Research on Virtual Reality Network Course Technology under Computer network technology

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Abstract. This paper explores the introduction of virtual simulation experiment as an auxiliary teaching method into the course teaching of computer network. This paper uses Packet Tracer virtual simulation software to explain the application of virtual simulation experiment teaching in computer network course in detail by introducing cases, analyzing cases, solutions, autonomous learning, basic steps, experimental tests and results. The practice proves that the virtual simulation experiment teaching is helpful to improve the teaching effect. This article through the image, intuitive, vivid graphical interface operation, convenient for students to understand and grasp the knowledge point.

Keywords: computer, Network technology, Virtual reality, Online courses.

1. Introduction

With the popularization of the Internet, information-based education has achieved good development. However, China has always been based on traditional classroom education and supplemented by online education. However, the sudden outbreak of COVID-19 has broken this education model. On January 29, 2020, the Ministry of Education put forward the policy of "no school suspension" in response to the epidemic of COVID-19, which made almost all schools, teachers, students and families nationwide invest in the largest online education classroom in history, and online education became the only education mode during the epidemic [1]. Governments, businesses, schools, teachers, students and families are all exploring the "grand experiment" of "online courses for all". With the good development of the epidemic prevention and control situation, schools began to resume at the end of May, and the era of "online courses for all", which has lasted more than three months, has come to an end. We need to timely summarize and reflect on the unique experience of this extraordinary period, which can provide useful reference for the future reform of classroom teaching methods and learning methods; It can provide effective enlightenment for special periods such as typhoons, thunderstorms, heavy snow, haze and other natural disasters or extreme weather caused by normal school cannot be provided. Augmented reality (AR) is a way to observe the world combined with virtualization technology. It mixes reality and virtual, uses computer technology to apply virtual information to the real environment, superimposes virtual scenes in the real environment seen by users, and presents a new environment with real effects for users. Augmented reality technology strengthens the interaction between people and the real world, improves people's perception of the real world, and has a wide application prospect in online course teaching.

2. Augmented Reality components

Augmented reality requires adding images to the real environment in real time and making these images adapt to the rotation of the user's head and eyes to ensure that the image is always within the range of the user's perspective. To build an AR system, you have to have three components: a head-mounted display, tracking and registration technology, and mobile computing capabilities [2]. The tracking and registration technology must be able to identify where the user is, track where the user's eyes and head turn, and map an image that is relevant to the real world as the user sees it at any given moment. Due to the complexity of tracking and positioning, the system will clear the virtual object when the mark is blocked, the light and dark changes in the environment, or temporarily moved out

of sight. Therefore, hybrid systems composed of various tracking and positioning technologies are used in most practical applications. Figure 1 is the experimental diagram of visual inertial tracking system based on marker.

