Research Article
Computational Intelligence and Applications of Virtual Reality Technology in Martial Arts Teaching System

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Conventional martial arts teaching system has the problem that the interactive teaching mode is not three-dimensional enough, which leads to the slow byte sending speed of the system. In this study, a martial arts teaching system based on virtual reality technology is designed. For the software part, according to the different degrees of muscle participation in the completion of the action, the technical characteristics of martial arts action are identified, virtual reality technology is used to build interactive teaching mode, the feedback of proprioceptors is used to adjust martial arts action, the software priority processing function is designed, and the priority of martial arts action frame is improved. The average sending byte speed of the martial arts teaching system in this paper and the other two martial arts teaching systems is 81.391 kb/s, 93.465 kb/s, and 94.557 kb/s, respectively, indicating that the performance of the martial arts teaching system has been improved after the combination of virtual reality technology.

1. Introduction

Martial arts is a sport originated in the long-term production and living practice of the Chinese people [1–3], and it is the core of China’s traditional sports culture. Martial arts not only have a deep cultural significance, but they also have a wealth of movement methods, and the world is amazed by the exquisite movement exhibition. Martial arts training not only strengthens the body but also helps to cultivate a strong will and a steadfast character. Setting martial arts courses and incorporating martial arts teaching into physical education have a positive practical significance in cultivating students’ interest in learning martial arts, inheriting martial arts culture, cultivating students’ national pride, and improving their confidence in national culture. At present, China is gradually realizing the Chinese dream of becoming a world sports power in the journey of building a world sports power, and the various functions of martial arts should also take on the corresponding historical mission. From the perspective of system theory, the basic action elements of martial arts are the subsystems that constitute the martial arts action skill system. In order to ensure the good development of the overall system of martial arts, it is necessary to ensure the coordination among the subsystems and the orderly development of each subsystem is the foundation of the overall operation of the system. Therefore, the study of martial arts movements is the logical starting point of this study. A relatively perfect teaching material system was gradually formed after martial arts courses were formally incorporated into physical education [4, 5]. Martial arts teaching material is an important carrier of martial arts teaching, which plays an important role in guiding physical education teachers in the process of martial arts teaching. The rationality of teaching material setting has an important impact on the quality of martial arts teaching to a great extent. Most martial arts learners believe that martial arts movements are complex and difficult to master and easy to forget. In addition, the exercise of martial arts movements requires high quality of the practitioners, whether it is flexibility, muscle explosive power, body coordination, etc., better than other sports. Due
to the complex structure of martial arts movements, higher requirements are put forward for the quality of educators. In the process of implementing teaching strategies, it is necessary to have both specialized professional knowledge and solid teaching skills. It plays an irreplaceable role in school physical education and is also an indispensable and important content in school physical education [6, 7]. Therefore, to strengthen the research and analysis of martial arts teaching materials in middle schools is not only conducive to improving the practical effect of martial arts education but also conducive to cultivating students’ national cultural pride, enhancing students’ cultural self-confidence, and carrying forward the excellent traditional culture of China. Educators should not only have a thorough understanding of martial arts action and training structure but also a thorough understanding of students’ individual learning characteristics and make timely and reasonable use of the most recent scientific research findings on action teaching strategies to support martial arts teaching practice.

