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Application of Internet of Things and Virtual Reality Technology in College Physical Education

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ABSTRACT College physical education is an important component of the higher education system and national health plans. Promoting the scientific and modern construction of the physical education teaching system in colleges and universities is conducive to enhancing the science and effectiveness of higher education. Aiming at the problems of single teaching methods and insufficient long-distance teaching ability in the current physical education teaching process of colleges and universities, based on virtual reality technology, this paper designs and proposes a college physical education virtual reality system consisting of the Internet of Things, cloud platform and mobile client. This system collects relevant data from the Internet of Things and interacts with the virtual reality scene in real time, rendering the scene through the cloud and experiencing virtual reality through the mobile terminal. After the requirements analysis and system framework design of the virtual reality system for physical education in colleges and universities, the system's main functions and data warehouse, software architecture design and system testing process were carried out. Through the analysis of specific trial cases and user feedback information of a college, it shows that the designed virtual reality system of college physical education has good application and promotion effect, and provides a scientific reference for deepening reform of college physical education. Suggest.

INDEX TERMS College physical education, Internet of Things, virtual reality, cloud platform.

I. INTRODUCTION

In recent years, with the development of higher education and the deepening of reform and opening up, higher education reform is also in-depth and development. As an important part of college education system, the teaching effect of physical education is closely related to the future development of national health and national education. The current research shows that there are some problems in college physical education, such as the single teaching method, the lack of distance teaching ability, and the lack of thorough analysis of technical actions. With the all-round progress of the society, the rich demand of college students for the content and form of physical education is constantly increasing [1]–[3]. At present,

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the existing physical education teaching in Colleges and universities cannot satisfy the needs, which affects the deepening reform process of higher education. Therefore, it is particularly important to explore the physical education teaching methods that are in line with the teaching practice in Colleges and universities and can improve the teaching effect [4]. With the further development of virtual reality technology, Internet of things technology, cloud platform, mobile Internet and other advanced information technology, it brings an opportunity for the construction of College Physical Education Virtual Reality service system based on Internet of things and cloud platform, and injects new scientific power into the modernization construction of college physical education.

The Internet of Things is a new type of network that extends the traditional Internet to the real world. It covers multiple technologies such as radio frequency identification,

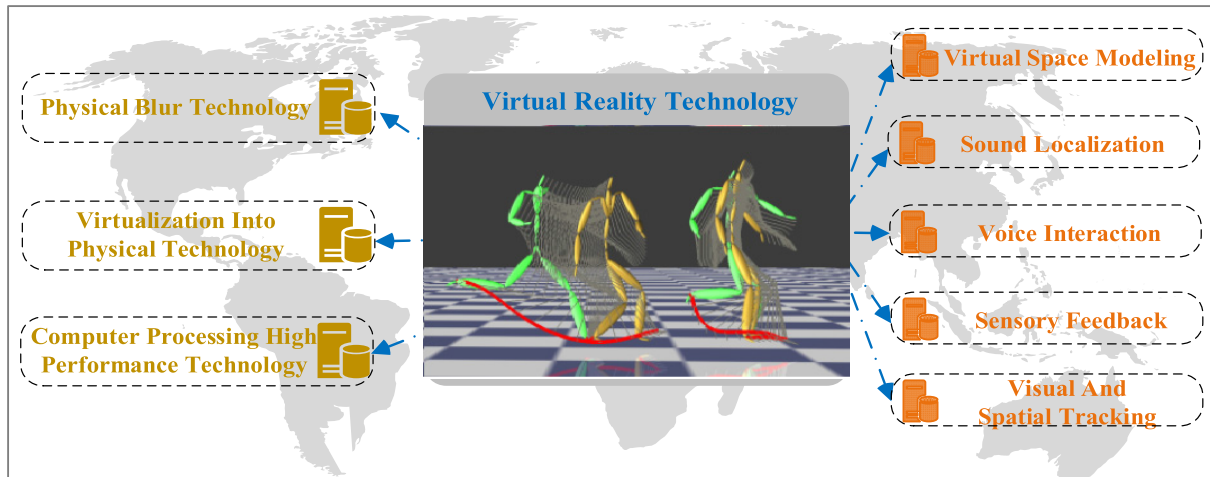


FIGURE 1. Schematic diagram of multi technology integration of virtual reality technology.

short-range wireless communication, mobile communication, sensor networks, real-time positioning, intelligent information processing, cloud computing, and big data. Research areas. Virtual reality technology is an emerging technology combining computer technology and simulation technology. Using computer to generate a simulation environment, with its multi-perception, interaction, immersion and other characteristics, it can simulate the real environment or things and present them to users [5]. In teaching, virtual reality technology can provide users with a virtual learning environment, provide rich sensory stimulation and natural interaction methods, and bring immersive learning experience effects.

