ISBN: 978-981-18-3959-7
2022 the 12th International Workshop on Computer Science and Engineering (WCSE 2022)
doi: 10.18178/wcse.2022.06.042

Research on the Simulation Training System based on web3D Technology for Building a Large Virtual Reality Display System

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Abstract. The large virtual reality display system is one of the important equipment of virtual reality display, but the construction experiment of large virtual reality display system has some problems such as high cost and covering a huge area, and therefore it is difficult to conduct training universally. In order to solve such problems, this paper proposes a simulation training system of building a large virtual reality display system based on web3D technology, applying Visual Studio to build web platform, making virtual reality scenes through Max3D and Unity, and using database to record data. This system combines theoretical teaching with simulation practice, and has a relatively complete feedback mechanism for teachers and students. Students can use the mouse and keyboard to simulate and build a large display system in the virtual scene, and integrate the game scoring system to increase the fun of teaching and training. This system can effectively carry out the teaching of building large virtual reality display system at low cost.

Keywords: simulation training system, web3D, large display system

1. Introduction

With the development of network technology, in addition to the traditional face-to-face teaching and written learning, we can also find a variety of relevant materials or online platforms on the Internet to assist learning, but most of them are presented in the form of text, pictures and videos, lacking interactivity. For experiments with high practical operation requirements, it is difficult to be mastered completely just by watching videos. In addition, some real experiments have the characteristics of high risk, expensive equipment, occupying too much space, which limited by conditions, and making students unable to carry out the actual operation. At the same time, the world is still in the COVID-19 situation, so teachers and students may not be able to teach face-to-face or access to laboratories. Virtual simulation experiment teaching can effectively solve these problems in a low cost and little risk environment. Therefore, virtual simulation teaching based on web3D technology has important research significance and practical application value.

Before that, there are scholars to the virtual simulation experiment teaching conducted in-depth research. Harry Brenton et al.[1] proposed the anatomy teaching method for medical undergraduates using web3D, but lacks hands-on simulation practice by students. Anita Singh et al.[2] proposed a combination of VR video and traditional 2D video to teach bioengineering students in interdisciplinary teams to solve medical device-related problems, but the lack of interaction can only be used as a demonstration link in teaching. F Nainggolan et al.[3] proposed a teaching and training simulator for steel structure installation using senso gloves to enhance the reality of virtual environment through tactile feedback. Vishawash Kumar et al.[4] proposed a crystal structure teaching system using Unity and headgear. However, for students, gloves and head-worn devices will cause some extra burden, and student will be limited by equipment and environment when learning at home which is difficult to achieve the universality of teaching. ChinLun Lai et al.[5] constructed a virtual reality subcutaneous injection scenario for nursing skill training, including interactive self-training and skill evaluation. Zheng Hong Sim et al.[6] proposed a quiz-based interactive virtual reality simulation workshop for safety training and teaching. However, both of them lack previous theoretical guidance, only suitable for auxiliary teaching assessment. Venkata V.B. Yallapragada et al.[7] proposed a molecular visualization tool for biology education based on virtual reality and adopted game mode to build molecular model in The Style of Lego, which increased the interest of learning. It can be seen that good

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virtual simulation experiment teaching needs strong interaction, integrated teaching process, real-time online learning results inspection and feedback, and gamification to motivate users to learn.

3D visual display system is one of the important hardware devices of virtual reality technology. Virtual reality scenes are presented on large 3D visual display equipment systems, which will have stronger 3D visual effects and avoid the discomfort caused by wearing VR helmets and glasses for a long time. However, it is with high price and occupying too much space, and the cost of assembly training is high, and there is no corresponding web3D training at present. Once the display system is defective, it will seriously affect the use of virtual reality system, which requires an online web3D simulation training system to train personnel, so as to achieve the purpose of timely maintenance and installation.

Therefore, we propose a simulation training system of building a large virtual reality display system based on web3D technology. Among them, database is applied to manage information, Unity3D is added to make a simulation setting scene with strong interaction and automatic scoring mechanism is integrated into the system to reasonably evaluate students' experimental situation and reduce the workload of teachers. Teachers can check students' scores and experimental reports, and give reasonable marks to open questions, or adjust the unreasonable scores scored by the semi-open questions system.