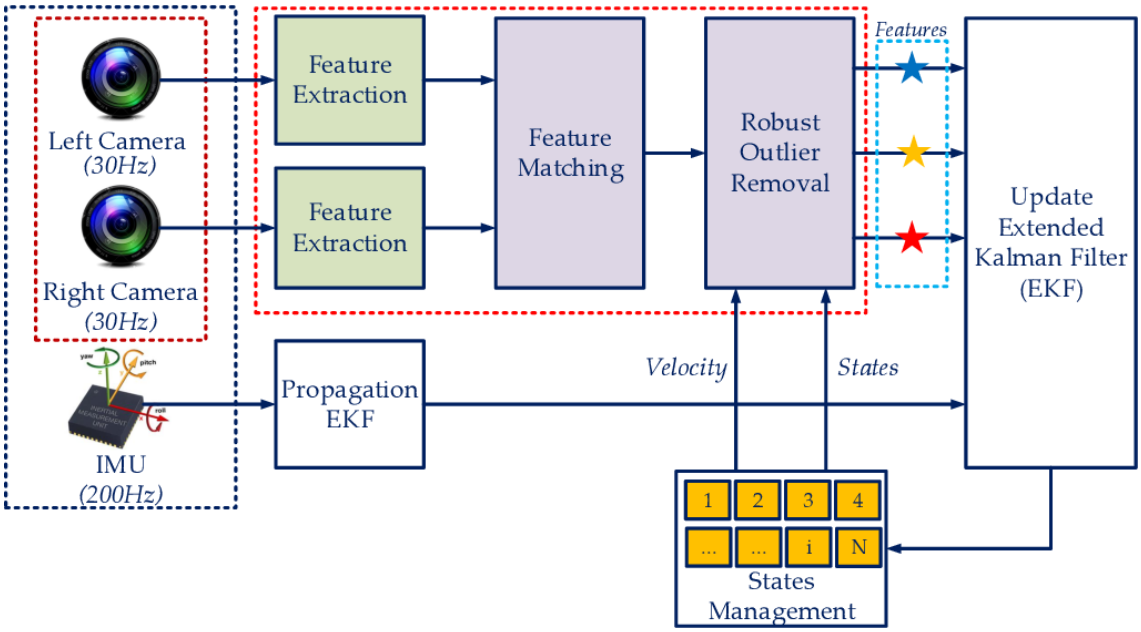

Figure 1. Experiment of visual inertial tracking system based on marker

3. Computer network virtual laboratory system

3.1. Design Ideas

The basic purpose of experimental teaching is to make learners learn the methods of experimental operation and verify the experimental results through demonstration and practice, so as to strengthen the deep understanding of the subject and impart the experimental methods and means of scientific research. The virtual experiment of computer network course makes it easier for the participants to understand the description of network in the textbook, understand the shape of network equipment and other external characteristics, and have a deeper understanding and understanding of the software knowledge of protocol installation and IP configuration, so as to better integrate into the society and meet the social needs. The main purpose is to enable students to complete the course experiments visually on the Internet, deepen the understanding and mastery of the teaching content, and cultivate the ability to practice and solve problems. We use asynchronous teaching mode in a variety of Web browsing, through the Internet and users connected to achieve remote communication [3]. The network adopts client/server mode, and the server side is responsible for the storage, maintenance and processing of data. The client is responsible for man-machine interface operation, sending out user requirements and displaying retrieved data. The whole system includes network course materials, experiment courses, experiment arrangement, virtual experiment, experiment report management, innovation practice, communication forum and user management and other content or function modules. For the experiment report management, exchange forum, user management of these subsystems, can use dynamic Web technology and the background database connected to achieve online management and other functions. The frame diagram is shown in Figure 2.