At present, some scholars have discussed the application of virtual simulation technology in higher education system, and confirmed its effectiveness. Sampaio A Z [6] and other scholars think that virtual reality technology can be used in the development of higher teaching models related to architectural activities and roof design. The model has obvious advantages in the first degree of civil engineering as an auxiliary means of education. The use of the model in the development of educational application brings a new perspective to the teaching of civil architecture related disciplines. Martins *et al.* [7] Eric and other scholars believe that virtual reality technology can be used in the learning process of Portuguese spelling rules in language teaching in Colleges and universities through the strategy of planning, developing, deploying and evaluating education virtual reality applications. Kang and Kang [8] and other scholars believe that virtual reality technology as exercise content is effective in the sports experience and rehabilitation of the disabled. Effective VR movement for the disabled should be applied according to the type and severity of the disabled. Liwei [9] and other scholars think that virtual reality technology has the characteristics of high immersion, dynamic interaction and multi-dimensional information digitization, which is the need of the combination of modern sports development and technological progress. Virtual reality technology has been gradually applied to sports broadcast, theoretical digital

physical exercise and physical education. Zhang and Liu [10] Eric and other scholars discussed the application of virtual reality and physical system simulation technology in sports and sports training and the development of interaction methods. Applying simulation technology to directional motion, simulating directional motion in virtual environment, enables users to show scientific, reasonable and standardized basic technology.

However, a large number of rendering in the virtual reality scene limits the running environment to the expensive high configuration integrated machine, and it is difficult for ordinary machines to run. How to find a convenient and economic method of entity training and virtual reality scene interaction suitable for college groups is also a big difficulty for researchers [11], [12]. In view of the above problems, based on the virtual reality technology, this paper designs and proposes a virtual reality system for college physical education teaching, which is composed of cloud platform, Internet of things and mobile client. The system experiences virtual reality through cloud rendering scene and mobile terminal, and collects relevant data from Internet of things and interacts with virtual reality scene in real time. Through the analysis of a university trial case and the feedback information of users, the good effect of the virtual reality system is explained, in order to provide a scientific reference model and basis for the university physical education teaching system.

II. OVERVIEW OF VIRTUAL REALITY TECHNOLOGY

Virtual Reality Technology (VR), It is an important direction of simulation technology, a collection of simulation technology, computer graphics, human-computer interface technology, multimedia technology, sensor technology, network technology and other technologies, and a challenging interdisciplinary technology frontier discipline and research field [13]. It combines a variety of technologies: computer technology, multimedia technology, image processing technology, simulation technology and so on, thus forming a new technology involving simulation and computer field.

Virtual reality technology (VR) mainly includes simulation environment, perception, natural skills and sensing equipment.

The simulation environment is a real-time and dynamic three-dimensional realistic image generated by computer. Perception means that the ideal VR should have the perception of all people. In addition to the visual perception generated by computer graphics technology, there are also perception of hearing, touch, force, motion, and even smell and taste, also known as multi perception [14]–[16]. Natural skills refers to the human head rotation, eyes, gestures, or other human actions. The computer processes the data corresponding to the participants' actions, responds to the user's input in real time, and feeds back to the user's five senses respectively. Sensing equipment refers to three-dimensional interactive equipment. Virtual reality technology mainly consists of virtual reality, virtual reality and high-performance computer processing technology. Among them, physical virtualization refers to mapping out a multi-dimensional information space through the real world [17]. The key technologies include: virtual space modeling, voice positioning, vision and space tracking, sensory feedback, voice interaction, etc. the application of these key technologies can make the virtual space created by virtual reality technology more realistic, and the user's immersion and interaction better.

In order to realize the virtual reality system, this paper will develop the system based on unity3d. Unity3d is a game development tool developed by unity company in Denmark. It is a powerful cross platform development tool. As a professional enterprise level integrated application, it is also a powerful game engine with cross platform publishing, terrain editing, shaders, scripts, networks, physics, version control and other features [18]. With rich functions, unity3d has become the leader of virtual reality engine and game development engine once it is released.

III. DEMAND ANALYSIS OF VIRTUAL REALITY SYSTEM IN COLLEGE PHYSICAL EDUCATION

As a physical education system for colleges and universities, the virtual reality system of physical education in Colleges and universities is related to the quality of physical education in Colleges and universities. Therefore, the high efficiency and safety of the system has an important impact on the reform of higher education. In order to design the virtual reality system of college physical education correctly and understand the functions of the project and the users, it is necessary to analyze the needs of the system reasonably, so as to determine some important functions and processes in the process of system realization.

