Research on intelligent somatosensory interaction devices based on virtual reality technology

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Abstract. Contemporary students have developed a dependence on electronic devices and developed the habit of sitting with screens for a long time, which has led to a trend of gradual deterioration of health conditions, declining physical quality and rejuvenation of diseases. Therefore, in this paper, based on the interactive and experiential characteristics of intelligent somatic interactive devices with virtual reality technology, the intelligent somatic interactive device body is improved according to the functions of virtual reality device body shape and experience, based on the handling needs, experiential needs and functional needs, and the educational interactive device experience strategy is designed to meet individual needs for the student group, and through comparison experiments with two groups of students, it is concluded that The interactive device experience strategy proposed in this paper outperforms the comparison group in terms of learning interest, motor interest, psychological anxiety, and emotional communication, verifying the effectiveness of the interactive device experience strategy, thus promoting students' physical health and improving individual physical signs, and also providing reference and learning for researchers engaged in intelligent somatic interactive devices based on virtual reality technology, from form design to development ideas.

1. Introduction
According to the World Health Organization (WHO), physical inactivity has become an important pathogenic factor that seriously threatens human health, and about 6% of global mortality is associated with physical inactivity. According to statistics, 81% of the world's adolescents are unable to achieve at least 60 min of moderate-to-vigorous physical activity per day [1], in which the dependence of contemporary adolescents on electronic games, cell phones, television, computers and other devices has led them to develop the habit of sitting with screens for a long time, resulting in a trend of gradual deterioration of health, manifested by a decline in physical fitness, younger diseases, poor entertainment and lifestyle habits have seriously affected their physical and mental health.

Studies have shown that unlike traditional static screen use, somatic play and the non-sitting screen time it entails have been shown to fully demonstrate its important role in promoting physical activity in adolescents in terms of energy metabolism, cardiorespiratory fitness, coordination, and balance. Energy expenditure is an important aspect of the physical benefits of somatic play, and somatic play is believed to increase energy metabolism by an amount of moderate physical activity equivalent to walking on a treadmill [2].

Somatosensory interactive equipment, on a suitable for youth groups entertainment and fitness as one of the sports and recreational facilities, to promote student health, improve physical fitness has a certain help, but also provides a certain reference for the design and development of fitness forms. Intelligent physical interaction equipment based on virtual reality technology is an improvement on
the original large physical interaction equipment. At present, the existing large physical interaction equipment in the use of the following aspects of deficiencies, first of all, the body is not easy to move and fixed, which does not facilitate the application of the device in large entertainment venues, mobile time and labor costs, very inconvenient, followed by low functionality of the body, the lack of heat dissipation mechanism, for the summer, will reduce the body's experience, and then the body lacks multifunctional seat and flash, etc. The body lacks multifunctional seats and flashing lights, which affects the experience of using the body and has greater limitations. Finally, the existing large physical interactive devices play a single method, single content, resulting in a lack of experience, cannot attract young people to use for a long time.

This paper discusses the design of a virtual reality-based intelligent somatosensory interactive device. The design is able to solve the large somatosensory interactive device body movement by improving the support structure, while improving the functional module to increase the functional components and enhance the experience of using the intelligent somatosensory interactive device based on virtual reality technology. By adding the virtual experience module, the playability of the intelligent somatosensory interactive device based on virtual reality technology is enhanced to meet the needs of the audience.

2. Problems of Large-scale Somatic Interactive Devices
The structure of existing large physical interactive devices includes the basic structure of the body, slow pressure plate, base, universal wheel, support block, cooling fan, protective side panel, multi-functional seat, multi-functional display, switch, protective roof and other components. The core of the large scale somatosensory interactive equipment is to solve the following problems:

- The body is not easy to move and fix. Large physical interactive devices are large, the bottom is not available to move and fixed devices, installation and removal are more troublesome, which does not facilitate the application of the device in entertainment venues, mobile time and labor costs, very inconvenient. This greatly reduces the use of the device scene, hindering the application and development of the device.
- Large-scale somatosensory interactive devices have a single function and poor entertainment and experience. Existing large somatosensory interactive devices only support a single function, for example, dance-type somatosensory interactive devices, only dance entertainment and fitness functions, do not support other sports, somatosensory interactive devices are mostly stand-alone games, game content is limited, cannot be networked interaction and update, in addition, in the body design, the lack of interactive devices and leisure equipment, the player experience is low, it is difficult to be long-term attraction [3].

3. Design Solution of Intelligent Somatosensory Interactive Device Based on Virtual Reality Technology

3.1. Overview of the design scheme of intelligent somatosensory interactive devices based on virtual reality technology
In response to the existing problems of large somatosensory interactive devices, the intelligent somatosensory interactive device based on virtual reality technology improves three major modules, adjusts the height of the support plate through hydraulic telescopic rods, which makes the gimbal wheels contact or separate from the ground, thus realizing the movement or fixation of the device and enhancing the convenience. Set the slow pressure plate to better protect the device; set the flash light to the surrounding environment for light processing, enriching the use experience and improving functionality; install the camera to enhance the security level of the device. The somatosensory module uses an improved oBB (convex bag) algorithm to achieve this, enhancing the sense of gaming experience. The basic structure of an intelligent somatic interactive device based on virtual reality technology, as shown in Figure 1.
Figure 1. Interaction device basic structure.

