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## Applications of distributed virtual reality in college experimental teaching

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### ABSTRACT

Recent years, favored by the rapid development of Virtual Reality (hereafter VR) and Computer Network Technology (hereafter CNT), Distributed Virtual Reality (hereafter DVR) has been greatly improved and applied in many fields, especially in college education. DVR has played an important role in college experimental teaching. Therefore, this paper, based on the elaboration and analysis of DVR, probes into its applications in college experimental teaching and proposes corresponding directions in college experimental teaching.

### KEYWORDS

Distributed; Virtual reality; Experimental teaching; Application.



## INTRODUCTION

Experimental teaching has gained an increasing importance in college education, especially in science and engineering. It is a main approach in cultivating the practical and innovative abilities of college students. Meanwhile, it can deepen the student's understanding of gained knowledge, hence to form practical and innovation abilities to analyze and solve the problems. However, restricted by the poor college atmosphere and experimental conditions, certain experiments cannot be conducted which leads to the decline of the experiment level. Promoted by the rapid development of VR and CNT, VR laboratory has emerged at the right moment to make up the shortcomings of traditional experiment and to extend the corresponding experiment space and time. Combining the modern technologies and keeping up with the pace, VR laboratory meets the demand of the development of experiment, broadens the horizons of the student and improves the education quality.

### BRIEF INTRODUCTION OF VIRTUAL REALITY

Virtual Reality (VR), sometimes referred to as artificial environment or immersive multimedia technology, is a new innovative and high technology<sup>[1]</sup>. It is a computer-simulated environment that can recreate mutual experiences and simulate the physical presence in places in imagined worlds. According to the specific demands, VR can recreate a virtual three-dimensional space and recreate sensory experiences, including virtual sight, sound, touch, etc. It enables the user to enjoy direct mutual experiences with the computer by observing things in the virtual three-dimensional space without any restrictions and delay. Combining CNT, sensor technology, image processing technology, Computer Graphics and intellectual technology together, it presents multi-dimension information synthetically.

Distributed Virtual Reality (DVR), a type of VR based on the web, is a fusion system which combines VR and CNT. In the actual applications, DVR, under the influence of web sharing, enables different users from different spaces to enter the same environment to communicate in text or sound, to study, entertain and train together, to fulfill the product design and to accomplish the mission together, etc.

### INFORMATION FILTERING

In the actual experiment, not every participant will need all the information. Information filtering is based on the different needs of the participants; the information is only passed to the needs of their participants. For some participants, the relatively useless information is filtered out; all the received information is he needs. For example, in computer courses circuit board wiring principle experiment, the circuit board can be divided into two work areas A and B which are not mutually linked, respectively, by two participants to take operations. During the experiment, the participants in area A do not need in time to see the progress of the work area B, it only needs to receive information about the area A, non-region A information can be filtered out. By filtering can reduce the traffic load of the network.

To achieve information filtering, we need to analyze need information based on what determine. Various attributes of virtual entities is the important information of entity type and status, the participants hope to attribute parameters by describing a virtual entity receiving or do not wish to receive, you can be certain of the information filtering. TABLE 1 exemplarily shows the attributes that can be used for filtering.

**TABLE 1 : Property can be used to filter**

Judgment basis	Property	Example
Virtual entity status	Location of the entity	the wiring hole in the B area, then for the participants to work in area A, the information about the wiring hole will be filtered out
	The entity color	if a participant only receive information about red connection, other colors connection information will be filtered out
	The length of the entity	if the connection has two lengths 15cm and 10cm, a participant may be required even about 15cm line information filtered out, only to receive information about 10cm connection
	.....	.....