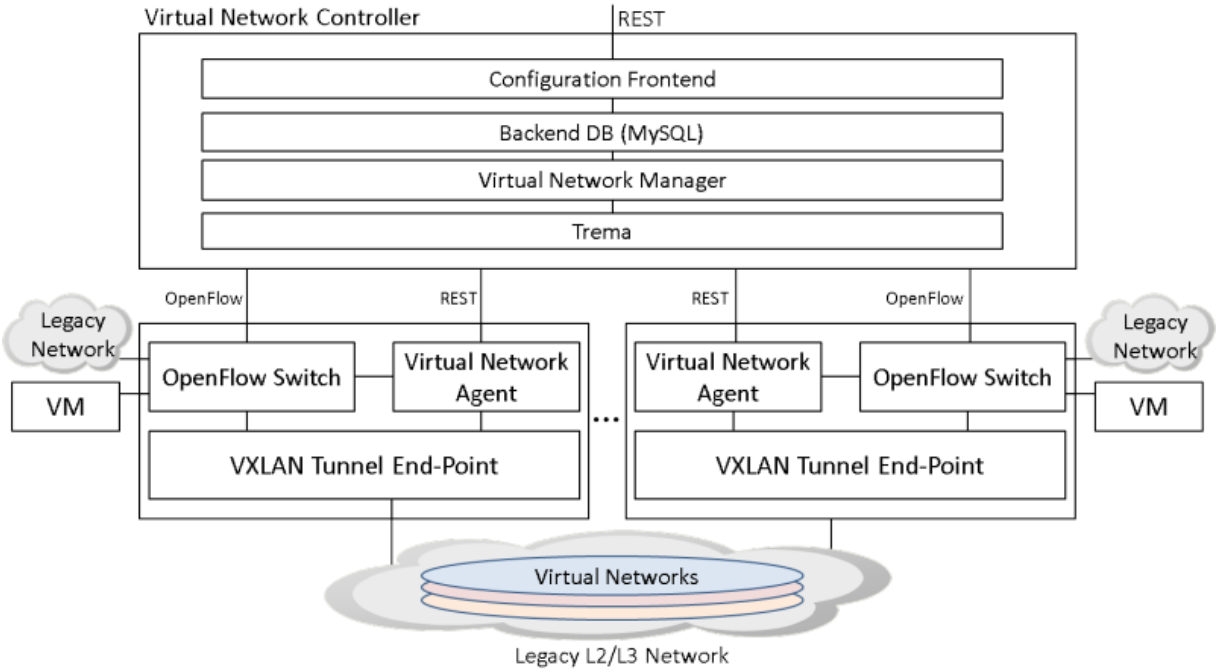

Figure 2. System structure diagram

3.2. Design of main modules

3.2.1. Laboratory Introduction

Introduce the experimental equipment, experimental contents, laboratory teachers, etc. For the listed experimental instruments and experimental content, you can enter the detailed project through the hyperlink.

3.2.2. Online course materials

This module will be the computer network course syllabus, network courseware, electronic teaching plan, video teaching and other resources to make, sort out, the theory and application of computer network related academic lectures [4]. Through this module, students can consolidate the effect of course learning, improve learning interest, improve knowledge structure, stimulate innovative thinking.

3.2.3. Experimental Courses

Computer network experiment tutorials are published in the form of web pages or electronic documents. Before the experiment, students can browse the experiment course to help them prepare for the experiment.

3.2.4. Experimental Arrangement

As a public teaching laboratory open to students, the system regularly releases experimental class schedule and graduation design arrangement to facilitate students to arrange their own learning. For unarranged students or experimental projects, students can make an online reservation application.

3.2.5. Virtual Experiment

The virtual experiment module is used to introduce the specific information of the experiment, and guide students to participate in the process of virtual experiment. The HTML web page text explanation, combined with FLASH and VRML, not only introduces the experimental content and experimental requirements in detail, but also vividly demonstrates the experimental equipment and experimental principles.

3.2.6. Experimental Report

Teachers use this module to view student lab reports, grade lab reports, and fill in comments. If teachers think students' lab reports do not meet the requirements, they can use the return function to ask students to modify the lab reports that do not meet the requirements. Until the teacher approves. Students use this module to submit lab reports and modify lab reports returned by teachers that do not meet the requirements.

3.2.7. Innovative Practice

In view of the interest of a wide range of students, have the ability to learn, but also opened innovative practice column. By selecting several novel research objects or experimental devices, students can carry out innovative practical activities under the guidance of teachers.

3.2.8. Exchange Forum

Including network theory teaching, computer network application, graduation design online guidance and other sections, for teachers and students to provide a platform for communication and learning.

3.2.9. User Management

User management has two aspects. (1) Teacher information management -- Used to add teachers, modify teacher information, delete added teacher records. (2) Class information management -- Manage all classes that need to use this virtual laboratory, including adding new classes, modifying existing class information and deleting classes. Generally, it is not necessary to delete effective classes. After adding a new class, click the class name directly to enter the management of student records in the class, including adding student records, modifying student information, and deleting student records.

3.3. Web-based virtual experimental environment

The advantage of the Web-based virtual experimental environment is that it runs on the campus network, uses TCP/IP protocol, is not restricted by region, and can be logged into the experimental environment to conduct experiments anywhere covered by the campus network. Generally speaking, there are four ways to implement Web-based virtual experimental environment:

3.3.1. Implementation method of Flash

Flash technology uses vector graphics technology to generate animation. Its advantage is that it occupies small storage space and is suitable for spreading on the network. But its object-oriented scripting language ActionScript to realize the interactivity is still insufficient, and ActionScript instructions can also complete the background calculation of the experiment, but because Flash uses vector images, insignificantly increased a lot of computation, it is difficult to complete a large number of images fast update. Therefore, Flash is only suitable for implementing relatively simple virtual experiments.