2. Functional Structure and Implementation Process

2.1. Function Module Division

The simulation training system of building a large virtual reality display system based on web3D technology proposed in this paper can be mainly divided into four modules: information management, 3D virtual simulation training, documents and web pages, as shown in Fig.1.

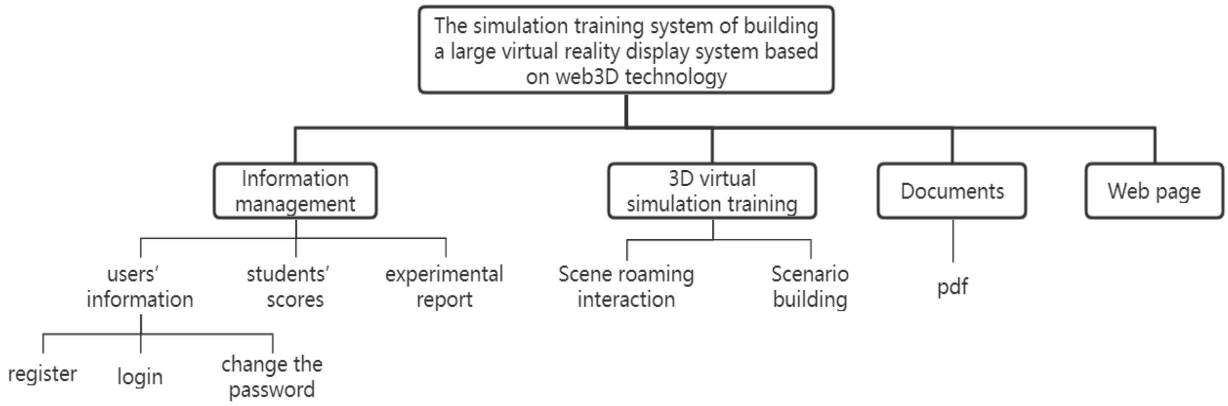

Fig. 1: System module framework

2.2. System Function Flow Chart

According to the above functional modules and teaching process, in order to better human-computer interaction and feedback between students and teachers, the function flow chart of the system proposed in this paper is shown in Fig.2.

In students' part, students can according to the navigation bar, study the experiment instruction and equipment cognitivein in the virtual simulation way. And learning outcomes can be checked through virtual building the equipment, test and the experiment report which will be marked by system immediatel. The open questions of the experiment report were given to teachers for correction again. Students' personal information is displayed in the left column of the interface. Through the button, students can view their current score, modify the password and log out.

For the teacher side, according to the navigation bar, the teacher can correct the experimental report submitted by the student and check the student's score information. The teacher's personal information is also displayed in the left column. Teacher can change the password and log out by clicking the button.