2. Hardware Design of the Martial Arts Teaching System

The telephone line and MODEM are no longer utilised in the system, and the end-to-end connection is made directly. Although only RXD, TXD, and GND are required to complete the most basic serial communication function, two serial interfaces are implemented in the system for the adaptability of the teaching and development of the system, one of which is a full-function serial port that fully meets the requirements of the RS-232-C standard. The Raspberry Pi has USB connections for the keyboard and mouse, as well as fast Ethernet, SD card expansion, and an HDMI HD video output connector for connecting to a monitor or TV. Almost all microcontrollers and PCS provide serial interfaces, using the RS-232-C standard recommended by the Electronics Industry Association (EIA), which is a common serial data transmission bus standard. Earlier, it was applied to computers and terminals through telephone lines and modems for long-distance data transmission, but with the development of microcomputers and microcontrollers, not only long-distance but also near distance adopt this communication mode. It is the size of a credit card and plugs directly into a TV. Raspberry Pi runs many traditional computer functions, such as word processing, spreadsheets, and games. The Raspberry Pi is unique in that it has an HDMI output. This means that you can plug in mice and buttons and plug directly into the TV, which means you have a fully functional computer with a user interface. This allows Raspberry Pi to be used to build Web browsing devices at a low cost in projects that require user interaction. There are many DC-DC converters that can convert 5 V to 3.3 V. According to the requirements and actual power consumption of the system, LT1085 of Linear Technology LTI08X series is selected. The corresponding current output is 3 A. Crystal circuits are used to provide working clocks to CPUs and other circuits. In this system, S3C4510B uses an active crystal oscillator. The connection structure of the active crystal oscillator in the system is shown in Figure 1.

As can be seen from Figure 1, the other pins of S3C4510B are power line, ground line, data bus, address bus, and input/output line of other functional modules, which have relatively little influence on the operation of CPU itself, and its connection mode is relatively simple. The Beagle board is actually an open-source project for education (STEP) supported by TI. The hardware of the four boards was designed by Gerald Coley, a TI engineer. In addition, the high- and low-level signals defined by RS-232-C standard are completely different from those defined by the LUTTL circuit of S3C4510B system. In the system, it is necessary to use a 5-V and 3.3-V DC regulated power supply, among which S3C4510B and some peripheral devices need a 3.3 V power supply, and the other parts need a 5 V power supply. In order to simplify the design of the system power circuit, it is required that the input voltage of the whole system should be a 5 V DC-regulated power supply with high quality. It has a built-in Ethernet port and USB for easy network connection. You may connect to a wireless module through the USB port, which enables you to connect to the Internet without utilising a network connection. The active crystal oscillator of 10 MHz is chosen based on the S3C4510B’s maximum operating frequency and the PLL circuit’s working mode. The maximum crystal oscillator frequency of 10 MHz may reach 50 MHz after frequency multiplication of the PLL circuit in S3C4510B. One pin of the active crystal oscillator is linked to the 3.3 V power supply, while the other two pins are suspended, three pins are grounded, and the fourth pin is the crystal oscillator’s output. Through a tiny resistor, it may be linked to the S3C4510B’s XCLK pin (33 ohms here). The phases of hardware design for a martial arts teaching system based on the preceding description is completed.

3. Martial Arts Teaching System Software Design

3.1. Identifying the Technical Features of Martial Arts Movements. In the operation process of martial arts action
skills, the action skills can be divided into continuous action skills, discrete action skills, and sequence action skills according to the characteristics of the start and end of actions [8–10]. Discrete motor skills are also called discontinuous motor skills. There is a kind of motor skills between continuous motor skills and discontinuous motor skills called sequence motor skills. When the education content of martial arts as the main body exists in martial arts education, these attributes further confirm that martial arts education has a variety of educational functions, and it can be said that the multifunctional characteristics of martial arts education is that martial arts has a complex structure and multiattribute decision making. Due to the violent nature of martial arts, martial arts education must focus on the promotion of external morals such as benevolence, honesty, justice, and responsibility in order to control the behaviour of violence holders and martial arts education should rigorously cultivate these qualities in students. Second, the nature of the martial arts attack requires that martial arts education must develop intelligence [11]. Small muscle group movement skill refers to the movement skill with small muscle group activity mainly and has a subtle and delicate characteristic. Large muscle group motor skill refers to the motor skill which mainly focuses on large muscle group activity. Martial arts movement is a complex movement skill system. In the process of movement, martial arts athletes mainly use large muscle groups and small muscle groups as auxiliary. In order to defeat the opponent, we need not only superb technique and clever tactics but also high wisdom. Therefore, martial arts sports have high requirements on athletes’ sports quality, physiological function, and body shape. The physical attribute of martial arts means that martial arts has a good function of keeping healthy body and building up the body. Classification of motor skills is characterized by the tasks of motor skills, as shown in Figure 2.

