# Design of Simulation System for VR Physical Education

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Keywords:     Motion Capture, Virtual Reality, Simulation Modelling.

Abstract:     This article introduces a design of "simulation system for physical education" based on virtual reality technology. The simulation system has interactive training function, achieving the self-learning of physical education and improving the level of learners.

## 1 INTRODUCTION

Virtual reality technology refers to the simulation system which creates and experiences the virtual world by using computer technology (Li Yan, Dong Fei, 2008). Virtual reality technology makes the most of the integration technology of computer's hardware and software, bringing users into the virtual world and making them to experience the "realism" of the virtual world. By breaking the constraints of time and space, users are able to feel what they can never experience in the real world. In practical application, virtual system has many output forms and is able to process multiple input devices. Meanwhile, it could be used for real-time interaction and collision detection, etc. With its continuous development, VR technology has been widely applied to various fields including military, online games, education, medicine and intelligent robots. Virtual reality technology reflects the integrated discipline of image and graphics processing, computer network technology and sensor technology. At the same time, with the development of business, virtual reality technology has been widely promoted and used. In foreign countries, this technology has been used in the teaching in universities. One good example is edx online virtual classroom. However, in China, the application of this technology for teaching has just started. In recent years with the investment of the government, certain progress has been made, but there is still a gap in terms of technology. The application of virtual reality technology in teaching will trigger a new teaching concept of education which will attract the attention of students and increase the efficiency of education and teaching, ultimately improving the quality of teaching.

## 2 SIMULATION SYSTEM FOR VR PHYSICAL EDUCATION

Simulation system for physical education reproduces the teaching experience and teaching intentions of PE teachers, the process of students' training and organizational plan for training by means of computer technology and virtual reality technology (Zhao Fenjun, 2006). Simulation system could analyze and compare the movement of trainees. Its development in recent years includes multimedia simulation and qualitative simulation, etc. The simulation system of VR is favored by trainees and sports departments because of its unique visual and audio effects. The most outstanding features of simulation system based on virtual reality technology are its multi-perception, immersion and interactivity. Generally speaking, traditional training carries out analysis by means of two-dimensional design, and it could only be analyzed from a single vision. For this reason, simulation system software based on virtual reality technology is very popular. At the same time, the purpose of teaching system is to build up a virtual learning environment, realizing the human-human interaction and human-computer interaction. Meanwhile, with the features of immersion and multi-perception, it is possible to enable students to study better with simulation software system.

## 3 COLLECTION OF MOTION DATA

With the development of technology, there are more and more measures to collect the sports data of

athletes. For example, principle of optics can be used for capturing the three-dimensional motion of athletes. The theory is to stall multiple different optical cameras and ask the athlete to wear motion clothing with optical radiation. Motion capture system will convert the pictures it captured into three-dimensional coordinates, which will be later connects to the anatomic points of human body model created by computer. Or the computer could be used to calculate the connecting parts or rotating parts which could be converted into animation. By using the functions of materials and textures of animation software such as MAYA, motions captured by those three-dimension coordinates are just like real motions.

# 4 DEVELOPMENT OF 3D ENGINE FOR SYSTEM SOFTWARE OF SIMULATION SYSTEM FOR VR PHYSICAL EDUCATION

As the most important platform in game development, 3D engine can design very realistic virtual environment, because it has the function of lighting effects. In addition, 3D engine can provide powerful physical environment for the system, making the virtual system more realistic and natural. Last but not least, as a development platform in common use for simulation software, the system can provide human-computer interaction, making the athletes study better. And the most important technology to realize the interaction is about objects picked and dragged by the mouse. The fundamental principle is to control the 3D scene by controlling the movement of the mouse in 2D screen.

# 5 SIMULATION MODELING OF VIRTUAL TEACHING SYSTEM

## 5.1 The Establishment of Human Body Model

To establish human body model, digital human skeleton model should be used to stratify the building of human body model, dividing the main skeleton into body joints, bones and center of gravity of human body (Zhan Shengli, 2006). The virtual human model has virtual skeleton and the surface model (skin, fine wrinkles, etc.) of surface human.

