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## Research into the Application of Virtual Reality Technology in Simulation of Sports Training

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**Abstract:** Virtual reality technology is one of the most popular simulation technologies both inside and outside China and increasing attention is paid to it in the world for its characteristics of high efficiency, safety and low cost. Virtual reality technology may improve sportsmen's scientific training level and athletic competition level when applied in sport training simulation. In this study, the current development of the sport (training) simulation technology based on the virtual reality is summed up, the key technologies of sport simulation are discussed; and the prospect of the application of the virtual reality technology in sport training simulation is studied.

**Key words:** Virtual reality technology, simulation, sports training

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### INTRODUCTION

The virtual reality technology relates to the fields of computer graphics, human-machine interaction technology, sensing technique, artificial intelligence and so on. It uses computers to generate the vivid three-dimensional senses such as visual, aural senses and the sense of smell so that human beings as participants may experience and interact with the virtual world by using appropriate devices. When the users move, the computer may carry out complicated operations immediately to transmit the accurate 3D images back as if the users were on the site personally. The technology integrates the newest development results of such technologies such as the computer graphics technology, the simulation technology, the artificial intelligence, the display technology and network computer technology and is a high technology simulation system generated by the aid of computer technology.

Virtual reality technology is a promising technology that has a great application prospect and has been widely applied in the field of sport training in developed countries. At present, in athletic sports, the countries all over the world focus their sport technology research on the two fields of video analysis of sport technology and three-dimensional simulation of sport technology (Ju and Li, 2003), wherein, the three-dimensional simulation of sport technology means that the details, including the excellent athletes' technical actions, the coaches' training intentions, the managers' organizational schemes and the training course of the sportsmen, are reproduced through the computer virtual reality technology to realize an

experimental technical science for interpreting, analyzing, forecasting, organizing and assessing the sport system.

### ANALYSIS AND DISCUSSION SECTIONS

**Simulation of the sport training system:** The modern athletic sport is quickly developing towards highness, difficulty, perfectness and sophistication which makes it more necessary for sport training to rely on modern technical methods. In order to best tap the potential of human beings, modern sport training needs continuous intervention of science and technologies. In this way it is necessary to apply the knowledge of the discipline relating to sport science and use scientific systematic methods to study the inherent laws of sports. Simulation of sport training system is an experimental technical science and is an experimental technical science to reproduce the coaches' teaching experience, the training intentions, the managers' organizational scheme and sportsmen's training course by using the computer simulation technique to interpret, analyze, forecast, organize and assess the training system. In recent years, the research into the system simulation focuses on the object-targeted simulation method, the qualitative simulation, the distributed interactive simulation, the visualization simulation, the multi-media simulation method, the VR-based simulation and the intelligent simulation and so on (Ji *et al.*, 2004). Unlike the object-targeted simulation method, the qualitative simulation, the distributed interactive simulation, the visualization simulation, the multi-media simulation method, the VR-based simulation lays emphasis on multiple perceptions, interaction, immersion and so on and sport

training needs the involvement of the sportsmen's multiple senses (visual, audial, touch and smelling), so as VR technologies further develops, the VR-based simulation will surely be widely applied in the sport field.

### **VR-BASED SPORT TRAINING SYSTEM SIMULATION**

**Functions required:** VR-based sport simulation system requires the following functions.

Constructing the virtual training scene, sport training scene requirements differ with the specific sports.

Sport data capturing. The sport data of the sportsmen are directly recorded through the sensor tracking equipment and are used for generating computer animation. The best advantage of this method is that it may capture the true sport data of human beings (including training apparatuses), so it is true to life and the training is ensured to be scientific.

Collection of physiologic and biochemical data: physiologic and biochemical data are very important as they can reflect the sportsmen's conditions, differ with the specific sports and sportsmen's physiologic and biochemical data may be collected through various sensors and intelligent apparatuses.

Recurrence and display of actions. Recurrence of actions is an important requirement for simulation of sports system, traditional photographic means can not achieve recurrence of actions under some conditions, for instance, the video effect of sailboard training technique is not so excellent.

Analysis of graphic training effect. The analysis method of graphic training effect is an error assessment method by using graphs to represent the error analysis results and generally is divided into an online assessment method and an offline assessment method.

**Constitution of system:** VR-based sport simulation system may be divided into the immersion-type sport simulation system and the non-immersion-type sport simulation system and the former needs the equipment such as the helmet-type three-dimensional display, the three-dimensional glasses, the data glove, the stereophone, the graphic workstation and the high performance computer and so on so that users may feel true stereoscopic vision, stereophonic audition and may interact with the virtual environment so that users may be completely immersed in the virtual environment. These systems have the characteristics of expensiveness of the equipment and high immersion while the non-immersion sport simulation system builds the virtual world involving rich auditory information and visual information by virtue

of the software technology and it has the characteristics of low cost and convenience.

**Key technologies:** Modeling based on physics and physiology. At present, the human body modeling in VR-based sport simulation system generally means the modeling based on human bodies' physical properties and physiological properties, wherein, the human bodies' physical properties mean human bodies' configurations, construction, quality, athletic abilities and adaptability and so on. The physiologic properties mainly include the human bodies' metabolism indices including the pulse, the blood pressure, the lung capacity and the functional indices of various organs and systems.

**Virtual human body animation. Since the 1980s, the human body animation has experienced four development stages:** kinematics control, kinetics control, athletic control and athletic capturing based on controller. The athletic capturing technology has the characteristics of high efficiency and being true to nature and so on and great importance is attached to it by the human body animation researchers.