Martial arts action tasks may be split into discrete skills, sequence skills, and continuous skills, as shown in Figure 2. They may be separated into sports skills and cognitive skills based on the relevance of martial arts sports and cognitive aspects. They may be split into open and closed skills based on the predictability of environmental changes in martial arts movement abilities. The feature of martial arts is that it is a kind of art with national cultural traits as a social and cultural form. This is the most basic feature of martial arts, i.e., the most important attribute of martial arts, and it has the biggest impact on martial arts’ instructional function. First, the nature of martial arts necessitates that moral and etiquette instruction be prioritized in its education. The repetition of continuous motor skills and the definite beginning and stopping point of discrete motor skills distinguish this kind of motor talent. The martial arts project consists of a series of offensive and defensive moves that are closely related, and they are organized according to the motion law of routines, with special attention to the effective connection between actions (one of which is also difficult to judge), and the action between the cohesion of the whole action skills plays an important role. The rhythm between the sequence of moves is crucial to finishing the martial arts series. On the one hand, many technical moves in martial arts match medical science’s needs. Martial arts instruction may help you learn these precise motions and improve your fitness [12, 13]. On the other hand, the process of martial arts education is also a process of improving physical function, developing physical strength, and strengthening the physique. Regular practice is also conducive to the formation of sports habits. Martial arts education is an educational
activity with martial arts culture as the main teaching content. Martial arts is by no means a simple punching or self-defense movement, fist waving, and stick dancing technique with skill but no tao. Based on the above description, the steps of identifying the technical characteristics of martial arts movements was completed.

3.2. Virtual Reality Technology Constructs the Interactive Teaching Mode. Virtual reality technology combines the most recent advances in computer graphics, digital image processing, sensors, multimedia technology, artificial intelligence, network and parallel processing technology, and other fields of information technology [14–16]. It gives us tremendous tools for creating and experiencing the virtual world, accelerating the development of computer technology. The most prominent feature of virtual reality technology is the creation of an artificial virtual world with a computer [17, 18]. This kind of virtual environment involves copying other actual surroundings onto the computer to create a realistic virtual world or just using the computer’s three-dimensional space to provide an immersive experience for the user’s many senses [19–21]. In physical education, virtual reality technology serves two purposes: one is to prevent difficult movement injuries and the other is to prevent mishaps during sports training. Virtual reality technology, with its realistic and life-like qualities, may provide students with a life-like and vibrant learning environment [22, 23]. Computer teaching has the characteristics of strong skills, so the application of virtual reality technology in martial arts teaching system is undoubtedly an effective way to improve the teaching method. Before the user uses the device, the system will initialize the image for a short time after startup. Therefore, the height of a pixel point needs to be calculated and the specific expression formula is as follows:

$$G = \sum \frac{\alpha + \beta + \delta}{3}$$  \hspace{1cm} (1)

In formula (1), \(\alpha\), \(\beta\), and \(\delta\) respectively, represent the red, green, and blue color components of the pixel. On the basis of formula (1), the average height value of the matrix is calculated and the formula is:

$$T = \frac{1}{pq} \sum_{i=1}^{p} \sum_{j=1}^{q} c$$  \hspace{1cm} (2)

