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Development of Virtual Simulation Teaching System of Architectural Decoration Structure Based on WebGL Environment

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Abstract:

This paper analyzes the particularity of students' skill acquisition based on WebGL virtual environment, explores the construction virtual simulation teaching system of Architectural Decoration Structure, provides systematic and scientific theoretical basis for vocational education teaching visualization, promotes the sharing and co-construction of high-quality teaching resources in colleges, and explores the new path and space of teaching reform in higher vocational colleges in the new era.

Keywords: *WebGL environment, Architectural Decoration Structure, virtual simulation teaching.*

I. INTRODUCTION

This paper studies the construction technology of virtual environment based on browser, deeply integrates information technology and architectural decoration structure, achieves the effect of knowledge visualization, and effectively makes up for the important measures of special difficulties such as invisible, inaccessible, high cost and high risk in the teaching and training of architectural decoration specialty. By taking the real engineering project as the background, using the image, lifelike and intuitive virtual simulation technology for teaching, simulating the site environment, let students be familiar with and master the knowledge of decoration structure, improve students' practical operation ability and vocational skill level, promote the application of virtual simulation technology in teaching, management, learning and evaluation, innovate the educational organization form and management mode, and promote the innovation of vocational education teaching mode.

II. RESEARCH TRENDS AND DEVELOPMENTS

2.1 Browser based 3D visualization program development technology

Virtual reality technology has the characteristics of interaction, immersion and imagination. It is widely used in the interdisciplinary fields of computer science, engineering, psychology, neurology and so on.

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Three-dimensional graphics technology is its core support, which has been applied to many fields such as teaching. At the same time, driven by network technology, Web3D technology [deng2020, wang2020] has been developed, which makes it possible to build a networked 3D virtual world. The development of 5g technology provides basic conditions for the rapid transmission of 3D graphics. In the current era of digital economy, Web3D has become the standard of 3D files on the Internet and has been widely valued by the industry. Especially in the field of education, Web3D technology can support the construction of scene based interactive courseware, increase the interactivity of classroom and the novelty of teaching methods, and become the key underlying technology to promote the development of contemporary education.

Corresponding to this is 3D modeling based on browser, and relevant experts and scholars at home and abroad have also made more attempts and research. For example, metastream technology developed by metacreation and Intel supports the generation of small format files, and endows 3D polygon meshes with scalability and streaming transmission characteristics, which is very suitable for network transmission applications. In terms of display technology, Java 3D API implements the corresponding interface. Java 3D provides an upper interface based on Java, encapsulates the underlying display technologies such as OpenGL and DirectX, and is integrated into the whole framework of J2EE and J2SE to ensure the scalability of Java 3D technology.

In terms of 3D modeling platform, tinkercad, leopoly, 3dtin, etc. are widely used at home and abroad. Tinkercad is a web-based 3D modeling platform, focusing on online rapid completion of 3D design works. Even non professionals can get started quickly and get good rendering effect and running performance. Autodesk adds tinkercad to the "123d" series of services and applications in an attempt to further simplify the use process. Cline shows the complete process of "Designing 3D models, meshing, generating drawings, and printing 3D models" using tinkercad.

2.2 Application of virtual reality technology in construction industry and teaching

Many scholars and architects began to use computer technology in architectural design. For example, Su Yang [2014] realized the virtual roaming of Wuyuan Huizhou architecture by using the virtual reality software unity3d; Yang Jinlong [2019] explored the wider application of virtual reality technology in the field of architectural design, explained the opportunities and challenges brought by virtual reality technology to architectural design through a large number of cases, and made research and judgment on the development of architectural design in the future according to the current situation and trend of information technology development.

In addition, the impact of digital technology on today's architectural design industry is also reflected through a series of international exhibitions: the theme of the 2004 Venice International Architectural Biennale is mesomorph. The curator, Kurt w Forster, a Swiss architectural critic, called on architects to face the future through transformation, deconstruction techniques, topography, surface, geometry and other themes, Endow architectural works with the concept of "deformation", and explore the contemporary architecture changed by architectural technology and materials. In the process of development in recent years, the impact of digital technology and informatization on architecture has gradually developed from

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theory to practical innovation and tool research and development focusing on technical application. For example, Quest3D aided design software developed by Dutch company, as a three-dimensional software that earlier realized the construction of virtual reality model, realized real-time interaction with virtual scene in the link of building model creation for the first time.

These studies not only provide more ideas for architectural design, but also bring better development space. However, there are still some deficiencies in making full use of the advantages of virtual reality real-time interaction in the teaching process of architectural courses: most software content forms are relatively single and lack effective attraction; Most systems are desktop VR systems, while immersive VR systems have problems such as complex equipment, difficult installation and high cost; Some system products are only used by professional designers, lack of scientific teaching evaluation and relevant education and teaching theories, and can not play a full role in educational activities.