3.3.2. ActiveX implementation method

ActiveX is an architecture that allows software components developed in different programming languages to interact in a networked environment. Developers can create their own ActiveX control, which contains fragments or independent components, not only can be repeated in the program, but also can be embedded in other applications and become a part of it. This technology brings great convenience for the creation of virtual experiments.

3.3.3. Java implementation method

Java is a general network programming language, it not only has strong programming ability and good portability, but also has good stability and security, these features are very important for the construction of virtual experiments. But for a pure Java platform, the development and maintenance costs are high.

3.3.4. VRML implementation Method

Virtual reality modeling language --VRML is a graphic descriptive language for 3D modeling and rendering. It can be used to build interactive 3D multimedia picture on the Internet, which provides a new solution for Web-based virtual experiment. However, it still has some shortcomings in complex calculation, precise control and file operation.

4. System development and implementation

The computer network virtual laboratory system is finally realized in the form of a website. Each module content is made into a web page using DHTML, CSS, JavaScript, ASP.NET and database technology, including rich text, pictures, video, animation and other multimedia content. Web page production needs a variety of development tools, including professional website development software, image processing software, video editing software, animation production software and so on. In order to enhance the display effect of the web page, the use of some small web design auxiliary software is also very necessary [5]. For the development of virtual experiment module based on Web, there are many kinds of development technology and professional software, such as Java, VRML, Flash, Author ware and so on. Considering the characteristics of the subjects and courses of the computer network experiment, the technical characteristics of the development software and the characteristics of the use object, this system can use Author ware to develop the virtual experiment module. Author ware of Macromedia Corporation is a kind of multimedia creation tool based on flow chart. It has powerful function, rich function, flexible and simple programming, and is very suitable for developing interactive multimedia programs running on the Web.

Using virtual technology to build simulation practice teaching system, which can be combined with the content of the network course, set up different training program, to make the students understand the virtual platform experiment principle, training practical ability, the router simulation experience, virtual experience platform integrates routers, servers, switches and other equipment, support UDP, HTTP, DNS protocol. Students can create the network topology structure and complete the configuration, debugging and experience of network devices through the intuitive network packet transmission process [6]. At the same time, students can analyze the network performance in the network simulation environment configuration. In the network security simulation experiment, hundreds of different virus source programs are integrated into the virtual network platform in combination with the requirements of current network virus detection and control, so that students can understand the working principle and mode of virus transmission from code analysis.

In the virus simulation experiment, the class was divided into groups and the students were used as part of the attack and defense. The attacker starts the virus source program to invade the network. The protection team starts the vulnerability detection program, captures the virus program, analyzes the infection situation of the network system, and proposes countermeasures [7]. In the whole process, the students really realized the harm of the virus, and through the analysis and prevention of the virus, strengthen the application of network virus attack and defense knowledge.

5. Virtual reality network performance

When a non-cellular slave receives interference from a dominant node, its interference source is the same as that of a cellular user receiving interference from a non-cellular dominant node. Select a non-cellular communication slave node as the observation object. In this case, the primary node corresponding to the slave node is not an interference source. But fortunately, when $\Pi_{DB}^{'}$ point is randomly removed from the SPPP, the set of points still retains the characteristics of the original SPPP. Therefore, the interference source can still be represented by A, and its density remains the same as $\lambda_{DB}^{'}$.

The interference received by the selected non-cellular communication slave node from the dominant node is denoted as

$$P_{DI_{d2d}} = \sum_{d_B \in \Pi'_{DB}} P_{r,d_0,d_B} \tag{1}$$

Where d_0 is the position of the observed subordinate node, which is set as the origin of the two-dimensional plane in the analysis. Let's compute P_{r,d_0,d_B}

$$P_{DI_{d2d}} = \sum_{d_B \in \Pi'_{DB}} G_{d_U} G_{d_B} P_{td_B} \left| d_B \right|^{\alpha} 10^{\left(m_{d_0,d_B}/10 \right)} \tag{2}$$