## CHARACTERISTICS AND SYSTEM MODEL OF DISTRIBUTED VIRTUAL REALITY

### Characteristics of Distributed Virtual Reality

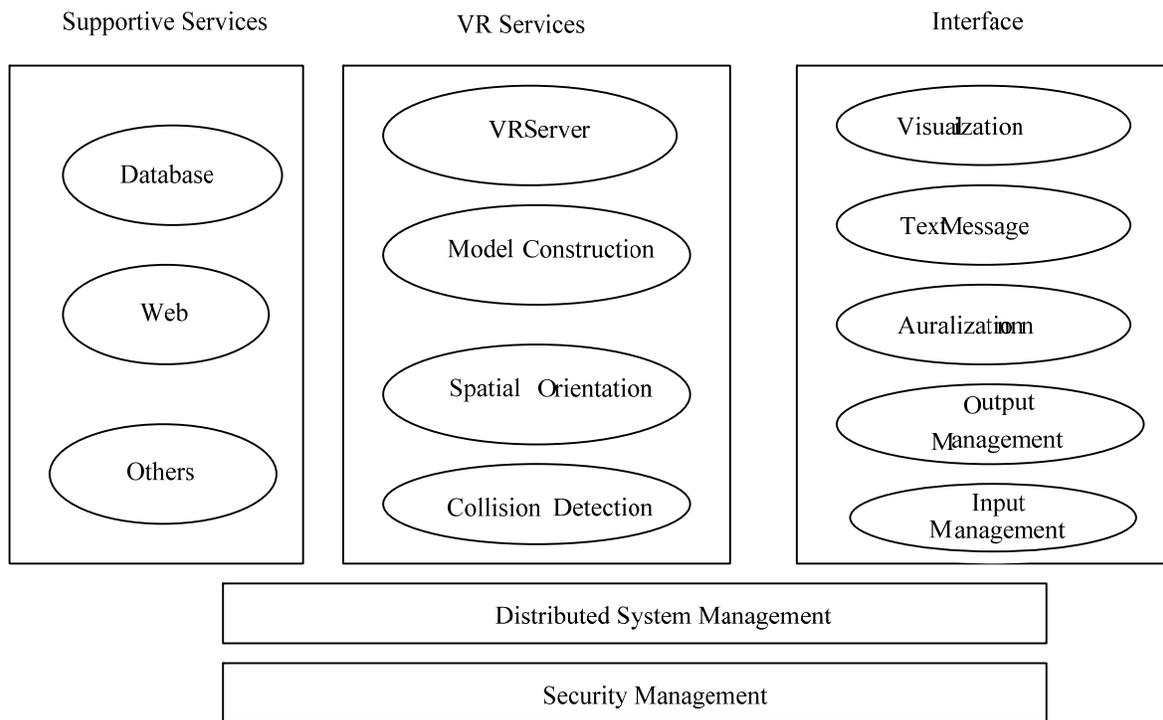
There are three basic characteristics: Immersion, Interactivity and Imagination<sup>[2]</sup>. Immersion is a perception of being physically present in a non-physical world. In line with human physical and mental characteristics, it is created by using computer technology and surrounding the user of the VR system in images, sound or other stimuli like interests to provide an engrossing total environment. Interactivity, which is different from the traditional three-dimensional static environment, refers to a mutual and open environment based on VR to monitor and control the system environment equipments to fulfill

human-computer interaction for users can actively control the environment or be influenced by the equipment. Imagination refers to the user's corresponding hallucination and the existence consciousness of the non-physical world. In addition to these three characteristics, there are other characteristics, namely, resource sharing, workspace sharing, mutual communication and the like.

**The Model of Distributed Virtual Reality System**

Communication, control equipment, displayer, data network as well as processing system are key components of the DVR system whose main structures are mainly replicated and centralized. On the basis of sharing system, the replicated structure requires each terminal to replicate the applications of the central server. However, the centralized structure only requires one single operation in the central server to control other terminals. Additionally, the sharing application system can be used as the process of conversation management as well as meeting management<sup>[3]</sup>.

Meanwhile, a sound DVR system should be equipped with a number of necessary functions, namely, managing the distributed system, constructing key non-physical world, securing the system, forming a friendly computer-human interface, providing supportive services, etc. Figure 1 is the reference model of a sound DVR system.



