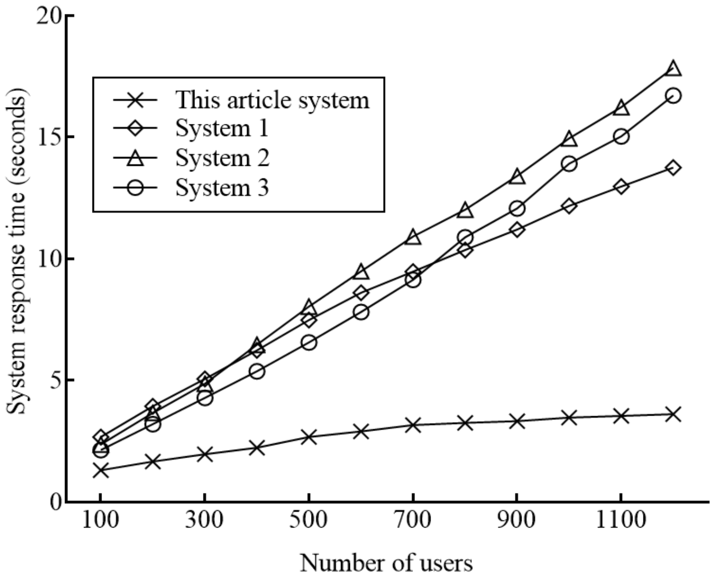

Figure 6. Comparison of the response time of each system under different numbers of users.

As shown in **Figure 6**, as the number of users gradually increases, the response time of all systems shows an increasing trend. However, compared with the systems constructed by other methods, the sports information processing and monitoring system based on multimedia computers constructed in this article shows significant advantages in response speed. When processing 100 users, the response time of this system is only 1.31 s, which is significantly lower than 2.68 s, 2.37 s and 2.14 s of system 1, system 2 and system 3. As the user scale continues to expand, this advantage becomes more and more obvious. When processing 800 users, the response time of this system increases to 3.26 s, which is 7.11 s, 8.77 s and 7.63 s less than the response time of system 1, system 2 and system 3. This data shows that when processing large-scale user data, the system of this article can provide users with feedback and analysis results more quickly. When the number of users reaches 1200, the response time of this system remains at a relatively low 3.62 s, while the response times of the other three systems surge to 13.76 s, 17.86 s and 16.72 s respectively. It can be seen that even when processing extremely high-load data, the system in this article can still maintain an excellent response speed, ensuring that users can obtain accurate sports data feedback in real-time. Through comparative studies with the other three sports monitoring systems, it can be found that the system in this article has obvious advantages in response speed. This advantage is particularly prominent when processing large-scale user data, enabling the system in this article to provide users with more real-time and accurate sports data feedback and analysis support.

A series of experiments with increasing exercise intensity are conducted to monitor the physiological data of athletes at different intensities. The exercise intensity is divided into low-intensity exercise and high-intensity exercise, and thresholds are set to detect whether the system can detect and alarm in time. The main research is based on four common physiological data: Heart rate, body temperature, blood oxygen and blood pressure. A monitoring and early warning accuracy rate is obtained by conducting early warning monitoring on multiple athlete users. The results are compared with system 1, system 2 and system 3. The specific comparison results are shown in **Figure 7**.

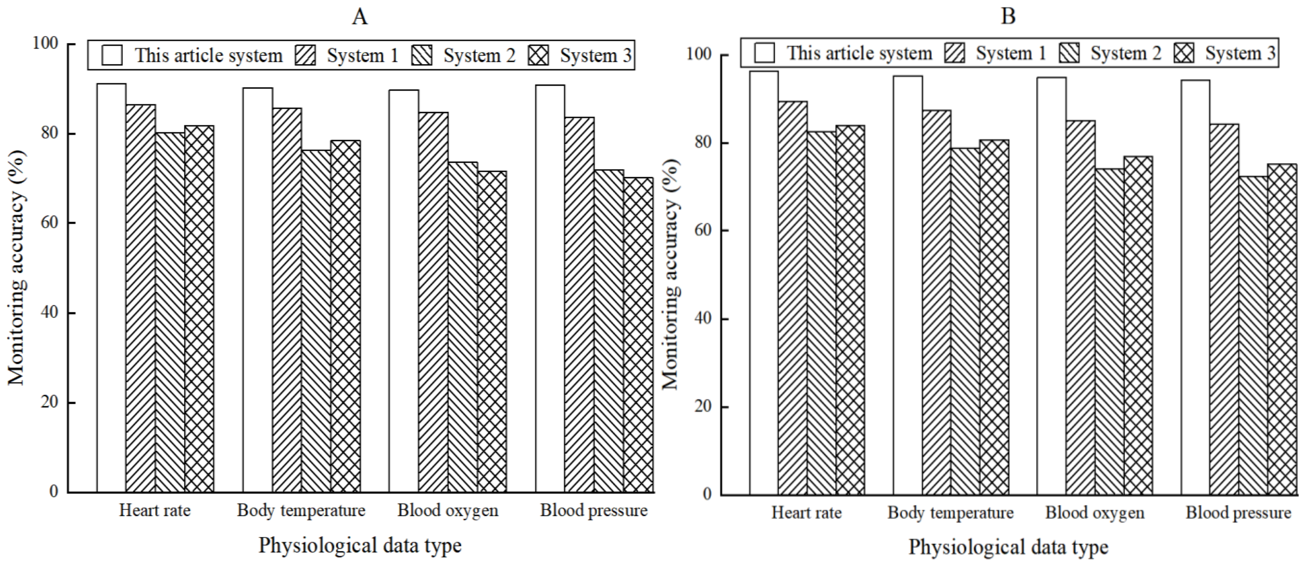

Figure 7. Comparison of system warning accuracy under different exercise intensities, **(a)** low-intensity exercise; **(b)** high-intensity exercise.