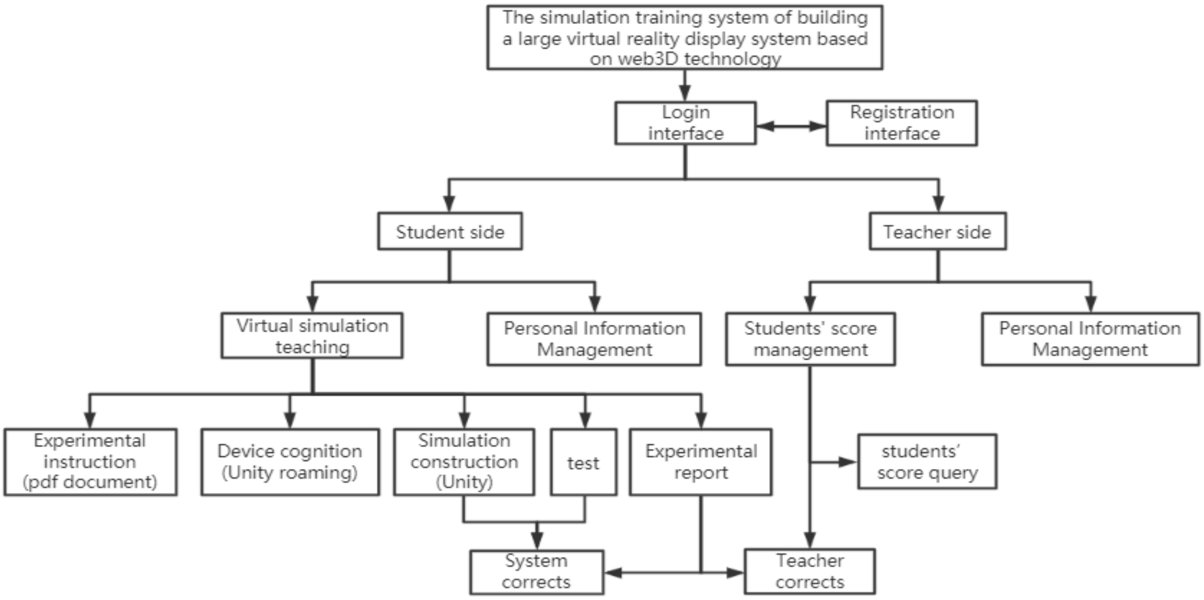

Fig. 2: System Function Flow chart

3. Concrete Module Function Realization Method

3.1. Information Management

If a large number of users access the system, it will cause information confusion, so users and their related information should be managed in a unified manner. Users can register personal accounts, login and password change on the system platform with their personal information. According to the user type, all users are divided into students and teachers, and given different system function permissions.

This paper uses SQLServer2008R2 as a database to achieve this part of the function, the realization process can be divided into four steps, the specific process is as follows. (1) Under the database, four tables named student, teacher, report and score are established to respectively store students' personal information, teachers' personal information, experimental reports submitted by students and scores obtained by students. (2) Students and teachers register their personal information and store it in the student and teacher tables accordingly, so as to obtain their own personal account and password, which can be used for system login and password modification. (3) After students complete the simulation training, test and experimental report, these scores and the content filled in the experimental report are respectively stored in the score and report tables, so that they can check scores and amend the experimental report repeatedly. A sign attribute is set in the report table to mark the revision progress of the experimental report and control that the experimental report can be modified before the teacher reviews it. (4) Combining the information stored in the four tables, teachers can view the information, grades and experimental reports of students under their management, review and score the experimental reports, and update the corresponding score attributes in the score table.

3.2. 3D Virtual Simulation Training

In order to increase the practical content and further consolidate the theoretical knowledge, 3D virtual simulation is carried out on the large virtual reality display system. In this module, students can realize two sub-function operations: roaming interaction and scene building. Roaming interaction enables students to better understand the appearance and function of the specific component models in the large virtual reality system. Scene construction to strengthen students' hands-on ability, understand the construction process of large virtual reality display system, as part of the assessment of the whole training system.

This paper applies 3Ds MAX2020 and Unity5.6.7 to establish a model and realize the simulation interaction of large virtual reality display system. The realization process can be divided into four steps, the specific process is as follows. (1) Make a 3D model in 3Ds MAX2020 and save it in .fbx format. (2) Import the 3D model into Unity5.6.7. (3) Write script files using function, such as Invoke() and iTween(), to realize roaming in the scene, so that students can immerse themselves in learning the composition of the large display system and have an overall perception of the whole system. (4) For the equipment building part, add UI interface board on the scene, set multiple buttons of the building steps and score bar. By writing the functions, such as AddListener() and onClick(), actting on each button in the script file. Set the correct order of the building operation and record current number of steps through a sign to determine whether it is the correct operation. When students operate correctly, the result of this step will appear in the scene and the score will be obtained. Otherwise, 5 points will be deducted and students will be asked to operate again.

3.3. Documents

Convert the Lab Instruction .doc document into .pdf format, including the experiment purpose, equipment, process, precautions, etc. Sharding materials is convenient for students to study independently, review theories and download for consolidation after class.

3.4. Web Page Interaction Function Realization

Through the Web page, The above three modules are connected, and displayed with reasonable and beautiful vision for users to switch function modules. This paper applies Asp.net of visual studio2019 to the UI interface design of the web page, writes the underlying C# code, and switches the page module by clicking the button or hyperlink to achieve the above functions.