A. ON THE CONSTRUCTION OF VIRTUAL REALITY SYSTEM OF PHYSICAL EDUCATION IN COLLEGES AND UNIVERSITIES

The ultimate purpose of this system is to realize a virtual system of physical education teaching which integrates virtual reality server, cloud platform, Internet of things platform

and mobile client. The system needs to achieve the following goals: 3D scene modeling, virtual physical education teaching scene through physical engine, real-time video stream received by mobile client to experience virtual reality; building Internet of things teaching platform through sensors, real-time interaction with virtual reality to achieve the effect of Physical Education Teaching [19]; Build a perfect private cloud platform management system for user registration, allocation and management of cloud server resources. At the same time, it can also provide data storage services, management, storage and view of moving data.

The system consists of "one center", "five subsystems" and "three core business platforms". The whole system uses a data center for data storage, transmission, conversion and other operations. Virtual reality subsystem, IOT subsystem, private cloud system, decision subsystem and external interface subsystem constitute the whole system structure. Within the system, the system functions are divided into three modules, namely cloud platform, mobile client and Internet of things platform, each module is responsible for different functions.

The user management module of the cloud platform is responsible for the login of users. Users can register and log in. Users who do not meet the registration conditions are not allowed to register. In this process, the data is generated by the user, and then saved in the database. The server-side verification function is of great significance. The security and convenience of the system should be considered to prevent the leakage of data information and waste of resources on the server-side. The virtual reality server runs in the cloud platform and is started by the user control. The modeling of virtual reality will directly lead to the user experience. Through the Internet of things platform, users can interact with the virtual sports teaching scene to achieve the real-time control effect, just like in the real scene.

Virtual reality server runs in the cloud platform, including resource management, scene modeling, scene rendering and user interaction, which is the design focus of the system. The user module needs to manage users, including registration, login and movement information viewing. The client runs in the mobile device, configures the server information, connects with the server, and can send the sensor data of the current mobile device to the server. The Internet of things platform is responsible for data collection and real-time control of the virtual scene. The demand analysis of virtual reality system of college physical education is shown in Figure 2. At present, the virtual reality system of physical education teaching in the university has been connected with more than 150 internal work stations, and a hierarchical network radiating more than 90% of the university area has been initially established. The system is designed and configured with multiple IBM midrange computers, EMC memory, ATM optical fiber line, DDN special line, trunk line and other related equipment to provide equipment foundation for the operation of the system.

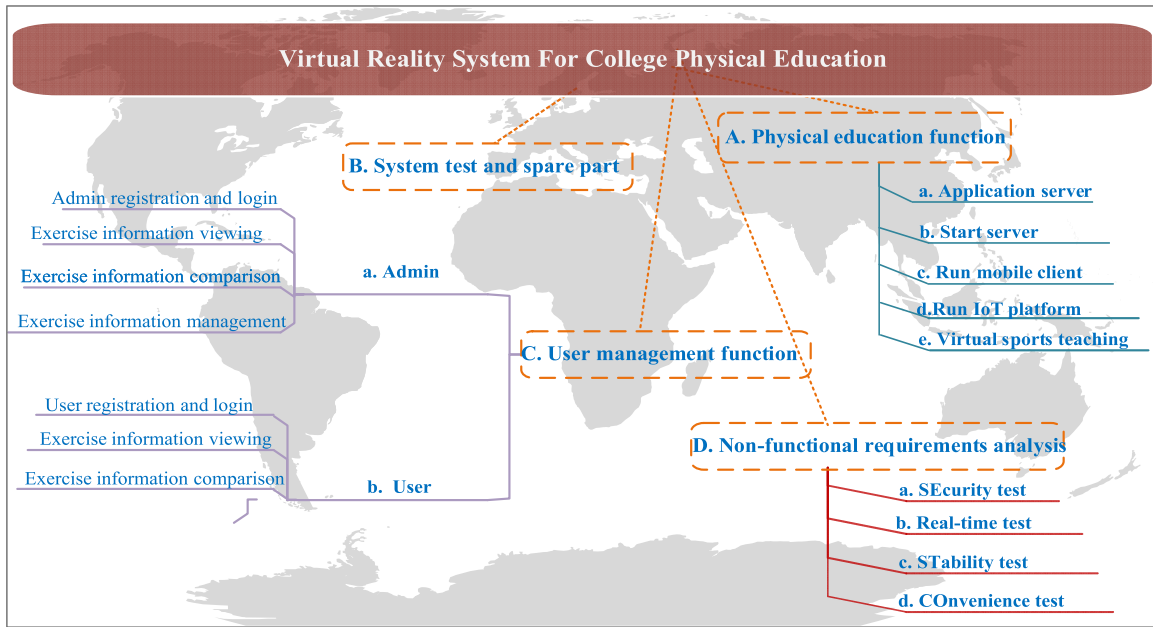


FIGURE 2. Demand analysis of virtual reality system of physical education in colleges and universities.