As shown in **Figure 7**, the system studied in this article shows significant advantages in monitoring and warning users under different exercise intensities. As shown in **Figure 7a**, in low-intensity exercise, the average monitoring and warning accuracy of the system in this article for the four indicators is 90.44%, which is 5.36%, 14.98% and 14.99% higher than that of system 1, system 2 and system 3, respectively. Especially in terms of heart rate monitoring, the system's accuracy in this article is as high as 91.05%, which is significantly higher than the other three systems. Similarly, in body temperature monitoring, the system in this article also achieves an accuracy of 90.18%, which is 4.56%, 14% and 11.76% higher than that of system 1, system 2 and system 3, respectively. As shown in **Figure 7b**, during high-intensity exercise, as the intensity of exercise increases, the athlete's physiological response becomes more intense, and the system in this article still performs well, with an average accuracy of 95.11% for monitoring and early warning, which is 8.61%, 18.21%, and 15.97% higher than system 1, system 2, and system 3, respectively. In terms of blood oxygen monitoring, the accuracy of this system is 94.77%, which is much higher than other systems. This means that the system in this article can more accurately monitor changes in blood oxygen levels during high-intensity exercise, thereby helping athletes maintain the best oxygen supply. In terms of blood pressure monitoring, the accuracy of this system also reaches 94.27%, which is significantly better than other systems. This result shows that the system in this article can capture blood pressure fluctuations in high-intensity exercise more timely and accurately, providing strong protection for the health of athletes. In summary, whether under low-intensity or high-intensity exercise conditions, the system in this article has shown excellent performance in monitoring and early warning accuracy, which is of great significance for ensuring the health of athletes and preventing sports injuries.

A satisfaction study is conducted on 30 system users. To make the results more intuitive, the study is mainly conducted in the form of scoring, with a full score of 10 points. The experimental results obtained are compared with system 1, system 2 and system 3, and the specific comparison results are shown in **Figure 8**.

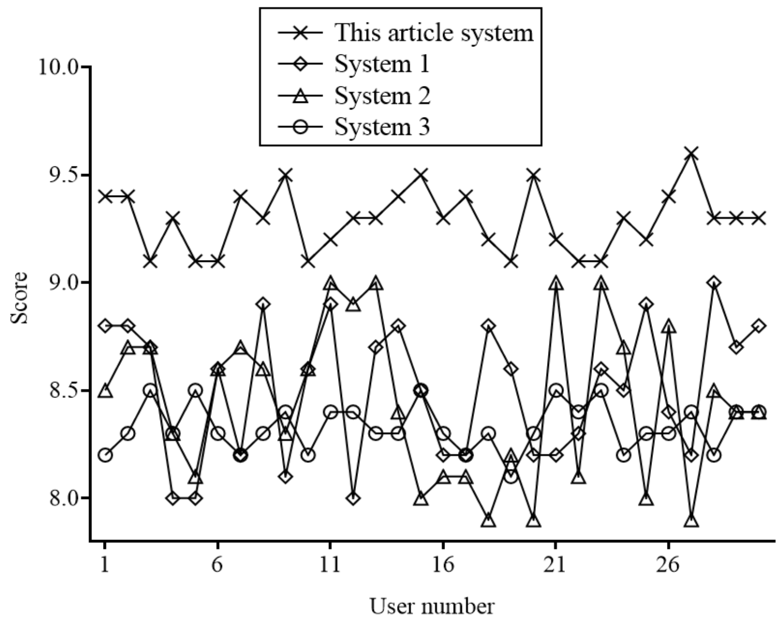

Figure 8. User satisfaction study of sports information processing monitoring system constructed by different methods.

As shown in **Figure 8**, the system in this article has achieved remarkable results in user satisfaction. In the evaluation of 30 users, the average score of the system in this article is significantly higher than that of the other three comparison systems. Users' scores for the system in this article are mainly concentrated between 9.1 and 9.6 points, showing that users highly recognize the overall performance and services of the system. The user scores of system 1 are mainly between 8.0 and 9.0 points; the scores of system 2 are between 7.9 and 9.0 points; the scores of system 3 are generally between 8.1 and 8.5 points. This shows that in most cases, the system in this article can provide users with a better user experience. The average user satisfaction score of the system in this article is 9.29 points, which is 0.78 points, 0.84 points and 0.96 points higher than the average user scores of system 1, system 2 and system 3, respectively. The highest scores of the other three systems do not exceed 9.1 points, and there are many evaluations below 8.5 points. This comparison further highlights the significant advantages of the sports information processing and monitoring system based on multimedia computers constructed in this article regarding user satisfaction, which is superior to other similar systems on the market.

5. Conclusions

The emergence of sports information processing and monitoring systems is an essential sign of the transformation of sports to scientific and intelligent. Traditional sports information processing mainly relies on manual observation and recording. However, this method is inefficient and susceptible to subjective bias, and it is difficult to meet the high standards of modern sports events and training. For this reason, this article studies a sports information processing and monitoring system based on multimedia computers. The system can achieve comprehensive and precise monitoring and management of sports events and athlete data by using advanced multimedia technology and computer management methods. This not only effectively makes up for the shortcomings of traditional sports information processing methods, but also provides strong support for athletes and coaches through scientific data analysis and intelligent feedback mechanisms, helping to improve training efficiency and competition results, and further promoting the scientific development of sports.

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