III. RESEARCH AND DEVELOPMENT CONTENTS OF VIRTUAL SIMULATION TEACHING SYSTEM FOR ARCHITECTURAL DECORATION STRUCTURE

3.1 Research on virtual environment construction technology based on webgl

The technology of virtual environment construction based on browser is studied. On the basis of establishing modeling standards, composite modeling and model simplification technology are used to build a large-scale virtual environment; Study the virtual environment rendering technology, and complete the scene rendering by using material mapping and light baking to ensure the realism of various devices; Study the interface design principles to ensure that the system function design is reasonable and clear, the layout is clear, the interactive operation is reasonable, coordinated and unified.

3.2 Research on virtual reality development engine based on natural language

Build a virtual reality development engine based on natural language like by encapsulating reusable functional modules. The core work involves: Research on zero starting point programming tools and compilers based on natural language like, multi-user collaborative application technology based on asynchronous event driven framework netty and web socket protocol, and multi-mode collaborative development technology of virtual reality based on resource sharing and role driven, And the dual data protection mechanism based on o2o "offline + online" mode.

3.3 Development of big data analysis visualization system for large-scale application

Research the big data analysis visualization system for large-scale application, and support the storage and tracking of Educational Digital Archives, including data storage, data processing, model establishment, model training, analysis application and visual display, including personnel category and attribute information, time information, virtual interaction information, virtual scene parameter information and other elements. Based on the educational big data technology, this paper systematically studies the learning

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behavior judgment mechanism, learning time distribution, knowledge structure layout, key skill maturity and other learning decision-making elements of individual users. According to the above research results, a complete and traceable chain of Educational Digital Archives has been established.

3.4 Development and demonstration application of building decoration structure knowledge visualization system

Fully integrate teaching resources and build a "hierarchical, modular and integrated" architectural decoration structure teaching knowledge system of "basic level dominated by strengthening professional basic cognitive ability and professional level dominated by strengthening professional curriculum training skills", which is not only hierarchical, focused, but also penetrated and promoted each other. On the basis of the above research results and based on the unified information data language standard, research and customize a set of building decoration structure knowledge visualization system for the training of enterprise employees in construction majors and related fields, and verify the application of the involved research methods, technical routes and cloud service system through teaching practice, so as to realize the demonstration application of building decoration structure knowledge visualization system.

IV. RESEARCH AND DEVELOPMENT TECHNOLOGY ROUTE

4.1 Virtual environment based on webgl

In order to achieve a real sense of experience, the construction of virtual content model often adopts high-precision and high surface number modeling technology. After giving materials, maps and lighting effects, the computer image processing ability of PC high-end graphics card often consumes a lot of computing resources. The application of such model to the web will lead to the problem of poor system operation. Therefore, the construction of model must meet the requirements of low capacity while ensuring accuracy. In addition, we need to build a unified logical structure to build a twin model in digital space in the face of different physical entity types and diversified functions, as well as the data generated by entities.

(1) Virtual environment construction

Composite modeling technology: select different tools under the specific conditions of the research site, and do 1:1 proportional modeling for the scenes and models required in the digital twin platform. It integrates solid modeling, surface modeling, wireframe modeling, display geometry modeling and parametric modeling. The modeling function is powerful and convenient for the efficient modeling of various instrument and equipment models.

Establish modeling standards: establish modeling standards by converting the scale, unit, coordinates, number of faces, wiring, normal, naming method and format of the model, build a virtual environment based on the real world, make a three-dimensional model of the virtual object, and conduct high simulation modeling.

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Model simplification technology: simplify the number of faces of the model, delete invisible faces, and reduce the number of faces after engraving the model with high precision, so as to minimize the number of faces of the model; Adjust the topological structure of some exhibit models to make the model have better display effect in the virtual interactive system; On the basis of keeping the display effect unchanged, appropriately reduce the pixels of the map and save it as DDS, PNG and other file formats with higher compression efficiency; Use small pieces of simple texture; Reduce the export of irrelevant and duplicate information.

(2) Virtual Environment Rendering

Virtual environment rendering adopts the most widely used animation rendering platform in the world as the rendering tool, which has many functions such as three-dimensional modeling, rendering and animation to complete the realism of the scene and various devices.

Material mapping: PBR realistic mapping based on physical attributes. PBR realistic map includes texture map, metal smoothness map, normal map, Ao map, etc. Texture mapping is used to represent the appearance characteristics of materials; The metal smoothness map is used to represent the physical characteristics of its response to light, while the normal map is rich in texture bumps and other details, and AO further represents the three-dimensional realism of the object. The four core maps show the characteristics of the object extremely realistic, and the map size is generally 2048 * 2048.