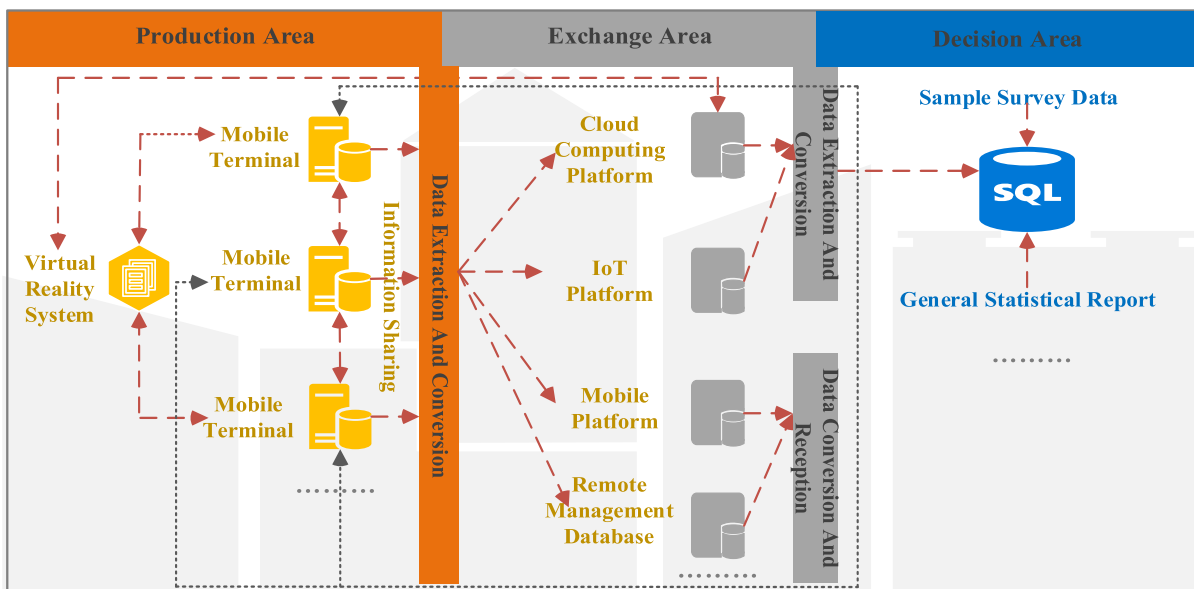


FIGURE 3. Logical diagram of data system in data center of physical education system.

B. DATA CENTER CONSTRUCTION

The sports and teaching data of the virtual reality system data center of physical education has reached 6000G since its trial operation, including the teaching and sports data of 50000 students and on-the-job teaching staff. The dense data center established by the system further ensures the stability of the system and the need for further processing of the required data. One disaster preparedness center, two data centers and two production centers constitute the information assurance system of the system. The disaster preparedness center is composed of 1 EMC cx700 disk array and 2 IBM p650.

The system consists of data production area, data exchange area and final decision-making area. The data generation area of the center includes the data accumulation of the University user’s body and motion information database. The exchange area of the center refers to the data accumulation generated by virtual reality interaction between mobile client and cloud platform database. The decision-making area of the center refers to the macro decision-making information database which can generate regular statistical tables and sample surveys. The above information database can cover the most comprehensive data and information of the college physical education teaching system. Using the above database