3.2. Improvement of support structure of intelligent physical interaction device based on virtual reality technology

The intelligent somatosensory interactive device based on virtual reality technology includes a body and a base, a gimbal and a groove at the lower end of the base, a hydraulic telescopic rod installed inside the groove, and a support plate fixedly connected to the lower end of the hydraulic telescopic rod. The intelligent physical interaction device based on virtual reality technology designed herein, when the device needs to be moved, the staff raises the height of the support plate by means of the hydraulic telescopic rod set inside the recess of the base, making the gimbal contact with the ground, thus realizing the movement of the device and enhancing the convenience of moving the device; when the device does not need to be moved, the hydraulic telescopic rod is driven to extend and contact with the ground by means of the support plate, avoiding the contact between the universal wheel and the ground, so as to achieve the fixation of the equipment. On the one hand, this method does not affect the mobile performance of the device, and on the other hand, it prevents the user from moving frequently on the physical interactive device when the gimbals are in contact with the ground, thus causing the problem of instability of the device, which greatly enhances the stability of the device.

There are four universal wheels, which are fixed at the four corners of the base. Installed in the four corners of the base universal wheels to better enhance the stability and convenience of the device when moving. At the same time, the lower surface of the support plate is provided with anti-slip pattern. Anti-slip pattern has the role of anti-slip, enhance the effect of stability. In the upper central position of the base is provided with a slow pressure plate, the said body is fixed on the said slow pressure plate. Slow pressure plate in the process of hydraulic telescopic rod lift, ease the pressure of the body on the base, play a better protection effect, the above scheme, perfect to overcome the virtual reality technology based on intelligent physical interaction device is not easy to move and fixed technical defects. As shown in Figure 2.

3.3. Functional module design of intelligent physical interaction device based on virtual reality technology

Intelligent physical interaction device based on virtual reality technology, the side wall of the body is
installed with a multifunctional display, the top of the body is fixedly connected with a protective roof, the lower end of the protective roof is symmetrically installed with a flash and a camera, the flash and camera are set with two. When the user uses, the flash at the lower end of the protective roof to the surrounding environment for light processing, enriching the experience of using the device and improving the functionality of the device; the lower end of the protective roof is installed with a camera, which can play the role of surveillance and enhance the security level of the device. At the same time, the camera can also record the real-time status of the player and collect face information to provide data for subsequent updates and improvements [4]. The input of the flash is electrically connected to the power supply, the output of the flash is electrically connected to the input of the body, and the output of the body is electrically connected to the input of the multifunctional display; the camera is separately connected to the power supply. The multi-functional display only runs when the body is powered on, the flash is electrically connected to the body and has the role of automatic work; the camera is separately connected to the power supply can keep the camera in working condition all the time. The two ends of the base are set with protective side panels, and the outer side of the protective side panels are installed with multifunctional seats, as shown in Figure 3. The multifunctional seat is used to provide pedestrian rest, which improves the humanization of the equipment. The multifunctional seat includes a pivot seat, a seat plate and a cushion; wherein one end of the pivot seat is fixedly connected to the outer side of the protective side plate and the other end is fixedly connected to the seat plate; the cushion is fixed to the seat plate. Set the pivot seat to achieve the rotational mobility of the seat, set the cushion to enhance the comfort of the seat and further improve the degree of humanization of the equipment. The outer side of the protective side plate is provided with a support block, and the upper end of the support block is against the lower end of the said seat plate. The support block plays the role of supporting the seat plate, making the multifunctional seat more stable and improving the safety of the equipment. There is a cooling fan and a switch installed on the inside of the protective side panel, and the input end of the cooling fan is connected in series with one end of the switch, and the other end of the switch is connected in series with the output end of the body. When the temperature of the equipment is high, the switch opens the cooling fan to enhance the cooling function of the equipment and improve the experience of using the equipment.

3.4. Design of physical sensing module for intelligent physical interaction device based on virtual reality technology

The recognition principle of this module is based on the virtual reality interaction system, the most critical part is the combination of both somatosensory technology and virtual simulation technology, in terms of function, the virtual simulation system is to realize the gesture recognition somatosensory interaction method with the human body movement this virtual realization of the scene in real time interaction [5]. The Kinect device has a great advantage in data acquisition and data optimization, with
simultaneous acquisition of RGB color image data and human joint point data, and easy matching of both data, and the Kinect has a good connection component with the Unity3D virtual development engine. The Kinect has a good connection component with the Unity3D virtual development engine. The user interacts with the virtual world, the Kinect recognition device extracts the user's motion information, extracts its features through a neural network, obtains classification results, and inputs the obtained classification information to the corresponding objects in the virtual scene through a specific interface to assign or modify their corresponding parameters [6]. The data interface is designed to achieve real-time data transfer between modules, to ensure data transfer and interaction events triggered between modules in the virtual simulation system, to modify and manage the system structure appropriately, and to optimize the performance of the system.