Light baking: according to different projects, the light forms are also different. Among them, the traditional rendering Vray renderer is combined with the latest GPU multithreading rendering of unity, which not only ensures the authenticity of the effect, but also ensures the fluency of the platform. Generally, unity's traditional lighting and baking lightmap form is adopted, and one lightmap is guaranteed to have a resolution of about 1024.

(3) Virtual reality UI design

Interface design is a man-machine system engineering combining computer science, aesthetics, psychology, behavior and demand analysis in various business fields. It realizes the communication between users and computers to control computers or data transmission system components between users and computers. The interface shall be concise and clear to ensure that the system function design is reasonable and clear, the layout is clear, the interactive operation is reasonable, coordinated and unified. The functions should be expressed clearly, the classification should be clear and organized, and the visual confusion caused by too many nested controls should be avoided; The operation purpose of a single function is clear and in line with the principle of ease of use, so as to avoid unnecessary information display and visual interference to users; Strive for simple operation. Simple functions can be completed in one step. Complex functions can be completed in three steps with the help of operation wizard.

4.2 Virtual reality development engine based on natural language

Develop virtual reality visual scene editor based on HTML5 and webgl, zero starting point based on webexcel online table technology, natural like programming language, programming tools and compilers,

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multi person collaborative application technology based on asynchronous event driven framework netty and websocket protocol, virtual reality multi-mode collaborative development technology based on resource sharing and role driven, and data dual protection mechanism based on o2o "offline + online" mode, Create a "zero starting point" and "open" software development engine.

(1) Visual scene editor of virtual reality based on HTML5 and webgl

The web version of virtual reality software development engine is a software development platform based on HTML 5 and webgl. It does not need to install any software or plug-ins. No matter where you are, you can directly use the browser to open the web page for program development. The web version of virtual reality software development engine has a fully functional visual scene editor, which can visually edit the scene as you see it, and uniformly manage the resources such as model, map, material, audio, video and so on. The edited items can be published with one click, and can be used through web browsing after publishing.

(2) Programming tools and compilers based on natural programming languages

The editable text system developed by the project team is used to replace the programming language for program development. Users do not need to master any programming language or any professional background, and can start through simple learning. Taking the object as the core, by analyzing the general characteristics of virtual simulation software, this paper abstracts four basic elements: object, state, trigger and response, takes the specific entity in the simulation software as the object, uses the state to represent the functional logic relationship of the object, and connects the specific state changes through trigger and response to realize the functions of complex virtual simulation software.

Using the form as the development script, the user fills in the object, state, trigger and response according to the specified format, and realizes the complex program logic through the free combination of trigger and response. Trigger and response is an extensible code module. The code module establishes a mapping relationship with the text in a specific format in the table through specific rules. The virtual reality software development engine creates the functional logic relationship of the whole simulation software by parsing the table text. Taking the object as the basic functional unit, an object contains one or more states, and each state is connected with an appropriate trigger and response, so as to realize the complex functional logic relationship.

(3) Multi person collaborative application technology based on asynchronous event driven framework netty and websocket protocol

The virtual reality software development engine supports the development of network functions similar to online games. The server adopts the high-performance asynchronous event driven framework netty for development, and uses websocket protocol to communicate with the client to realize high-performance network collaborative applications. The networking function of the virtual reality software development engine adopts the frame synchronization technology as the bottom implementation method of the network. The complex functions such as creating a room, obtaining identity and joining games are encapsulated into simple table statements. Users can realize the basic network application development by simply connecting

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them in series, which greatly reduces the threshold of network development.

(4) Dual data protection mechanism based on o2o "offline + online" mode

All data used by the virtual reality software development engine are uploaded to the cloud through the web page. During the use process, key data backup is carried out in the cloud at the same time. In addition, in order to improve the development and use experience and save network traffic, the virtual reality software development engine also makes a local backup through the browser cache technology, and controls all files to keep the latest version through the signature change of data files.

4.3 Big data analysis visualization system for large-scale applications

Research the big data analysis visualization system for large-scale application, and support the storage and tracking of Educational Digital Archives for lifelong learning, including data storage, data processing, model establishment, model training, analysis application and visual display, involving personnel Category attribute information, time information, virtual interaction information, virtual scene parameter information and other elements. Based on big data technology, research the judgment mechanism of individual learning behavior of system users, analyze the distribution map of individual learning time, the mastery coverage of knowledge points, the proficiency of key skill points and other elements, and establish a complete and traceable chain of Educational Digital Archives. In addition, the system can also analyze the behavior data of different groups, and provide data support for subsequent teaching resource modification and function optimization decision-making. Big data analysis and visualization system is a systematic project, which involves a series of functions such as data storage, data processing, model establishment, model training, analysis and application, visual display and so on. It mainly includes four parts: metabase, label mechanism, calculation model and display output.