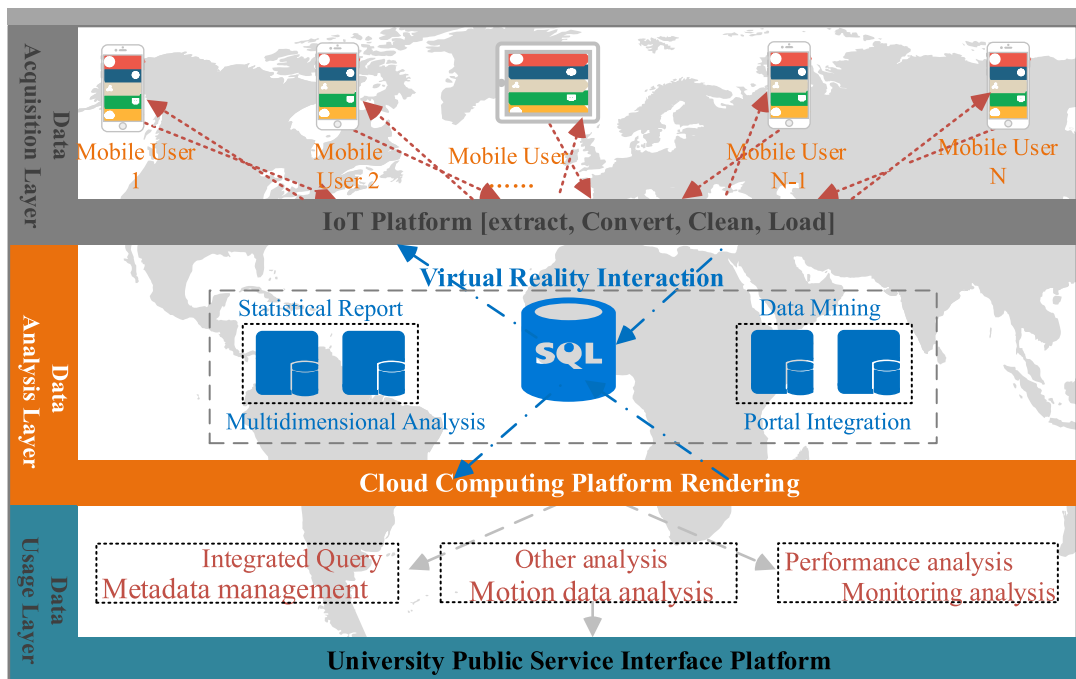


FIGURE 4. Overall structure of virtual reality system of physical education in colleges and universities.

for data analysis, mining and other operations, we can get a more accurate and effective data model, so as to provide effective suggestions for the development and reform of physical education in colleges and universities.

IV. THE DESIGN AND IMPLEMENTATION OF VIRTUAL REALITY SYSTEM IN COLLEGE PHYSICAL EDUCATION

A. SYSTEM DESIGN CRITERIA

In order to ensure the sustainable development and successful construction of the virtual reality system of physical education in Colleges and universities, the design of the system needs to be based on the relevant software design. The following criteria should be followed in designing the virtual reality system [20], [21]:

1) Safety criteria: as an important part of the higher education system, the physical education teaching system is closely related to the reform of higher education. The system involves various identities, movement data, personal privacy data, etc. The security of the system should be fully considered in the design of the system, which can effectively protect the data security and user privacy of the system.

2) Practicality criteria: on the premise of meeting the actual needs and functions of the system, the construction cost of the system should be reduced as much as possible to make the system easy to maintain and simple to use.

3) Extensibility criteria: as a physical education system for colleges and universities, the design of the system needs to take into account the development needs of colleges and universities for the future main business models, to fully consider the compatibility and upgrading of the system, and to reduce the coupling degree of modules as much as possible.

4) Unified quasi criteria: from the perspective of the long-term use of the system, starting from the overall system architecture, the system construction design structure, data model structure, data storage structure, etc. can meet the industry guidelines in the field of system development.

5) Open criteria: the virtual reality system of physical education teaching in colleges and universities should use standardized and unified data interface in order to exchange and share information and data with other information systems. At the same time, the system should be able to support multiple network systems and multiple types of hardware devices at the same time.

B. SYSTEM STRUCTURE DESIGN

1) SYSTEM ARCHITECTURE

In order to realize the development of virtual reality system of College Physical Education Based on Internet of things and cloud platform, this paper adopts three core modules: virtual reality system based on unity3d, Internet of things platform based on Arduino and private cloud platform based on OpenStack. The virtual reality system of physical education teaching based on the Internet of things, cloud platform and data warehouse cleans, filters, transforms and loads the external data collected by the Internet of things equipment and the data obtained from the business database, and finally stores it in the data warehouse in a unified format and expression [22], [23].