Except for the variance of the gain of the receiving antenna and the shadow fading, the spatial distribution of the interference source and the formula form of the received signal are consistent, so the statistical characteristics of $P_{DI_{d2d}}$ can be obtained. The mean of $P_{DI_{d2d}}$ is

$$\begin{aligned} E\left[P_{DI_{d2d}} \right] &= G_{d_U} G_{d_B} P_{td_B} \lambda'_{DB} \mathrm{e}^{\frac{a_{dd}}{4}} \bullet \\ &\frac{2\pi}{\alpha+2}\left(R_{dd,\max}^{\alpha+2} - R_{dd,\min}^{\alpha+2} \right) \end{aligned} \tag{3}$$

Where, $a_{dd} = 2\beta^2\sigma_{dd}^2$, $\beta = (\ln 10)/10$. $R_{dd,\max}$ And $R_{dd,\min}$ respectively represent the maximum and minimum distances between nodes belonging to different non-cellular communication pairs. $R_{dd,\max}$ is the equivalent radius of $\mathscr{A}$, and $R_{dd,\min}$ is a very small value close to zero. The PDF and CDF of $P_{DI_{d2d}}$ are respectively

$$\begin{aligned} &f_{P_{DI_{d2d}}}\left(p_I \right) = \\ &\frac{\pi}{2}\lambda'_{DB}\sqrt{G_{d_U} G_{d_B} P_{td_B}}\ p_I^{-\frac{3}{2}} \mathrm{e}^{\frac{a_{dd}}{16}} \mathrm{e}^{-\frac{\pi^3 \lambda'^2_{DB} G_{d_U} G_{d_B} P_{td_B} \mathrm{e}^{\frac{a_{dd}}{8}}}{4 p_I}} \end{aligned} \tag{4}$$

$$F_{P_{DI_{d2d}}}\left(p_I \right) = \mathrm{erfc}\left(\frac{\pi^{\frac{3}{2}} \lambda'_{DB} \sqrt{G_{d_U} G_{d_B} P_{td_B}}\ \mathrm{e}^{\frac{a_{dd}}{16}}}{2\sqrt{p_I}} \right) \tag{5}$$

During downlink transmission, the interference source received by the non-cellular subordinate node consists of two parts: one is the macro base station, and the other is the non-cellular dominant node [8]. Since Π_{CB} and Π'_{DB} are two independent SPPPS, using the characteristics of SPPPS, we can know that Π_{CB} and Π'_{DB} combined also form A SPPP, which is denoted by Π_{DLi2d} here. However, since the transmit power of the nodes in Π_{CB} and Π'_{DB} is not the same, and the shadow fading between them is different from that between the non-cellular communication subordinate nodes, the densities of the two cannot be directly added together in the process of solving the statistical characteristics of Π_{DLi2d}. In order to further observe the relationship between the statistical characteristics of the interference and the density and transmission power of the interference source, (4) and (5) are rewritten here

$$F_{P_{DI_{c2d}}}\left(p_I\right)=\operatorname{erfc}\left(\frac{\pi^{\frac{3}{2}}\lambda_{CB}\sqrt{G_{d_U}G_{c_B}P_{tc_B}}\,\mathrm{e}^{\frac{a_{d_Uc_B}}{16}}}{2\sqrt{p_I}}\right) \tag{6}$$

$$F_{P_{DId\,2d}}\left(p_I\right)=\operatorname{erfc}\left(\frac{\pi^{\frac{3}{2}}\lambda_{DB}^{'}\sqrt{G_{d_U}G_{d_B}P_{td_B}}\,\mathrm{e}^{\frac{a_{dd}}{16}}}{2\sqrt{p_I}}\right) \tag{7}$$