**Figure 1 : The Reference Model of Distributed Virtual Reality**

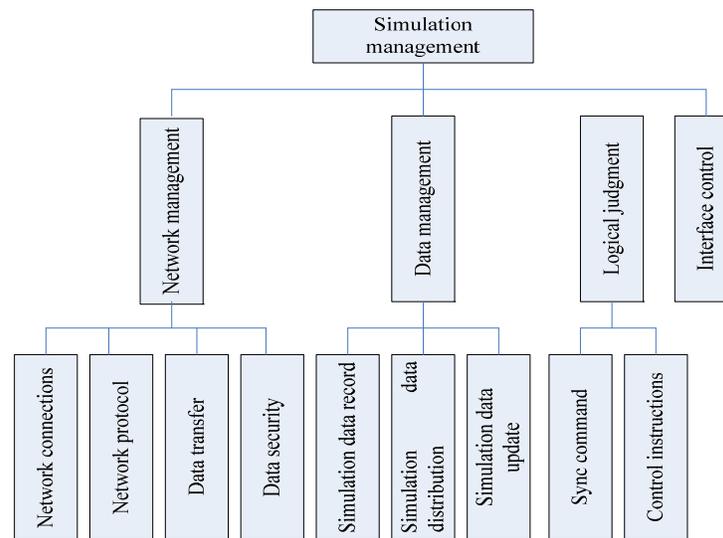
**Node modules**

According to the functional design and mission planning of simulation management node, it can be divided into four functional modules: network management, data management, logic and information management, which constitute shown in Figure 2.

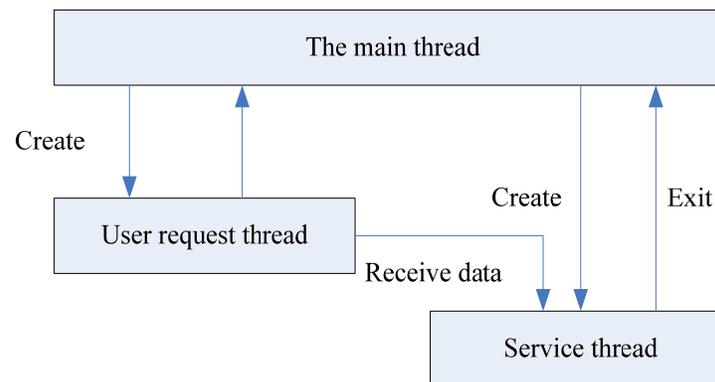
Among them, network management module provides network connectivity, network transmission, simulation node monitoring and other functions; processing data management module is responsible for each node in the system simulation data and back testing and the system re-analysis; logic module is mainly responsible for system synchronization control, ensure that the system simulation runs; interface control module is responsible for responding to user input, provide drivers for other modules to run the event.

**Simulation management node control mode**

The distributed virtual experimental system uses an event-driven mechanism, apply each node moves by other drivers for system simulation process, in order to ensure real-time performance of the system, using completed port mode design to achieve its network control functions. System communication section was composed of a user requests a service thread and CPU times by two users consult thread, the user requests a service thread is responsible for receiving user connection requests and initialization, the server thread is responsible for providing services to users. The main thread, the relationship between threads and service user requests thread shown in Figure 3.



**Figure 2 : Emulation management node function modules**



**Figure 3 : Management control pattern of emulation management node network**

The data mainly refers to the simulation data generated during a simulation run, staging in memory firstly, when the simulation run is completed, according to the analysis results of retrospective, make the choice of data storage or deleted, if you choose to store the external data, then have to consider how the database data files or conduct.

## APPLICATIONS OF DISTRIBUTED VIRTUAL REALITY IN COLLEGE EXPERIMENTAL TEACHING

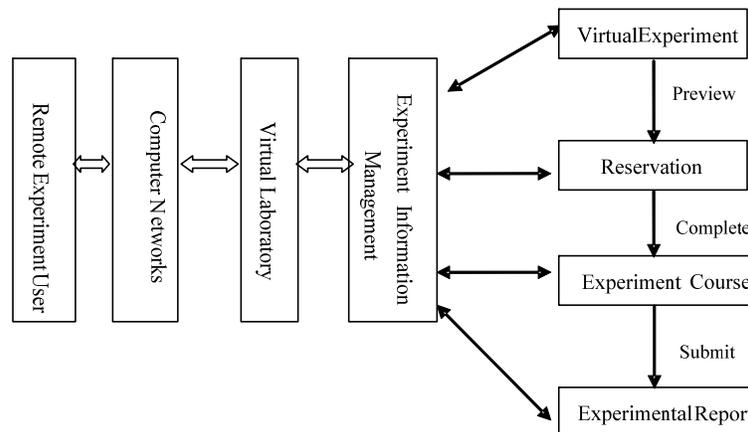
### Virtual Reality Laboratory

VR laboratory is a networking and open virtual experimental teaching system which is constructed on VR and CNT. Normally, it consists of three parts: equipment library, laboratory furniture and open laboratory management system. It provides certain teaching conditions to virtual experimental courses and enables students to connect, allocate equipments and apparatuses to carry out the experiment<sup>[4]</sup>. Compared with the traditional experiment, VR laboratory enjoys a number of advantages, such as, flexible interactivity, openness, resources sharing, low cost, promoting the creativity of students. First, it is an open experimental platform which enables teachers and students to freely conduct their experiments during their free time and communicate with each other without restrictions of space and time from the traditional experiment. Second, there is no need to purchase high-priced and high standard equipments, let alone to worry about the missing or damage of the equipment. Third, it stimulates the students' interest in experiment by presenting the experiment in a game-playing way and improves the student's innovative ability by allowing the user to change the experiment conditions freely in order to observe different experimental results. Figure 4 shows the principle of VR laboratory.