In order to ensure that the system can support the access, query and other operations of historical business data, the collected historical data should be saved and maintained for a long time. At the same time, the administrator can carry out

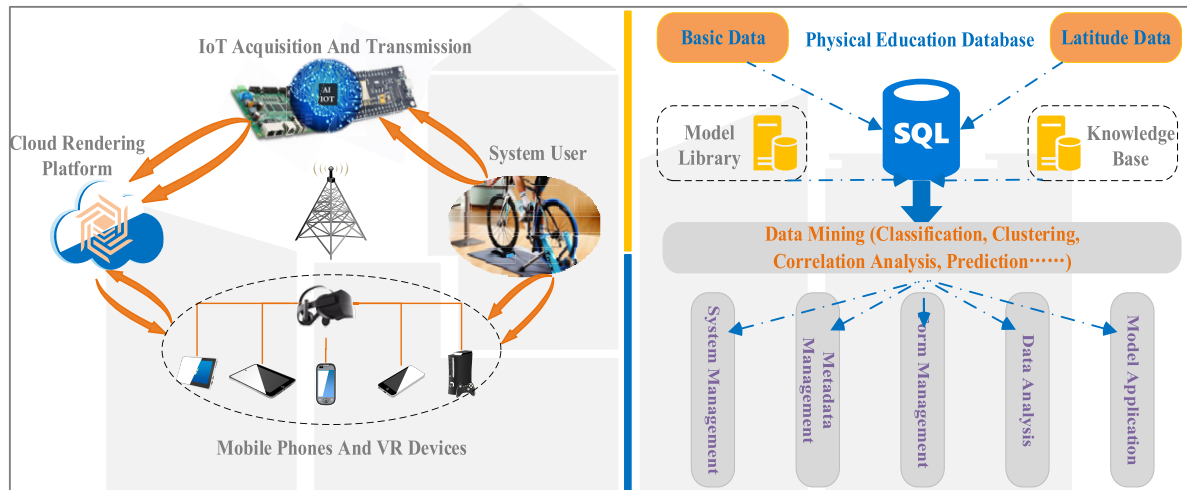


FIGURE 5. Software architecture of virtual reality system for college physical education.

statistical analysis on a large number of data in the database, build data model and other operations, and transform the data into knowledge that can carry out decision-making analysis.

Data management is the core content of virtual reality system of physical education. On the basis of the existing system, through the extraction, cleaning and effective integration of the original data, and according to the business theme of data re combination and determine the physical storage structure. System administrators or specific users can extract data from different data sources, and maintain and modify it according to the decision-making requirements of virtual reality system of physical education in colleges and universities, so as to serve the whole system [24].

The front-end tools and applications of the system mainly include a variety of data cleaning and analysis tools, statistical report tools, data mining tools and a variety of database based development technologies. Among them, the statistical analysis tool of data contains the following functions: multivariate analysis technology, cluster analysis and other technologies represented by principal component analysis and factor analysis. For businesses without mature models, statistical modeling can be designed according to the needs of business models.

2) SOFTWARE ARCHITECTURE

B / S structure is adopted in the software architecture of virtual reality system of physical education in Colleges and Universities [25]. This structure makes use of the technology of World Wide Web browser, which makes a part of simple thing logic priority in the front-end implementation, and the server is responsible for the more important thing logic. When the user needs to access the database, he sends the access request to the web browser through the browser. When the server receives the request, he responds the access information to the browser, and the browser can present the data to the user [26]. The system adopts three core modules: virtual reality system based on unity3d, Internet of things

platform based on Arduino and private cloud platform based on OpenStack. The system software architecture is shown in Figure 5.

Arduino was jointly created by Italian and Spanish engineers. It is a Simple I / O platform based on open source code. The platform consists of two parts: hardware and software. The hardware part includes MCU and circuit board. The software part is mainly an integrated environment based on C / C ++ language [27]. OpenStack is a cloud computing platform jointly developed by backspace and NASA to help service providers and enterprises realize cloud infrastructure services.

OpenStack adopts modular design, which consists of three modules. Each module corresponds to a service, namely, Nova, swift and glance [28]. Nova is the controller of the cloud platform. It provides management tools to deploy the cloud platform, including the operation of virtualization instances, network management, user control and access rights of the cloud. Swift is a large capacity, scalable, redundant and fault-tolerant object storage system, which supports a variety of applications, including graphics, video, file replication and archiving. Glance is the storage, query and retrieval system of virtual machine image. It can not only provide nova with image search operation, but also store image with swift service. The operation of virtual reality system needs not only CPU and network bandwidth, but also concurrent capability and high performance computing of GPU to improve rendering effect. The virtual reality system of college physical education adopts Oracle 10g, ETL tools and Oracle data mining tools [29]. Power designer is used as the design tool of data warehouse, and business objects is used for data warehouse modeling.