Through observation, it can be found that if the transmit power and antenna gain of all nodes in Π_{CB} and $\Pi_{D}^{'}$ are considered to be "1" after merging, and the shadow fading as A random identifier is also incorporated into the density, then the equivalent densities of Π_{CBeq} and $\Pi_{Deq}^{'}$ are λ_{CBeq} and $\lambda_{Deq}^{'}$ respectively, and can be expressed as

$$\lambda_{CBeq}=\lambda_{CB}\sqrt{G_{d_U}G_{c_B}P_{tc_B}}\,\mathrm{e}^{\frac{a_{d_Uc_B}}{16}} \tag{8}$$

$$\lambda_{Deq}^{'}=\lambda_{DB}^{'}\sqrt{G_{d_U}G_{d_B}P_{td_B}}\,\mathrm{e}^{\frac{a_{dd}}{16}} \tag{9}$$

Therefore, if the transmit power and the effect of antenna gain of all nodes in SPPP merged by Π_{CB} and $\Pi_{D}^{'}$ are set to "1", then the density of $\Pi_{DLi2d,eq}$ is

$$\begin{aligned}&\lambda_{DLi2d,eq}=\lambda_{CBeq}+\lambda_{Deq}^{'}=\\&\lambda_{CB}\sqrt{G_{d_U}G_{c_B}P_{tc_B}}\,\mathrm{e}^{\frac{a_{d_Uc_B}}{16}}+\lambda_{DB}^{'}\sqrt{G_{d_U}G_{d_B}P_{td_B}}\,\mathrm{e}^{\frac{a_{dd}}{16}}\end{aligned} \tag{10}$$

Obviously, the CDF of the combined interference power P_{DLi2d} can be expressed as

$$F_{P_{DLi2d}}\left(p_I\right)=\operatorname{erfc}\left(\frac{\pi^{\frac{3}{2}}\lambda_{DLi2d,eq}}{2\sqrt{p_I}}\right) \tag{11}$$

Similarly, a PDF can be expressed as

$$f_{P_{DLi2d}}\left(p_I\right)=\frac{\pi}{2}\lambda_{DLi2d,eq}\;p_I^{-\frac{3}{2}}\mathrm{e}^{-\frac{\pi^3\lambda_{DLi2d,eq}^{\;2}}{4p_I}} \tag{12}$$

6. Conclusion

The construction of virtual laboratory of computer network course based on Web can not only solve the problem that many schools are unable to meet the requirements of network experiment due to lack of funds, but also meet the requirements of network course experiment in distance education.

Many domestic scholars and educators have done relevant research in this field and achieved certain results. The author got some inspiration in the actual work and study, consulted a large number of materials, and made some practical development attempts, received the expected effect.

References

[1] Sun Junhui, Gao Ling, Gao Quanquan, et al. Virtual chemistry intelligent classroom system based on Unity3D. Application of Computer Systems, vol.2021, 30, pp.78 - 83, June 2021.

[2] Li Linxia, Wu Chunwang. Design and application of network teaching system based on virtual simulation. Modern Electronic Technology, vol. 44, pp.48 - 54, February 2021.

[3] Jia Zihang, Bi Huijing, Bai Tingyu. Personalized recommendation algorithm for massive Open Online course resources. Automation Technology and Application, vol. 41, pp.49 - 51, August 2022.

[4] Sun Zhibo, Shi Chengkun, Li Ruihao, Pan Zhuowu, Zhang Mengsen. Exploration and research of drill press engineering practice teaching auxiliary system based on VR. Journal of Experimental Technology and Management, vol. 37, pp.24 - 27, September 2020.

[5] Yin Xingling. Curriculum design of Chinese Character teaching with virtual reality technology. Education Research, vol. 5, pp.29 - 30, January 2022.

[6] Zhang Juan, Han Xiaoyuan, Song Jinjun. Application of blended teaching method based on wechat platform in online public elective courses for medical students. Chin J Medical Education, vol. 40, pp.66 - 69, April 2020.

[7] Yang Yong, Sui Xiyun, Sui Zhen. Spatial evolution characteristics of virtual tourism flow network structure among provinces in China. Progress in Geography, vol. 41, pp.1349 - 1363, August 2022.

[8] Chen Kai-ling, Gu Wen, WANG Hai-qun. Virtual power plant operation and scheduling mode in energy block chain network. Journal of Systems Management, vol. 31, pp.143 - 149, January 2022.