In formula (2), \(p\) represents the highest point at the touch position, \(q\) represents the lowest point at the touch position, and \(i\) and \(j\) represent the static force and supporting force in the vertical direction and the friction force in the horizontal direction, respectively. According to Weber Fischer’s law, people’s sense is directly proportional to the logarithm of voltage. The larger the edge height is, the more obvious the people’s sense will be, so that users can clearly distinguish the texture and contour of objects. Martial arts motor skills are closed loop actions; in the process of completing martial arts motor skills, the movement environment and basic martial arts skills procedures are fixed. Wushu athletes do not need to make rapid and repeated adjustments according to the environment and the situation of competitors but can adjust wushu movements with the feedback of proprioception. Teaching intermediary system is the link between teachers and athletes, which is one of the ways of teaching activities. The three elements of teaching are independent and influence each other and together constitute a practical activity system with a complete structure. It is impossible to carry out teaching activities without teachers, and learners cannot get effective guidance. Without the person being taught, the teaching activity lacks the object to shoot without a target. Without the teaching intermediary system, teaching activities will become bricks without rice and water without source. Compared with complete teaching, martial arts is only a part of the teaching intermediary system, namely, the teaching content. Taking martial arts teaching as the main teaching content as an independent system, martial arts teaching is a form or way of teaching. Martial arts teaching has its own specific teachers, students, and teaching systems. The quality of martial arts action skills is mainly related to the exercise level of the practitioners. Therefore, the key to learn martial arts action skills lies in repeated practice until it reaches the standard mode and degree of automation of martial arts event drills. Martial arts teachers may come from masters, boxers, and coaches. The students of martial arts teaching are those who practice martial arts. The intermediary system of martial arts teaching includes martial arts and its related teaching methods and means. Its three elements are independent of each other, but they also affect each other, constituting a complete system structure, and play a specific function. Based on this, the steps of constructing interactive teaching mode are completed.

3.3. Designing Software to Handle Functions First. After the construction of system interactive teaching mode, the system function modules will be divided. The division of system function modules is to decompose the system with more complex functions into multiple function modules with basic independence, simple function, and easy implementation. The main purpose of module division is to facilitate the separate development, modification, and maintenance of modules because the modules that constitute the system have basic independent and clear functions, so the separate development and maintenance will not affect other modules in the system. The purpose of priority design is to ensure the priority recognition of martial arts actions. It is a .NetFramework class library. In particular, when the martial arts action frame is directly inserted into the queue and when received according to the discretion of the priority to perform sorting, the martial arts action frames from a database is avoided to send a queue waiting for the process and the high priority of martial arts action frame at the front of the queue is ensured. Prioritization of martial arts action frames should be enhanced for those who wait too long in the database, ensuring completion within the minimum time restriction and consistency of 3D candidate position time and movement of each martial arts action joint. The core

Mathematical Problems in Engineering
premise of module division is “low coupling, high aggregation.” The degree of coupling reveals how closely modules are linked. The degree of aggregation reveals how closely components within a module are linked. A low degree of aggregation suggests a poor relationship between modules, whereas a high degree of aggregation indicates a strong connection. The lower the coupling degree is, the weaker the connection between modules is and the smaller the probability of mutual influence and the chain reaction. According to the calculation results of formula (2), the relative height value of the touch position in the system is obtained and the calculation formula is as follows:

\[ D(m, n) = \eta \times \frac{(m, n)^{3}}{T}. \]  

In formula (3), \( \eta \) represents the constant coefficient, \( m \) and \( n \) represent the position height of image texture bump and depression, respectively, and \( T \) has the same meaning as formula(2). In other words, when a module is faulty or needs to be modified, the impact on other modules is small. This principle helps improve system maintainability and scalability. In the output module, when a large number of processed martial arts action frames are waiting for output, high-priority martial arts action frames can be output first. Similarly, abnormal martial arts action frames with high priority will be placed in the front of the queue in the abnormal monitoring module, which is convenient for the system to give priority to human intervention. The event callback mechanism throws an event when an event needs to be processed directly, while in the polling framework, the state change can be determined only when the state of the previous frame and the current frame is known. Using the sinusoidal height model, the geometric state of the bulge is modeled first and the expression formula is as follows:

\[ H = g \sin \theta + g\left(\frac{\pi}{2}\right). \]  

In formula (4), \( g \) represents the relative change of the surface height of the system image and \( \theta \) represents the included angle between the tactile feedback and the height. Therefore, we need to take the derivative of the convex geometric model to transform it into a gradient model:

\[ \nabla = \begin{cases} 
\frac{\sigma H}{s \theta}, \\
g \cos \theta \left(\frac{\pi}{2} \leq \theta < \frac{3\pi}{2}\right).
\end{cases} \]  