V. SYSTEM APPLICATION ANALYSIS AND EVALUATION

The above content describes the design and implementation of virtual reality system of college physical education. In order to verify the feasibility of the virtual system of

TABLE 1. Test environment of virtual reality system of physical education in colleges and universities.

Test Environment	Application Server	Database Server	Client
CPU	Inter L5520	Inter L5520	IOS A13
RAM	Kingston 2g	Kingston 2g	4g
Operating System	Centos-6.5	Centos-6.5	IOS
Middleware	Apache Tomcat 7.0.79		
Database		MySQL 5.5.28	

TABLE 2. Test list of virtual reality system of physical education in colleges and universities.

Test Items	Test Input	Test Output	Test Results	Remarks
System Registration	Enter Legal Data	Registration Success	Registration Success	✓
System Registration	Illegal Input Data	Registration Failed	Registration Failed	
System Login	Legal Username, Password	Login Successful	Login Successful	✓
System Login	User Name And Password Are Illegal	Login Failed	Login Failed	
User Review	User Information Is Legal	Successful Review	Successful Review	✓
User Group Management	Addition And Deletion Of Users	Database User Data Changes	Functioning Normally	
User Group Permission Configuration	Configure User Group Permissions	User Has The Appropriate Permissions	Permission Configuration Succeeded	✓
User Management	Add, Delete, And Change Users	User Data Changes Accordingly	Functioning Normally	
.....
User Role Configuration	User Role Configuration	User Has The Appropriate Permissions	Permission Configuration Succeeded	
IoT system management	IoT system Information Change	Database Corresponding Information Change	Successful Management	✓
Mobile management	Mobile Information Change	Database Corresponding Information Change	Successful Management	
Cloud platform management	Cloud platform Information Change	Database Corresponding Information Change	Successful Management	✓

physical education teaching based on cloud platform, and users can interact with virtual reality scene in real time through the Internet of things. We have built a private cloud platform server based on OpenStack, as well as mobile client and Internet of things system, and will test the function of the system, analyze and verify the practicability and efficiency of the system. The cloud platform is mainly responsible for the start-up and address allocation of unity3d server, and builds the cloud platform according to the cloud platform network topology. In order to realize the real-time interaction between the Internet of things and virtual reality, the Internet of things sensors are used to control the devices in the virtual scene, and the Internet of things platform is built.

A. SYSTEM TEST ENVIRONMENT

When testing the virtual reality system of college physical education teaching, the configured test environment is shown in Table 1. The application server and database server adopt inter L5520 CPU, centos-6.5 system and MySQL

5.5.28 database. The client uses the normal IOS operating system, equipped with inter coretm i5-3210.

B. SYSTEM FUNCTION TEST

After the realization of virtual reality system of physical education in Colleges and universities, the system function test is carried out first. The test results show that the system can meet the needs of physical education in colleges and universities. The main test is shown in Table 2. Among them, it mainly tests the functions of registration, login, user audit, user group management, user authority configuration, user role configuration, Internet of things system, cloud platform system, etc. The test results show that the virtual reality system of physical education teaching has been able to operate normally and deal with business operations.

C. SYSTEM PERFORMANCE TEST

In the process of system performance test, two indicators of system response time and packet loss rate are used to test the concurrent performance of the system and the performance

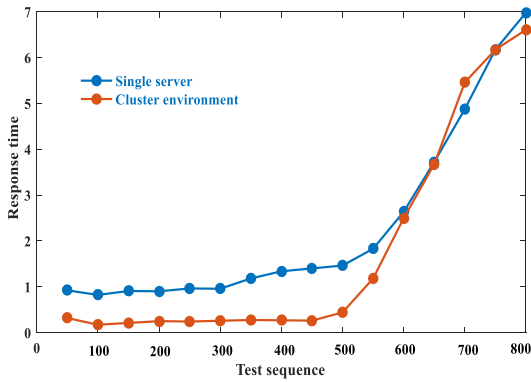


FIGURE 6. Response time test of virtual reality system of physical education in colleges and universities.

