Research on the Application of Mobile Internet Information Technology in Sports Training System

Qiuling Wu(✉)

Department of Physical Education, College of General Education, Guangdong University of Science and Technology, Dongguan, Guangdong, China
wuql0228@163.com

Abstract. With the development of modern information processing technologies such as computers, communication and multimedia, as well as the increase in demand for talents in China's economic construction, all walks of life have begun to pay attention to the use of advanced information technology to improve their own work efficiency. Especially in recent years, with the increase of national investment in education, various new teaching media have emerged and been widely used, making fundamental changes in traditional classroom teaching, and also providing strong support for school sports reform. At present, many colleges and universities have carried out or are carrying out the construction of digital campus based on campus network, which requires us to give full play to the advantages of existing resources and combine them with new technologies to meet the needs of social progress and comprehensive development of students. Therefore, it is of great significance how to make full use of the existing campus network environment to build a sports training management information system suitable for the actual situation of our university.

Keywords: Web-based information technology · Sports training system · Applied research

1 Introduction

With the continuous development of social economy and science and technology, people pay more and more attention to health issues. Exercise is one of the most effective ways to maintain physical health and enhance physical fitness. However, there are many shortcomings in the traditional physical education teaching mode, such as students' passive learning which is difficult to stimulate their interest and lack of interactive communication. Therefore, how to use modern means to improve the existing physical education mode has become an urgent problem to be solved. In recent years, with the rapid development of mobile Internet information technology, it has been widely used in various fields and achieved remarkable results. Its introduction into physical education is also gaining attention. Through mobile devices, students can learn and interact with each other anytime and anywhere, so that they can participate in classroom activities more actively

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and improve the learning effect. At the same time, various APPs and WeChat platforms developed based on mobile Internet information technology also provide teachers with more options for personalized teaching. The purpose of this project is to investigate the specific application methods and advantages of mobile Internet information technology in sports training system, hoping to contribute to improving the quality of physical education in colleges and universities [1].

2 Research on Network-Based Somatosensory Technology

2.1 Principles and Technical Evolution of Somatosensory Technology

(1) Inertial sensing somatosensory technology

Inertial sensor is a device that can measure the movement state or acceleration change of an object. Through real-time monitoring of the acceleration generated by the human body movement, the user's body posture, movement trajectory and other important data can be obtained, thus achieving a comprehensive sensing and recording of the user's movement status. The commonly used inertial sensors include piezoelectric accelerometers, capacitive accelerometers, gyroscopes and other types. Among them, piezoelectric accelerometers have the advantages of small size, fast response speed, high sensitivity, and are widely used in robotics, smart wearable devices and other fields; capacitive accelerometers are mainly suitable for low precision, low frequency motion detection occasions. In addition, there are some new types of inertial sensors are emerging, such as magnetometers, optical accelerometers, etc., they will become one of the future development trends [2].

(2) Optical sensing body sensing technology

Optical sensor is a device that can sense light signals and convert them into electrical signals or other forms of output. Currently, commonly used optical sensors mainly include accelerometers, gyroscopes and geomagnetic sensors. These sensors can measure parameters such as attitude, position, speed and direction of moving objects to capture and identify human movements. By processing and analyzing these data, more accurate body state assessment results can be obtained. In addition, the use of optical sensors can also achieve real-time monitoring of the trainer's strength, endurance, flexibility and other aspects, which can provide the basis for the development of personalized training programs.

(3) Combined inertial and optical sensing

An inertial sensor is a device that uses inertial elements such as gyroscopes and accelerometers to measure the motion state or parameters of an object. It can analyze the movement trajectory, speed, and acceleration data by recording the movement of the test subject's body. The optical sensor mainly relies on infrared emitters and infrared receivers to sense the environment, including distance, direction, shape, etc. The combination of these two sensors can be used to more accurately capture the small changes in human movement, so as to achieve a more detailed data analysis and processing. For

example, the use of inertial sensors and LIDAR with the work can be real-time monitoring of the athlete's posture, position, speed and other aspects of information, and this can also provide appropriate feedback mechanisms to help coaches adjust training programs in a timely manner [3].