(1) Metabase

The main function of metabase is to store and manage metadata in the system. Metadata refers to the original and indivisible data unit. The data comes from the user's use traces in the "new media +" smart education platform, including the user's region, use duration, learning times, learning achievements, etc. at the same time, it provides an external interface of the metadata database, which can be accessed by other software or platforms according to the metadata protocol. The meta database has a tag mechanism. In the meta database, metadata is managed through tags.

(2) Labeling mechanism

Tags are used to classify and filter metadata. For example, the data generated by all operations can be subdivided again through "category label", and the filtering and achievement degree calculation can be carried out according to "category label". You can paste labels when importing metadata, or the administrator can add labels to metadata. For example, in the user analysis report, you can paste the category

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label at any time, and use the pasted label to filter out the corresponding metadata.

(3) Data analysis and calculation model base

The computing model combines metadata and tags to realize data mining and statistical analysis. The system is intended to provide several typical calculation models and establish a data analysis and calculation model library, including several traditional statistical analysis tools and machine learning algorithm tools. The analysis results can be generated for the input data, and the user can choose independently, or even set relevant parameters.

(4) Visualization technology of analysis results

This project plans to design a data visualization system for large-scale application, and show the analysis results in the form of charts. Design chart drawing tools with several shapes. For the input data, it can carry out visual display of graphics or tables, including radar chart, histogram, pie chart, disconnection chart and other display data, and export PDF, Excel and other documents to display the data calculation and analysis results. In addition, standard display templates are also designed. The system provides several sets of label display templates and report templates, such as operation big data statistics and analysis templates.

The platform supports automatic recording of each step of user's operation to realize teaching management. The big data center will record the time, courseware name, learning duration, learning person times, as well as the in-depth operation data such as the correct answer rate, hot click completion, plot progress completion and resource expansion completion, which will be used as the teaching intelligence evaluation model based on big data to generate the teaching white paper. For different objects such as institutions, individuals and courses, various data such as summary data, class learning report, class big data, courseware learning report, course learning data, courseware learning data and course learning report can be exported to provide more targeted data support for evaluating learning effect.

4.4 Application of building decoration structure knowledge visualization system

Carry out proportional modeling and restoration according to the actual scene of architectural decoration. According to the development principles of "full scene", "full equipment" and "full process", the real architectural scene is cloned into the virtual space through virtual reality technology. Combined with God's perspective, spatial positioning, product perspective, three-dimensional animation, particle special effects, parameter linkage and other display methods and interactive means, an immersive architectural decoration structure knowledge visualization system is formed and put into practical application, Verify the applicability and reliability of the system.

Based on the real building, the real scene is cloned into the virtual space by using 3D modeling and rendering technology, and has gorgeous and realistic 3D immersion effects, including brick wall, setting out, slotting, air conditioning, cold water pipe, strong current socket, strong current switch, hot water pipe, weak

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current pipeline, fire prevention pipeline, slot sealing, waterproof detection, ground leveling, floor tile, brick wall, exterior wall cement, ceiling light steel keel, wall light steel keel, ceiling gypsum board Ceiling multilayer board, wall plasterboard, door frame, ceiling anti cracking belt, wall crack prevention belt, wall plastering, wall plastering, scraping putty powder, bottom coat painting, topcoat layer, section, lamps and lanterns, switch panel, socket panel, etc. Through the construction of knowledge visualization system and VR helmet and handle, the digital immersive display of architectural decoration structure, the experience display of architectural decoration structure process, the principle display of architectural decoration structure process, and the design and training of architectural decoration structure are realized.

V. CONCLUSION

In the teaching of architectural decoration structure, virtual reality technology is adopted to implement the interactive learning of the whole process and scene. Through the big data tracking and collection of users' learning behavior and learning data, the massive data generated are mined, analyzed and sorted out, According to the specific "teaching object (person), teaching time (hour) and teaching scene (empty)", a teaching effect evaluation model and artificial intelligence decision-making model based on learning big data are formed. On this basis, a complete and traceable Educational Digital Archives Record chain is established to realize the full automatic tracking, recording and evaluation of learning process and results, and the visualization of teaching content, teaching method and teaching feedback, Provide data support for smart education.

By encapsulating reusable functional modules, the zero starting point and granular agile development engine system is studied, which is easy to reconstruct, customize and promote, so as to complete large-scale, low-cost and efficient resource customization and development with simple template operation, and completely solve the problems of "the last kilometer" that is difficult to connect Teaching resources with actual needs and "one-time project" that is difficult to continuously update development results.

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