Taking the students’ homepage as an example, the realization process can be divided into five steps, the specific process is as follows. (1) The page consists of studentmenu.aspx and studentmenu.aspx.cs files. (2) in the .aspx file, through <div>, <a>, <Label>, <ImageButton>, <iframe> and other tags with their attributes, the page layout mainly divided into title bar, navigation bar, left bar, right bar and subscript bar five areas. By setting background-image and background-color, the interface looks more beautiful. (3) The navigation bar is composed of 5 hyperlinked pictures to guide students to learn and test. The hyperlink is realized through the <a> tag, the relative storage path of the .aspx file of the module subpage is filled in the href attribute, and the display area of the subpage is set to the right column. (4) The left column is used to display student’ s information and contains two hyperlinks and a picture button. Hyperlinks are implemented in a similar way, in the right column showing student scores and changing password subpages. The image button is used to log out. Write Logout_Click() function in the studentmenu.aspx.cs file to switch to the login page after clicking the button. (5) The display of student information is realized with connecting the database. In the Page_Load() function written in the studentmenu.aspx.cs file, link the dataset added in the web.config file, according to the Session created when users login, write the sql statements, search in the student table, replace the Text value of the <Label> tag in the studentmenu.aspx file used to display student information with the query result, so that the realization of displaying student information is finished.

4. Experimental Results and Analysis

When users enter the homepage of the website, that is the login interface, as shown in Fig.3. At the same time they can see the number of current online users. Select the student or teacher identity, fill in the ID, password and random verification code, click login button to enter. If the entered user name, password, or verification code is incorrect, a message is displayed asking you to fill again. If the user has not registered his/her personal information, click the registration button to enter the registration interface.

In the registration interface, as shown in Fig.4, select the user’s identity and fill in the name, ID, password, school and other identity information. Click the registration button to complete the registration and jump to the login interface. If click the back button, you will go back to the login page directly.

Fig. 3: Login interface

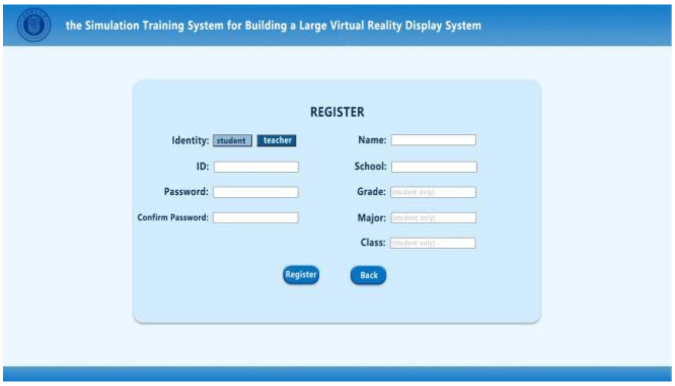

Fig. 4: Registration interface

Fig. 5: Student homepage

4.1. System Student Side

If the user is a student, after login, the student homepage will be displayed, as shown in Fig.5. In the navigation bar, there are five teaching and inspection buttons: experiment instruction, equipment cognition, simulation construction, test and experiment report. The left column is the display panel of students' personal information, and there are three functional buttons: query results, modify passwords and log out. If you click the logout button, the login page is displayed.

Click the “experiment instruction” button to display the PDF document of the experiment instruction in the right area to guide students to learn, as shown in Fig.6.

Click the “device cognition” button, and the scene tour made by UNITY is displayed in the right area. Student users can more intuitively and immersively tour the scene of large virtual reality display system to learn the composition of the large display system, as shown in Fig.7.

Click the “simulation build” button, and the simulation build subpage made by UNITY is displayed in the right area, as shown in Fig.8. The simulation building scene is an empty workshop, and the left side is the operation menu with multiple operation buttons. Students can choose any button as the next operation. If the operation is correct, the real-time score bar in the upper right corner will be given extra points and congratulatory sound effect will play; if the operation is wrong, 5 point will be deducted accordingly.