2.2 KinectV2 Somatosensory Device

(1) Body sensing equipment comparison

By comparing and analyzing the differences in physical fitness between different individuals, students can better understand their own physical condition. Therefore, the use of somatosensory equipment for exercise ability testing is a very effective method. For example, Nike's FuelBand and Garmin's HEROS have high accuracy and stability, and their ability to provide users with accurate and comprehensive results of sports data analysis. At the same time, these devices also support real-time data transmission and synchronization functions, convenient for coaches and players to communicate and adjust training plans in a timely manner. In addition, various fitness software developed based on mobile terminals such as smartphones and tablets are becoming increasingly popular, such as Keep and Peloton, which can not only record users' exercise trajectory and heart rate and other indicators, but also provide personalized training programs and diet recommendations to help users improve their physical fitness and health [4]. After market research, I finally selected two optical sensing body sensing devices alternative: KinectV2l3 launched by Microsoft in 2014 and RealSense SR30037l launched by Intel in 2016, after a more detailed comparative analysis, the comparison is shown in Table 1.

(2) KinectV2 hardware composition and architecture

The second generation of Kinect is the latest generation of somatosensory device improved by Microsoft in 2014 based on the first generation of Kinect, and the Kinect somatosensory device series is arguably the most successful and well-known somatosensory device. KinectV2 main hardware components: Kinect module is a system that can complete the image acquisition, processing and analysis functions, it can provide real-time accurate data support for trainers, and through the acquisition of the original video information to organize and integrate.

As shown in Fig. 1, the key components of KinectV2 mainly contain a color camera, an infrared camera, a set of microphone arrays, and a self-developed processor, through which the core components are used to complete the analysis and processing of the

Table 1. Comparison table of somatosensory equipment selection

Device name	KinectV2	RealSense SR300
Price	About 1,300 yuan	About 1600 yuan
Technical principle	TOF (Time of Flight)	Light Coding
Field of view	70° Horizontal 60° Vertical	71.5° Horizontal 55° Vertical
A platform to use	XBOX, Windows, Linux and mac	Windows and Linux

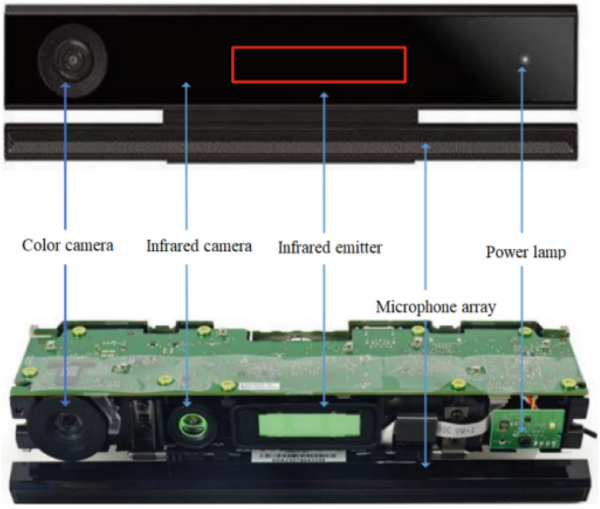

Fig. 1. Key components of KinectV2

collected information. In the training system, the mobile Internet technology can transmit the original data to the computer, and automatically obtain the relevant data according to the program and method set by the user, and analyze the collected data to complete the corresponding judgment and finally draw conclusions. The system can get the user information through cell phone terminal, and understand the training situation of the athletes according to the sports rules and physical condition, etc.

KinectV2 data flow: When Kinect acquires data, the original data is processed first, and then the image is used to identify the scene feature points. Since there is often a lot of noise interference and various noise effects in the image. So we need to reduce the adverse effects of these factors through a certain suitable algorithm, and eliminate the hidden unsafe hidden problems. The first step is to extract the pixel values, count all the pixel values, and then input all the data into the computer by calculating parameters such as mean, standard deviation and average. Secondly, the target area is represented by pixels and the weight coefficients are calculated to get the final result. Finally, the data is pre-processed, and then the location, direction and change of the feature points of the scene are analyzed according to some phenomena on the image to classify them, so as to achieve the effect of recognition, localization and tracking. The KinectV2 data flow diagram is shown in Fig. 2, so it can be clearly seen that the location of the feature points of the scenery, and through a certain analysis and processing of the image, and finally determine the scenery information.