To facilitate the use of KinectV2 programs on the PC, Microsoft has released a software development kit to accompany the sensor, Kinect for Windows SDK Browser v2.0. This SDK provides drivers and technical documentation to support Kinect applications, and more importantly, it also provides API interfaces for secondary development to provide data streams including depth images, RGB images, audio, and skeletal tracking [7], and can be programmed in visual studio using C++ or C#, providing support for application development based on the KinectV2 hardware. According to the somatosensory game device design, wherein the processing module is conductively connected to a device body so that virtual 3D images [8] are displayed on a display screen of the device body, thereby allowing game participants to interact with the somatosensory game device through the display screen. According to the somatosensory game device design, further comprising an apparatus body, wherein the processing module is conductively connected to the apparatus body so that the virtual three-dimensional image is displayed on a display screen of the apparatus body, thereby allowing the game participant to interact with the somatosensory game device through the display screen.

![Figure 4. Key module design.](image)

4. **Technical indicators**

The intelligent physical interaction device based on virtual reality technology has improved three major modules on the original large physical interaction device, and the following are the improved technical indicators, as shown in Table 1 and Table 2.
Table 1. Control board performance indicators.

| Product Properties      | Parameter         |
|-------------------------|-------------------|
| Core Processor          | AVR               |
| Transfer speed          | 20MHz             |
| Program memory size     | 32KB              |
| Program memory type     | Flash             |
| ADC Resolution          | 10bit             |
| Interface type          | I2C, SPI, USART   |
| Operating supply voltage| 1.8V–5.5V         |
| Pin                     | 32                |

Table 2. Core module parameter indicators.

| Product Properties | LD-220MG | LD-1501MG |
|--------------------|----------|-----------|
| Size               | 40*20*40.5mm | 40*20*40.5mm |
| Weight             | 65g      | 60g       |
| Operating Voltage  | 6-7.4V   | 6-7.4V    |
| Rated voltage      | 6V       | 6V        |
| Blocking torque    | 20kg/cm  | 15kg/cm   |
| No-load current    | 100 mA   | 100mA     |
| Speed              | 0.16sec/60° (7.4V) | 0.16sec/60° (7.4V) |

5. Experimental results

In order to verify the effectiveness of the device, the team selected classes 20 Animation 1 and 2, and 10 students were randomly selected from each class. 10 students from class 20 Animation 1 learned the course content in a conventional way, and 10 students from class 20 Animation 2 learned the course by using the intelligent physical interaction device with virtual reality technology, and according to the students’ learning situation, each student's learning interest, motor interest, psychological anxiety, and emotional communication were evaluated respectively. interest, psychological anxiety, and emotional communication to evaluate, and the scores were: very dissatisfied (1-2 points), dissatisfied (3-4 points), normal (5-6 points), relatively satisfied (7-8 points), and very satisfied (9-10 points) in five dimensions, with a total score of 10 for a single item. The scores before the test are shown in Table 3.

Table 3. Test results.

| Grade Point Average | Pre-test | Post-test |
|---------------------|----------|-----------|
| Study Interest      | 4.2      | 5.0                   |
| Sports Interest     | 4.1      | 3.9                   |
| Psychological Anxiety | 4.2    | 4.3                   |
| Emotional Communication | 5.3    | 5.4                   |

Based on the experimental results, it was concluded that the dopamine secretion induced by exercise through the use of intelligent somatic interactive devices with virtual reality technology after
school hours could effectively release stress, increase interest in learning and exercise, and alleviate psychological anxiety, while students promoted emotional communication in the process of performing activities together.

6. Conclusion
In this paper, we designed a virtual reality-based intelligent somatosensory interactive device that uses human activities to complete the operation of the game, choosing Kinect somatosensory device and HTC VIVE head-mounted display to achieve a better effect similar to virtual reality, while the system also maintains compatibility with traditional gamepad operations, enhancing the immersive experience, making the user feel immersive in the somatosensory game, increasing the playability of the game, improving the fun, stimulating the imagination, while also allowing the user to invisibly enhance physical fitness, improve physical function, and achieve the effect of exercise and health. The system also maintains the compatibility with traditional gamepad operation, enhances the immersive experience, and makes users feel like they are in the game, increasing the playability of the game, improving the fun and stimulating the imagination, while also making users invisibly enhance their physical fitness, improve their body functions and achieve the effect of exercise and health. In addition to achieving the basic functions of conventional games, it also enhances the experience of the body settings and improves the external experience of the device. Finally, the body enhances the convenience of moving the device and the stability performance when it is fixed. The interactive device strategy designed in this study can better improve learners' motivation and contribute to the quality of teaching and learning. The research in this paper is mainly designed for practical courses and teaching, and the more theoretical courses are to be further verified, so in order to our research direction will mainly focus on the research in this direction.

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