### Experiment Training Base and Digitalized Campus

It is necessary to establish college experiment training base based on the technologies of virtual reality, hardware-in-loop simulation and multi-media. By considering the state of course implement as well as students' experiments and the orientation of different majors, it is required to timely update the virtual equipments to construct corresponding virtual environment to ensure the promptness and advancement of experiment training base and to cultivate highly skilled graduates. Favored by its high-speed multi-media trait of data transmission, the parallelization and distribution of mass data processing

and storage provide an excellent research environment for college education and prompts the development of the educational technology.



**Figure 4 : The Principle of VR Laboratory**

### Functions of Distributed Virtual Reality Laboratory Completed by VRML

Network applications are essential in the VR laboratory. Virtual reality markup language (hereafter VRML), the 3D simulation of HTML, is a reasonable way to describe the virtual reality. The main working principle is to utilize the text formatting of VRML browser to implement the link and describe the non-physical world. With the help of VRML browser the real time control of 3D non-physical world can be fulfilled by explaining 3D scene. Meanwhile, in the VRML document, utilizing of one scene graph can describe the feature and structure of 3D non-physical world, such as, material, geometrical relationship, light and texture. Node is the basic unit of the scene graph. Different function is accomplished by different node which enjoys its particular type, name and domain<sup>[5]</sup>. For example, under the effect of node Inline, it can import a document from 3D scene graph to form a new node with the domain value of Geometry and the node of Shape and import the figure file into scene file. In addition, node Viewpoint can effectively control the spatial viewpoint of VRML browser and set different viewpoints in different places in virtual reality to ensure the browser always reaches the demanded places. Besides, node NavigationInfo construct substitutes in virtual reality for the browser to control it by setting the corresponding parameters of the substitute, such as moving direction, speed and size.

### Design of Reasonable Experimental Platform for Interaction

Education is a process of mutual communication, therefore, in experiment, interactions between the new concept of the original concept, students and teaching factors, students and media interface should be realized, and the input, output, sharing, feedback etc. of information and knowledge are to be achieved. In an experimental teaching, the application of distributed virtual reality technology to the construction of virtual lab enables students to complete the experiment in a virtual environment by means of technique operation. The above interactions are still needed to achieve in this experimental teaching. It's needed for the designer and explorers of virtual reality experiment to use scientific and reasonable information interaction method and principle, as well as design some feedback mechanisms to achieve information interaction. For example, experimental scene, presentation mode of information feedback, webpage interface, controlling mode of virtual components etc. should be designed reasonably. Among them, the experimental scene, which is the reproduction and simulation of the real scene in the virtual experiment system and the starting point of all experiments, is mainly composed of experimental equipment and laboratory environmental factors. The experimental equipment includes consumptive material and instruments, while the experiment environment consists of the office room, building, decoration etc. In the actual design, there should be a comprehensive grasp and reasonable design of equipment placement and the size of the model from the perspective of the experimenter. At the same time, learner's control of components is carried out manually in the real experiment, such as device connecting and power switch pressing; however, learner's control of virtual components is done by keyboard and mouse operation in the virtual scene. Since there are some operation limitation and inconvenience, the scene of real component operation should be enhanced so as to facilitate the implementation of migration movements.

## CONCLUSION

Together with the network's open, sharing and interactive features, the application of distributed virtual technology to experimental education in Colleges and universities, has broken down the traditional experimental space and time limitation, enabling the students to experiment at any time, improving the experimental environment and promoting the level of educational technology in the development of modern education. At the same time, in a virtual experiment where equipment and instrument are virtual, it helps to solve the unpredicted problems of danger and risk in the experiment sites,

making students understand more about the nature of the experiment, and through different experimental condition it improves the students' ability of solving problems and innovation.

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