(3) Kinect depth measurement principle

Kinect is a somatosensory device based on infrared sensor and RGB-D camera, which can realize human motion capture. Its core algorithm is to calculate the depth value in 3D spatial coordinate system by the time reflected back from the infrared beam, so as to obtain the position information of each joint point. Kinect has the advantages of non-contact, high resolution and high speed, so it is widely used in the field of motion analysis.

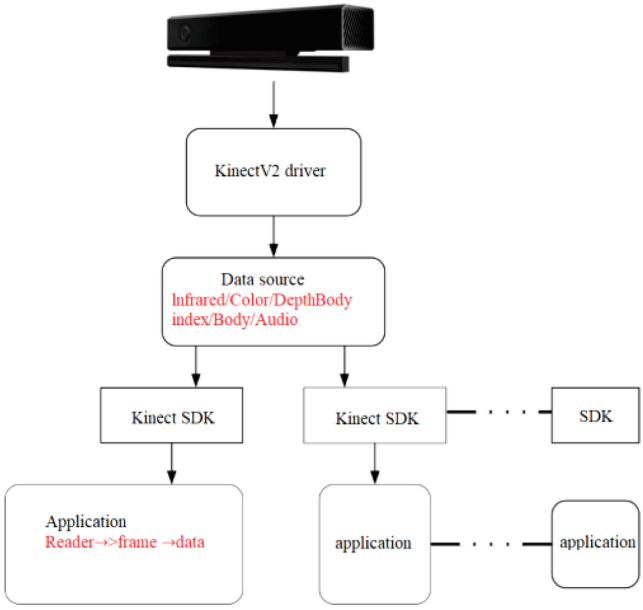

Fig. 2. KinectV2 data flow diagram

The application of Kinect to sports training systems can obtain real-time information on the position of each part of the athlete's body and the posture angle, which can provide more accurate data support for coaches and thus help them make scientific training arrangements and adjustments. At the same time, Kinect can also track and record the athletes' movement trajectory to form a complete video clip of the game, which is convenient for subsequent data analysis and accurate judgment of the game results [5].

(4) KinectV2 skeleton recognition principle

Kinect is an infrared sensor and depth camera based body sensing device, it can capture the light reflected from the body through infrared light to obtain depth data. At the same time, Kinect can also track the user in real time and convert these data into the corresponding skeleton point position coordinates, so as to achieve the tracking of human movement. Kinect bone recognition technology mainly includes two aspects: skeletal point data extraction and skeletal model building. Among them, skeleton point data extraction refers to the use of Kinect hardware devices to scan the human body parts to obtain the spatial coordinates of each joint point; Skeletal model building is based on the obtained skeletal point data, using a specific algorithm to build the connection relationship between each joint point, and finally form a 3D skeleton structure map. This method can be used not only in the fields of motion analysis and posture estimation, but also in virtual reality and augmented reality.

3 Motion Recognition Algorithm Research

3.1 Motion Recognition Algorithm Requirement Analysis

Through motion capture of athletes, a large amount of human posture data can be obtained. These data are the important basis for the subsequent data analysis and mining work. Therefore, it is necessary to design corresponding motion recognition algorithms for different types of sports items. Take basketball as an example, its basic movements include holding the ball, passing, shooting and many other aspects, and each movement has multiple joint angle values involved in the calculation. At the same time, since there are many changing situations during the basketball game, such as change of direction running, emergency stop and jump shot, etc., this requires that the adopted motion recognition algorithm can quickly adapt to the changes of the scene and accurately detect the player's movements. In addition, the stability and real-time problems under the actual usage environment need to be considered [6].