Therefore, it stratifies the virtual human model into two layers: skeleton and different parts. Surface model has 53 pieces of different sizes. Those pieces form public areas between parts where there is no double connection. Every part rotates around its joint, which result into different postures, making the digital virtual human movements even more realistic and perfect.

## 5.2 Modeling of System Software of Simulation System for VR Physical Education

Simulation technology using the computer is crucial to the modeling of software. To obtain the state change of the system, complicated law of motion should be described in terms of mathematical model or physical model. Then relevant calculated should be made by setting values and boundary conditions. Ordinary computer simulation system implementation includes system modeling, programming of the software, operation of the software, analysis of experimental results and the adjustment and improvement of the model. While the mathematical modeling of simulation system for physical education is actually carried out using the personification compositing software package VHSDK5.0 made by Chinese Academy of Sciences (Fu Qiang, 2013). The example of each motion is displayed by three-dimensional method and adjusted and designed by means of visual interaction design. After that the model will be verified using Euler's Theorem of Newton, obtaining standardized system design. In terms of the movement of human body, adjustments for the gestures could be achieved by selecting and dragging rigid body from XY window. By means of dragging, the variation quantity in X Axis and Y Axis could be checked. By using Euler's Theorem, the rotation angle of euler angles $\langle \alpha, \beta, \gamma \rangle$ in the directions of zyx could be obtained. Then the following relationship is obtained:

$$\sin \alpha = \frac{a\Delta x}{X} = \frac{(1-a)\Delta y}{Y}$$

$$\sin \beta = \frac{b\Delta x}{X} = \frac{(1-b)\Delta y}{Y}$$
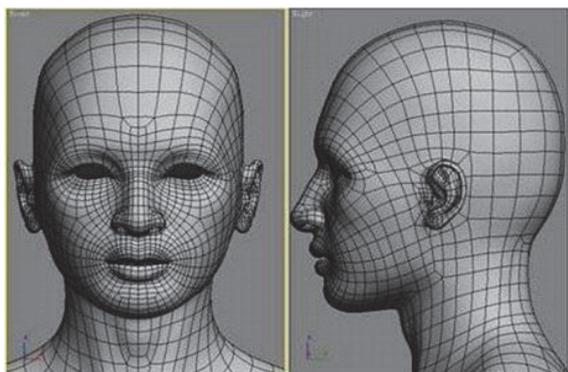
Figure 1: The establishment of three-dimensional human body model.

After obtaining the new gestures by changing the angle, new directions of motion could be achieved by offsetting mapping technique. The construction process is as follows:
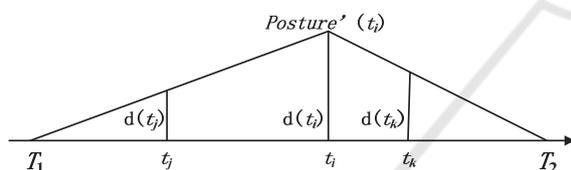


Figure 2: Construction process of creating the offset.

The last step is to determine the personalized equation and verify the model according to relevant parameter index of human body.

# 6 CONCLUSION

As the sports competition is becoming fiercer, the requirements for athletes are also higher and higher. Since simulation system based on VR technology enables the software to guide and teach the practitioners by using the data collection, 3D real-time rendering and interactive function, making the software more practical. Meanwhile, with the continuous improvement of computer hardware system and software system, development of simulation system based on VR technology is becoming more and more wide-spread and personalized, which adds to its commercial value.

# ACKNOWLEDGEMENTS

# REFERENCES

Li Yan, Dong Fei, 2008. *Design of Simulation System for Physical Education* [J]. Shandong Institute of Physical Education Journal, 94-96.

Zhao Fenjun, 2006. *Study on the Influences of Physical Exercises on College Students of China* [J]. Inner Mongolia Sport Science, 39—40, 2006.

Zhan Shengli, Application of Virtual Reality Technology in Online Education [J]. China Modern Educational Equipment, 68—69, 2006.

Fu Qiang, 2013. *Design and Development of Port Logistics Teaching Simulation System based on OSG* [J]. Laboratory Research and Exploration, 245—248, 2013.