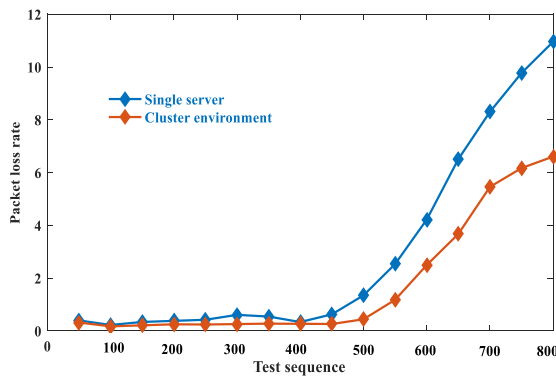


FIGURE 7. Packet loss rate test of virtual reality system of physical education in colleges and universities.

of responding to customers [30]. Limited to the influence of network environment and server performance on performance indicators, the network environment in the test process is selected as the internal network of colleges and universities. The server is a stand-alone server with a new system and a cluster with two stand-alone servers. The test tool is Mercury LoadRunner. Using Mercury LoadRunner to make concurrent access, we test the performance of the system in a single server environment and the system in a cluster environment, and collate the recorded data to get the results as shown in Figure 6 and Figure 7.

It can be seen from the test results that the number of concurrent services closest to the system is 400 in the single server environment and 700 in the cluster environment with two servers. The test results show that the system performance can meet the requirements, and can be reused in multi system environment, and can further improve the performance through later expansion.

D. USER FEEDBACK

Taking the user feedback of the virtual reality system of physical education teaching in the University as an example to analyze the effect, the evaluation data of users' use of different businesses of the system within 60 days are collected, including the change of users' satisfaction with different

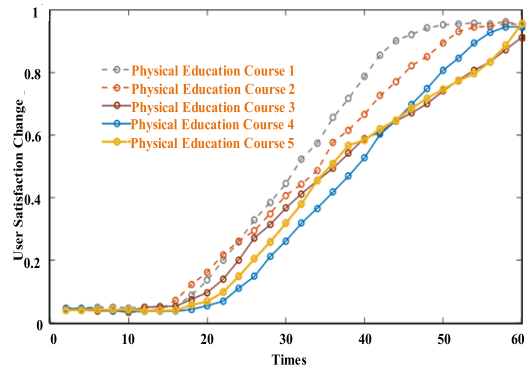


FIGURE 8. Change of user satisfaction of college physical education teaching system.

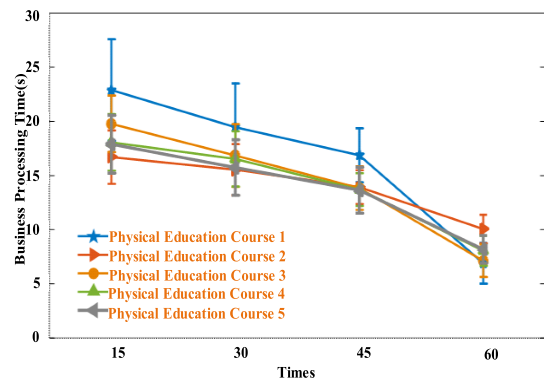


FIGURE 9. The change of the average waiting time for the start of physical education.

physical education teaching items of the system, the change of average waiting time for the start of teaching items, etc.

Among them, as shown in Figure 8 changes in user satisfaction, after the trial of virtual reality system of physical education teaching in colleges and universities, the satisfaction of a number of physical education courses in colleges and universities has increased significantly in a certain period of time. Virtual reality system of physical education teaching can simulate real environment or things and present them to users by virtue of its multi perception, interaction, immersion and other characteristics. In teaching, virtual reality technology can provide users with virtual learning environment, rich sensory stimulation and natural interaction mode, and bring immersive learning experience effect. In addition, as shown in Figure 9, the change of the average waiting time for the start-up of a sports teaching project, the virtual reality system for sports teaching can gradually reduce the waiting time for the start-up of the project and improve the satisfaction of the user experience under the rapid growth of the number of users due to the consideration of the expansibility of the system in the early design stage. Through the analysis of a college trial case and user feedback information, it shows the good effect of the virtual reality system, which is conducive to the further development of college physical education reform.

VI. CONCLUSION

As an important technical means to enhance the scientific and effective level of physical education in Colleges and universities, virtual reality system of physical education in Colleges and universities can strengthen the construction of teaching level and effectively promote the process of education reform. In this paper, the application prospect of virtual reality technology in college physical education teaching system is studied. Virtual reality technology, Internet of things technology and cloud platform technology are combined. The system experiences virtual reality through cloud rendering scene and mobile end, and collects relevant data from Internet of things and interacts with virtual reality scene in real time. Through the actual case analysis, it shows that the virtual reality system can provide a scientific reference model and basis for modern universities to use virtual reality technology to establish distance education information system. In addition, with an eye to the increasing and in-depth demand for physical education in Colleges and universities in the future, we will continue to explore and improve the existing physical education teaching system, so as to provide scientific support for the reform of physical education and the development of higher education in Colleges and universities with high-tech such as virtual reality.

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