3.2 Skeletal Data Filtering

Skeletal data filtering refers to the processing of the acquired skeletal muscle signals of athletes to remove the noise interference and unnecessary details and retain the useful feature information. The commonly used skeletal data filtering methods include low-pass filtering, high-pass filtering, band-pass filtering, etc. These filtering methods can effectively reduce the high-frequency noise due to muscle contraction and improve the accuracy of subsequent analysis results. In addition, wavelet transform-based denoising algorithms can be used to further reduce the noise level in skeletal muscle signals.

This system uses a filter that combines jitter clear and double exponential smoothing. Jitter clear attempts to suppress peaks in the input by limiting the range of variation allowed in the output of each frame. That is, if the difference between the current input data and the previous filter output is less than a threshold, the filtered output is the same as the input. Otherwise, the filter limits the changes in the output, which can be achieved by using different methods as shown in Eq. (1).

$$\hat{X}_n = \begin{cases} X_n, \ |X_n - \hat{X}_{n-1}| < t \\ \alpha X_n + (1-\alpha)\hat{X}_{n-1}, \ |X_n - \hat{X}_{n-1}| \geq t \end{cases} \tag{1}$$

3.3 Finite State Machine Based on Skeletal Space Features

(1) Skeletal space feature extraction

The skeleton is one of the most basic structures when the human body moves. By analyzing and processing the skeletal data, more accurate body state parameters can be obtained. The commonly used methods for skeletal data analysis include morphological transform-based, vector-based, wavelet transform-based, and deep learning-based methods. Among them, vector method is a more commonly used method, which can transform the data vector into linear space, thus improving the accuracy of the analysis results [7].

Using the above method, the vectors between each joint point of the human body can be composed, and then calculate the angle between the two vectors, and simplify the body and joint points as shown in Fig. 3, then this action is mapped in the 3D coordinate system as shown in Fig. 4.

At this point, it is only necessary to calculate the angle θ of the vector $\overrightarrow{ES}$, $\overrightarrow{EH}$ to obtain the angle of the elbow joint formed by the three points of the shoulder, elbow and hand in space, the formula is shown in the following Eqs. (2), (3) and (4).

$$\overrightarrow{ES} = (Sx - Ex, Sy - Ey, Ez - Sz) \tag{2}$$

$$\overrightarrow{EH} = (Hx - Ex, Hz - Ez, Ez - Hz) \tag{3}$$

$$\cos\theta = \frac{\overrightarrow{ES} \cdot \overrightarrow{EH}}{\left|\overrightarrow{ES}\right|\left|\overrightarrow{EH}\right|} \tag{4}$$

In the same way, the shoulder rotation angle α can be calculated, as shown in Fig. 5, using the normal vectors of the two planes, as follows.

The normal vector of the XOY plane is given in Eq. (5).