In formula (5), \( \sigma \) represents the brightness of the object surface, \( s \) represents the normal vector of points on the surface, and the other variables have the same meaning as in formula (4). Therefore, a polling class is needed to simplify and reuse Kinect state polling in order to make it easier to call different components. This approach is used by teachers to plan lessons. Courses, lesson plans, and reference materials may all be uploaded. You may inquire about a student’s academic progress. Real-time classroom teaching can be done after virtual reality technology is completely integrated with the teaching style [24, 25]. The heart of the system, as well as courseware creation, is the lesson preparation system. Courseware creation should meet the following goals, in accordance with technological advancements: provide a feature for managing courseware and material resources. Static setting makes teaching courseware simple. The teaching plan directory tree can record handwritten information, screen content, record courseware real-timely, edit multimedia files, compress files hierarchically, and encrypt courseware, which is suitable for broadband and narrowband operation to apply in streaming media complied with SCORM standard. Exception processing is responsible for receiving martial arts action recognition exceptions and internal system exceptions, processing martial arts action recognition, filtering exceptions according to abnormal martial arts action recognition processing rules and alarm filtering rules, and sending abnormal information to the interface through the adapter. Exception handling consists of two parts: exception handling policy and alarm filter. The exception handling policy is responsible for analyzing exceptions, extracting the exception handling policy code, and returning the policy code. Alarm filter sorts out exceptions and alarms that do not need to be handled based on filtering rules.

4. Application Test

4.1. Test Preparation. An experiment was conducted to evaluate the feasibility of a system’s performance. According to the application test needs of the system, a Kinect experimental platform was built under a simple indoor background and data were collected with the Kinect capture device. The distance between people and Kinect was about 2 meters. Kinect works at a range of 1.5 to 4 meters. The resolution of each depth image is 320 * 240 pixels, the acquisition speed is 30 frames/SEC, and there are 10 candidate thresholds for each feature. The core of the depth map acquisition process is the optical coding technology, which uses near-infrared light to encode the scene, forming a volume coding with three-dimensional depth. The system uses SpeedMT as the main form of courseware playback, and the playback test mainly tests the effect of playback fluency, bandwidth, download time, and encryption effectiveness. Test conditions were as follows: courseware playback duration, 25 minutes; courseware file size, 3.5 MB. The first section has a 2-minute video. Access bandwidth was Netcom 512K ADSL, with a download time of 2.1 minutes. Effective time was set as 48 hours. The client installed was MS Mediaplayer 8.0.speedmtPlayer. The code comes from laser speckles and random speckles of diffraction that form when a laser hits a rough object or penetrates frosted glass.

4.2. Test Result. In order to verify the effect of the design system, the martial arts teaching system based on Web and the martial arts teaching system based on FMS are selected for experimental comparison with the martial arts teaching system in this study. The sending byte speed of the three
systems is tested under the condition that different client threads access the site at the same time. The experimental results are shown in Figures 3 and 4.

From Figures 3 and 4, we can get the average speed of sending bytes between the martial arts teaching system and the other two martial arts teaching systems, as shown in Table 1.

### Table 1: Average sending byte speed of three martial arts teaching systems (kb/s).

| Client thread | Martial arts teaching system based on web | Martial arts teaching system based on FMS | Martial arts teaching system in this paper |
|---------------|------------------------------------------|------------------------------------------|-------------------------------------------|
| 50            | 74.591                                   | 75.619                                   | 64.332                                    |
| 100           | 82.216                                   | 76.319                                   | 68.025                                    |
| 150           | 103.948                                  | 106.122                                  | 89.996                                    |
| 200           | 113.105                                  | 120.166                                  | 103.210                                   |

**Figure 3:** Sending byte speed of client 100 threads accessing the site at the same time (kb/s).

**Figure 4:** Sending byte speed of client 200 threads accessing the site at the same time (kb/s).
5. Conclusion

This study breaks the space limitation of traditional martial arts teaching methods, makes use of the immersion of virtual reality technology, and effectively meets the martial arts needs of martial arts lovers all over the world. In the login interface of the system, you can enter the education system through the obtained learning account to carry out independent learning of martial arts basic theory and martial arts movements, which improves the effect of martial arts teaching to a certain extent. Due to the limited research conditions, this study also needs to continuously improve the compressive capacity of the system and will carry out detailed research around this goal in the future.

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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