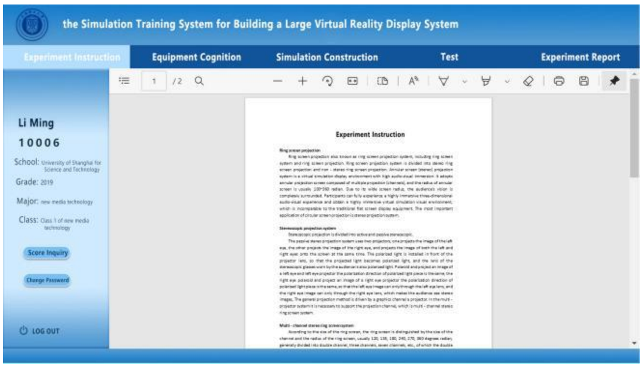

Fig. 6: Experimental instruction

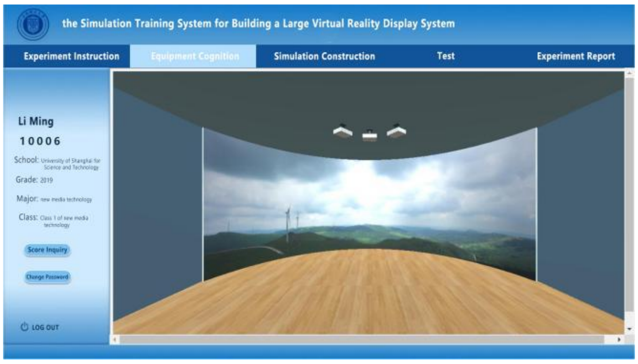

Fig.7: Device cognition

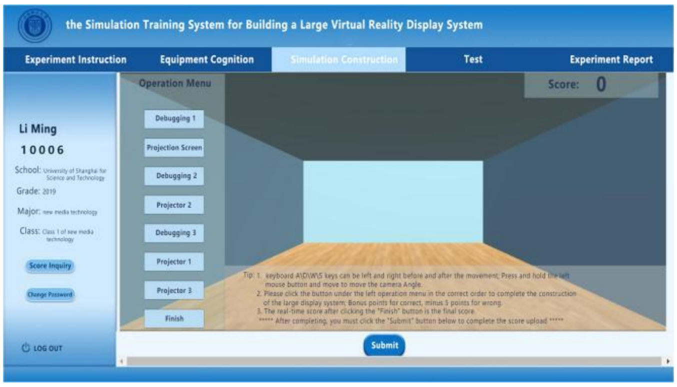

Fig. 8: Simulation construction

If students click the “projection screen” button in the first step, the annular projection screen will appear in the scene, and this step is correct, then the score column will be integrated, as shown in Fig.9. Assuming that students click the “projector 1” button next, similarly, one of the projectors appears in the scene and as a correct step the score column will be integrated, as shown in Fig.10.