$$n_2 = (0, 150, 0) \tag{5}$$

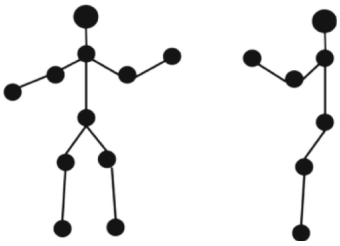

Fig. 3. Simplifying the body and joint points

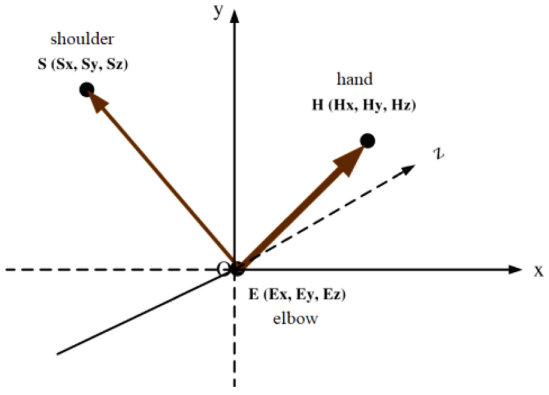

Fig. 4. Motion coordinate mapping in 3D coordinate system

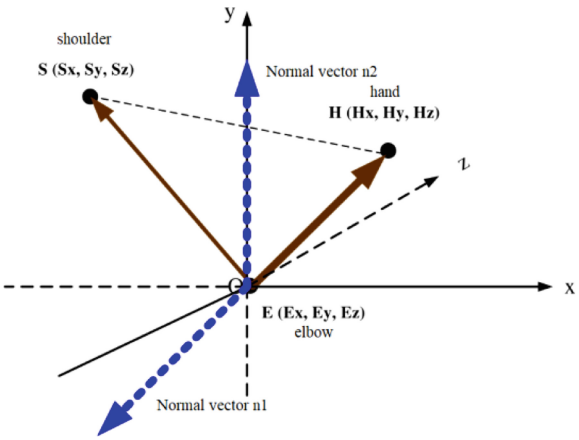

Fig. 5. Calculation of shoulder rotation angle

The normal vector of the plane formed by $\overrightarrow{ES}$ and $\overrightarrow{EH}$ is given by Eq. (6).

$$n_1 = EH \times ES \tag{6}$$

The angle of rotation α of the shoulder can be obtained as in Eq. (7).

$$\cos\alpha = \frac{n_1 \cdot n_2}{|n_1||n_2|} \tag{7}$$

(2) Finite-State machine

Finite-State Machine (FSM) is a mathematical model proposed by John Hopcroft, an American computer scientist, in the early 1960s. It can describe many simple processes and behaviors, but cannot handle complex tasks or problems. In practical applications, we often need to decompose a large problem into several smaller problems to solve, which is similar to using a finite state machine. By properly extending and combining finite state machines, we can construct a wide variety of algorithms and models to cope with problems of different types, sizes and complexities.

3.4 Motion Recognition Algorithm Process

Motion recognition refers to the processing and analysis of video or image sequences to extract the various motion information contained in them. Its main purpose is to help people better grasp the human movement rules as well as characteristics, and provide support for further data analysis and diagnosis [8]. Its motion recognition algorithm flow is shown in Fig. 6.

4 Sports Training System Design and Implementation

4.1 Hardware Design

Mobile terminal device is an important material basis for realizing the combination of mobile Internet information technology and sports training system. Therefore, this study will take Android smartphone as an example to explore. This smartphone has high

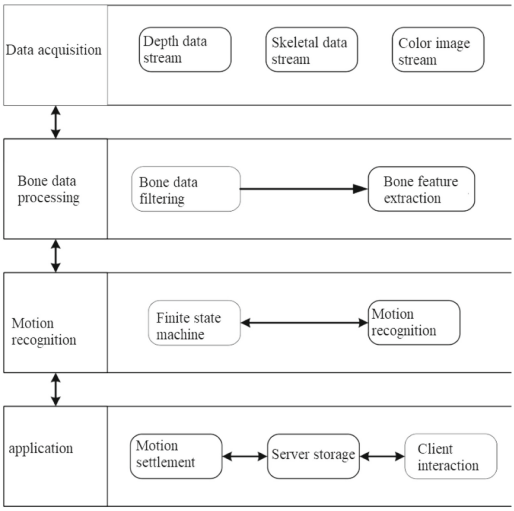

Fig. 6. Motion recognition algorithm flow

processor performance and running speed, and is equipped with large-capacity memory and storage space, which can meet the user's needs for data transmission and storage. In addition, due to the strong open source nature of the Android operating system and the relatively low development cost, it makes the software resources on the platform rich and diverse, so that it can be easily transplanted to different types of sports training systems. In addition to smartphones, tablet PCs are also a common mobile terminal device. Compared with smartphones, tablet PCs are smaller and more convenient to carry, and have higher computing power and larger display screens, making it easier for users to process and analyze data. Based on the above advantages, using tablet PC as a mobile terminal device to build sports training system will become one of the future development trends [9].

4.2 Functional Design of the System

The design of the system function is to make an overall plan of the whole sports training system, and divide it into several different modules, each individually and interconnected. It is necessary to determine the purpose of each part before proceeding to the specific operation. First we need to decide whether the software can meet the needs according to the research content of this topic, then we can select and sort out the required information content, and what features each function should have as a series of issues as a basis, and finally form a complete system model diagram, in this process we can find that the functional modules of the system is very important, it can make the whole sports training system more perfect. The sports training system is shown in Fig. 7.