**Capturing of sport data:** Sport capturing technology is to record human bodies' actions in a three-dimensional form by using sensors and then the computer drives the virtual human beings on the screen according to the data recorded (Ji *et al.*, 2009). The greatest advantage of the method is that true sport data of human beings may be captured and as the sport generated is basically the reproduction of the human beings' sport it is true to life and may generate many complex sports.

**Real-time drawing and interaction:** As the virtual sport simulation relates to the virtual scene and virtual human beings (sportsmen), in the virtual sport simulation environment involving virtual human beings, real-time drawing and interaction are extremely important. Real-time drawing technologies are divided into the visual judgment, levels of details and image-based drawing technologies. The concept of interaction herein mainly means the interaction of users with the system through virtual and real interaction equipment.

### **INTRODUCTION TO TYPICAL SYSTEMS-MASS CALLISTHENIC DRILLING SIMULATION SYSTEM**

**Group callisthenic drilling simulation system:** The simulation system consists of three sub-systems: The formation or pattern design system, the behavior and action generation system and the group calisthenics

formation or pattern change simulation system. The formation or pattern design system is responsible for designing the formations or patterns of each section of group calisthenics. The behavior and action generation system may edit the actions required for the group calisthenics according to the human bod data captured. The objective of the group calisthenics formation or pattern change simulation system is to change the original formation of the virtual human beings into the objective formation continuously. Firstly, the group calisthenics formation or pattern change simulation system defines the original position and the target position of the virtual human beings; secondly, the path is planned. Finally, the event-driven group calisthenics formation or pattern change simulation is achieved.

**Achieving technology:** The simulation flow is mainly divided into three steps: Path forecasting, path correction and action implementation (Fig. 1). During path forecasting, the group members forecast the positions to reach in the next time unit according to the user control information from their current status and events. Then the path correction phase follows when the group members acquire all of other members' action information within the collision overage and correct the positions to reach next according to the circumstances around to avoid collision. Finally, comes the action implementation phase, all of the members' paths are corrected to get the new positions. When all of the members begin their actions, the system enter the next forecasting/correction/implementation steps.

**PATH PLANNING METHOD**

**Individual path planning:** Individual path consists of several control points. The generation method of the individual paths of the system includes the linear generation method and the B•zier curve generation

method (Su *et al.*, 2004). The linear generation method of the individual path generates the path by using the linear interpolation method between the original position and the target position. Complex formation may be changed into several linear walking series combinations, the linear interpolation formula is as follows:

$$x = x(t) = (1-t)a+tb$$

Where in, a and b are the two end points of the path,  $t \in [0,1]$ .

In regard to the individual path B.zier curve generation method, smooth curve paths are fitted by using the B.zier curve formula according to the several path control points (including the original position and the target position) input by the users:

$$P_i^r(t) = (1-t)P_i^{r-1}(t) + tP_{i+1}^{r-1}(t)$$

Where in,  $r = 1,2,\dots,n; i = 1,2,\dots, n-r \quad t \in [0,1]$

**Group path planning:** The simple group path planning methods include the shortest path dispersion method, the dispersed (centralized) formation method and the parallel combination method and so on. By using the shortest path dispersion method, complex patterns are dispersed into scattered formation or other regular pattern (such as round pattern) in the shortest path. The dispersed (centralized) formation method is a generally used formation change mode, for instance, square or round formation is dispersed or centralized and for this formation change, a reference person and a reference line shall be designated (Zhong, 2009). The parallel combination means combing one queue with another parallel queue. The individuals in the queues move forward in parallel at the same speed.

The composite path planning method adopts the two simple path planning methods and then the planning results are combined (in parallel or series). In this way,

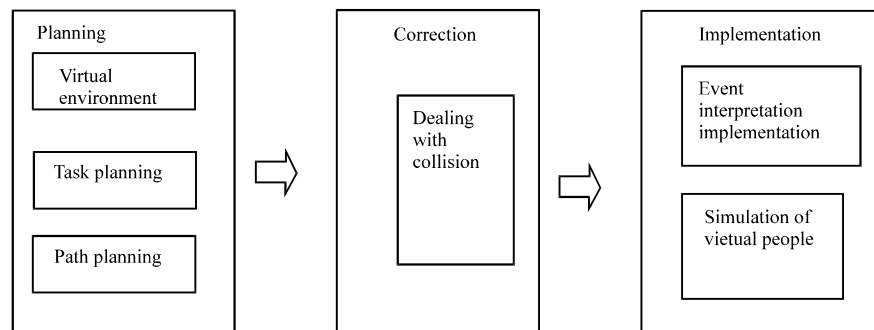


Fig. 1: Structure of virtual drilling system of group calisthenics

complex sports may be achieved, thus saving so many setting efforts in between and simplifying the setting and simulation courses.

### **RESEARCH CONCLUSIONS**

In this study, the status quo of research and development, the key technology and the typical systems of VR-based sport simulation are introduced. While the virtual reality technology is applied for sport technology analysis and innovation research, the experts in computer must keep close cooperation with the experts in sports to carry out the project to ensure the results are converted into driving factors in sport training and matches, namely, improving the sport achievements. It will surely help to promote our deep research in the virtual reality-based sport simulation technology. As all the countries throughout the world, in particular China, pay attention to and invest on the scientific research of competitive sports, the virtual reality technology frequently appears in the preparation for large sport competitions and in such competitions such as Olympic Games and so on.

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