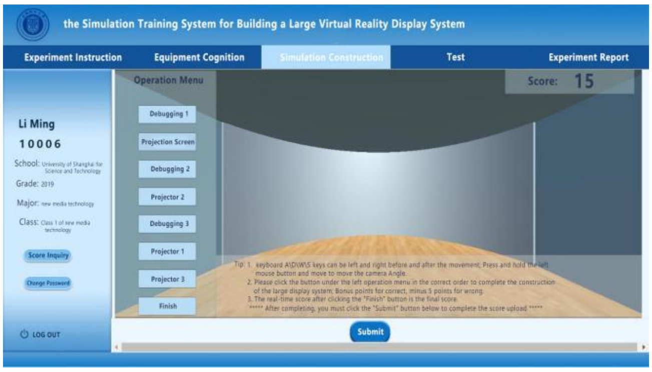

Fig.9: Projection screen

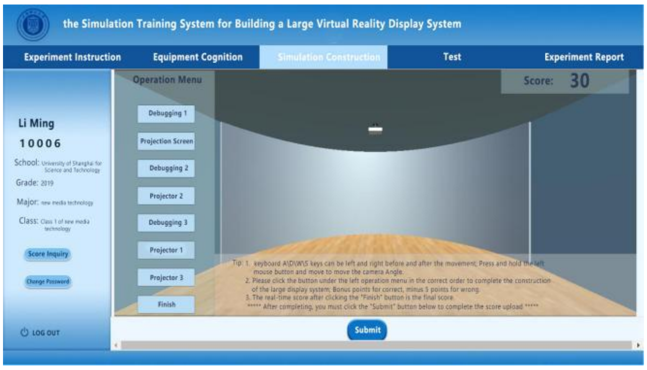

Fig. 10: Projector 1

After completing the basic scene through clicking buttons, enter the equipment debugging stage, click the three debugging buttons to open the corresponding three projectors, and the corresponding part of the image will be projected on the annular screen. When the “Debugging 3” button is clicked, the result looks like Fig.11. When the debugging phase is over, the simulation construction is completed. Students can click the “Finish” button to tour the whole large-scale virtual reality system scene, and end the experiment. After clicking the “Finish” button, there is no score for subsequent actions, whether they are right or wrong. And student should click the “Submit” button to update the score in the database, as shown in Fig.12.

Fig. 11: Debugging 3

Fig. 12: Simulation completed

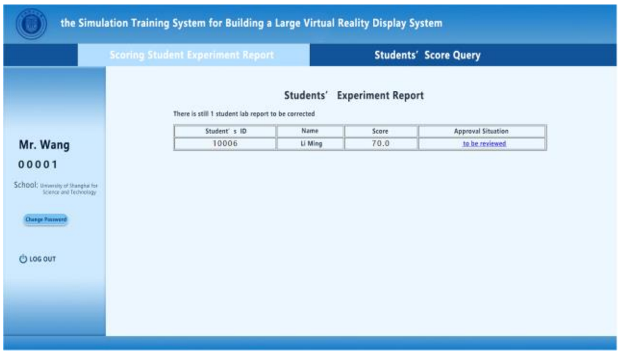

Fig. 13: Scoring student experiment report

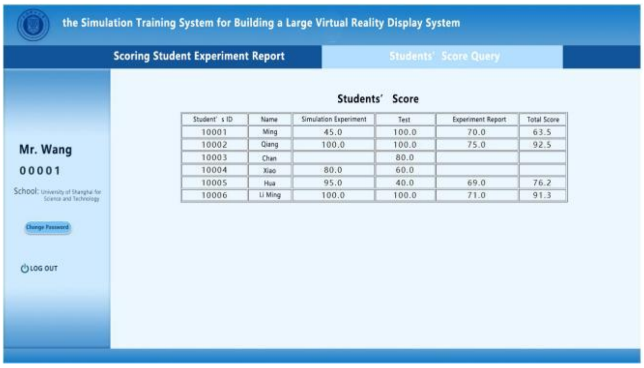

Fig. 14: Students ‘score query

4.2. System Teacher Side

If the user is a teacher, after login, the teacher’s homepage is displayed, similar to the student’s homepage. In the navigation bar, there are two functional buttons: scoring student experiment report and student score query. The left column displays teacher's personal information and two function buttons to change the password and log out. Click the “scoring student experiment report” button, and the number of student experiment reports to be reviewed will be displayed in the right area, and the information of experiment reports will be displayed in the form of a table, including student number, name, system scoring and approval status, as shown in Figure 13. Click the “to be reviewed” link in the approval situation, the student's experimental report will be displayed in the right area, which teachers can review, score again. Click the “students’ score query” button to display the current score information of all students, as shown in Figure 14. The total score will be calculated only when all module students have completed submission and the teacher has corrected the lab report.

5. Conclusion

This paper puts forward a simulation training system of building a large virtual reality display system based on web3D technology. Apllying the virtual simulation teaching on large virtual reality display system, let students do experiment online. It can solve the problems of the original offline experiment such as high cost, high risk and large space. When students have to study at home due to the epidemic or other factors, this online training system can effectively continue the teaching content of the experiment. And through virtual simulation interaction, the combination of theory and practice, adding gamification points system, can mobilize the enthusiasm of students. Meanwhile, the system automatically corrects part of the homework to reduce the workload of teachers. Therefore, the simulation training system of building a large virtual reality display system based on web3D technology this paper proposed, has high application value.

6. Acknowledgements

This research was funded by the Natural Science Foundation of Shanghai under Grant 19ZR1435900 and the Innovation and Entrepreneurship Project of College Student of University of Shanghai for Science and Technology(No. XJ2021451), 2021 scientific research project course of Shanghai University of Technology, 2021 Shanghai University of science and Technology Postgraduate Integrated Course (No.10-21-115-007).

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