4.3 System Testing

In order to verify the feasibility of the design solution, system testing is required. This testing mainly includes two aspects: functional testing and non-functional testing. The

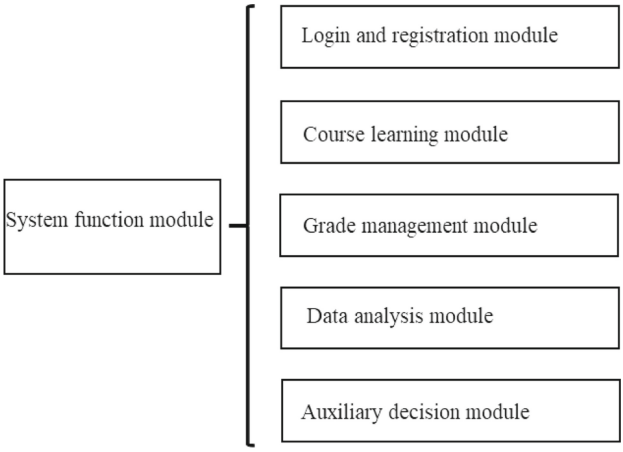

Fig. 7. Functionality of the exercise training system

functional test is to test the basic functions of each module of the whole system to ensure that it meets the user's requirements, while the non-functional test focuses on checking the system performance, stability and security to ensure that the system runs normally and the data is accurate.

(1) Functional testing: The system functions are fully tested through test cases, and the correct results and causes of errors of each test case are recorded to find and fix defects in time. The testing process focuses on the following aspects: ① Login and registration module testing: this module involves a number of operations such as user name password verification, account auto-saving, and exit from the system, etc. It is necessary to simulate the use scenarios under various abnormal situations, such as violent cracking and account leakage, in order to fully check the security of the system. ② Course learning module test: the module provides video teaching, graphic display, online communication and many other functions, it is necessary to simulate the actual use of student scenarios to examine its interface friendliness, interaction effects and other indicators. ③ Testing of result management module: The module supports querying and statistics of students' learning results at various stages, and it needs to consider the concurrent accesses in different time periods, and also prevent malicious attacks from causing loss or tampering of results. ④ Testing of data analysis module: This module can analyze and process a large amount of data received, and it needs to have efficient data processing ability, and at the same time, it also needs to ensure the real reliability of the data. ⑤ Test of auxiliary decision-making module: This module can be used to generate various reports, charts and other forms of data reports, which need to meet the requirements of visual display and multi-dimensional analysis, so that coaches can visually view the training conditions of athletes.

(2) Non-functional testing: In addition to functional testing, non-functional testing should also be conducted on the performance, stability, and security of the system. This time, 15 male students and 5 female students were invited to use the system once a day

Table 2. Experimental analysis table

Category of exercise	Number of movements	Motion recognition rate	Accuracy rate
pull-up	198	100%	99.0%
squats	200	99%	97.5%
Standing long jump	594	97.8%	87.9%

for 5 days, and 200 test samples were obtained, and the recognition rate of the movement was calculated as shown in Table 2.

In summary, the application of this mobile Internet information technology in the physical education training system has achieved remarkable results. It not only improves the efficiency of students' independent learning, but also enhances the interaction and communication between teachers and students, and promotes the improvement of teaching quality [10].

5 Conclusion

This paper analyzes the combined use of mobile Internet information technology and sports training systems to further improve the use of mobile Internet technology and related software in the process of sports teaching to improve the ability of sports team personnel and coaches to judge the direction of sports development. As the social economy continues to advance, people's pursuit of a healthy lifestyle is becoming stronger and stronger, which requires us to strengthen the cooperation and communication between various industries to jointly promote the cause of national fitness to move forward. Therefore, the application of mobile Internet information technology in sports training system will become an important trend in the future development, which will not only change the existing structure of sports training system, but also drive other related industries to a higher level.

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