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Application and Research of Immersive Virtual Reality Technology in the Interior Decoration of Folk Houses in Guanzhong*

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***Abstract*—With the development of economy and society, virtual reality technology has been paid more and more attention and gradually applied to various industries. Because of the interaction, immersion and real-time of virtual reality technology, its application in the field of architecture has a wide range of prospects. Especially in interior decoration and design, the advantages of this technology are unparalleled with other technologies. The interior design of virtual reality can make designers and users realize the effect of "what you see is what you get," and at the same time, make users feel the artistic conception in the virtual scene of this design. In this paper, with the audience residential buildings as the research object, the research and analysis of interior decoration are conducted using immersive virtual reality technology, which provides a theoretical basis for better research and development of interior design assisted by immersive VR technology.**

Keywords: immersive VR technology, indoor space, Guanzhong inhabitants, 3D modeling

I. INTRODUCTION

The emergence of virtual reality has undoubtedly opened up a new way of thinking for the field of architectural design, which combines innovative art and technology. It breaks the expression mode of "plane, facade, section and 3D model" in the past architectural design. Designers can "walk into" their design scene space at any time, observe and review their design from any angle, and feel the changes of space, scale, environmental light and even sound, thus making the design creation more perfect [1-2]. It is a new attempt to use virtual reality for virtual indoor roaming, so as to evaluate the effect of the indoor design. In the planning and design stage, people can use dynamic and interactive way to examine the future residence in a virtual three-dimensional environment. Virtual interior system application in house sales will become a powerful tool for developers [3-4]. Compared with the sand table model, it can be a full-scale model of the real house, and it can be used to watch the structure of the house with the help of the mouse, so it is convenient for the user to choose the house. Compared with the sample room, it takes less time and saves money. Convenient and natural interaction makes people have a stronger sense of reality. These advantages make such systems more interactive between human and device applications and also open a new world for the application of virtual reality technology in construction and real estate industry. It is of great practical significance to study this subject [5].

II. RELATED RESEARCH BASED ON IMMERSIVE VIRTUAL REALITY TECHNOLOGY

A. Meaning of virtual reality

The concept of virtual reality technology includes the following meanings. Firstly, in terms of the simulated environment, it is a computer generated 3D stereo image that changes in real time according to human visual angle. In the case of technological attainment, in addition to 3D vision, it also includes three-dimensional perception, such as hearing, smell, and touch, etc. Moreover, the virtual environment is not necessarily the scene in reality, but also the virtual world conceived by the designer. Secondly, in perception, the virtual reality technology should simulate all the human senses in theory, and the virtual world conceived by users is more real. The most common perception function is visual and hearing, touch, force and so on, and the sense of smell also has new development. Finally, in the interactive aspect, it is necessary to ensure the real-time and feedback characteristics of the virtual reality system. In other words, the system can identify human natural movements such as head rotation, gestures, etc., and can provide feedback to various senses of people in real time, allowing users to interact naturally with the system environment and other users [6-8]. The working mode of virtual reality is shown in "Fig. 1".

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Fig. 1. VR operation mode.

B. *Implications of immersive virtual reality*

Immersive VR is an artificial virtual space in which human beings interact with each other through hardware, such as workstations and sensing devices, using computer technology and biotechnology. Immersive VR technology engine mainly includes computer mainframe, input equipment such as motion capture device and various hardware equipment, output equipment like display screen, the software of VR system and related technology and so on [9-10]. According to the purpose of the device, the immersive VR system is usually composed of three parts: display system, processing control system and action capture system, as shown in "Fig. 2".

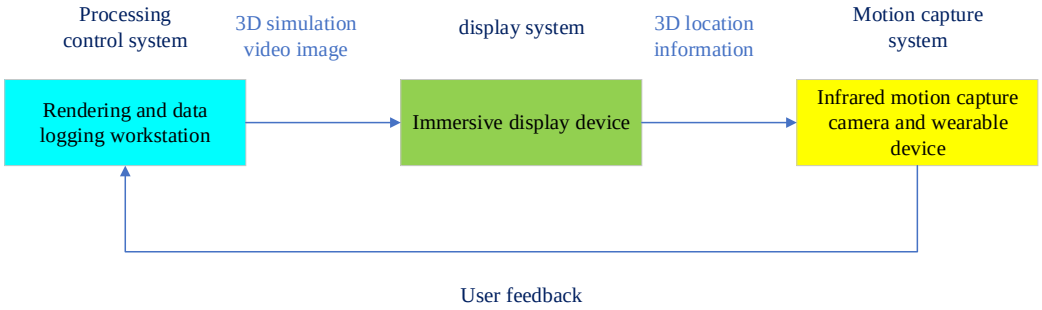

Fig. 2. Composition of immersive VR system.

The difference between traditional virtual reality and immersive virtual reality is shown in "Table I".

TABLE I. THE DIFFERENCE BETWEEN TRADITIONAL VIRTUAL REALITY AND IMMERSIVE VIRTUAL REALITY

	Traditional VR	Immersive VR
Key technology	Data acquisition technology, modeling technology, sensing technology, interactive technology, tracking technology, collision technology, etc.	Environmental modeling technology, stereo synthesis and stereoscopic display technology, tactile feedback technology, interactive technology, positioning technology, system integration technology, etc.
Scene presentation mode	Desktop display based on pc	The head HD screen presents a perfect, full-field 3d scene.
Visual angle control mode	Trackball and torque ball	Gyroscope, accelerator
Interactive mode	Keyboard input, mouse click, joystick, steering wheel and other hardware devices for simple interaction	Head tracking, eye tracking, gesture recognition, speech recognition and motion recognition are more in line with people's natural interaction habits.

III. RESEARCH ON THE INTERIOR DECORATION OF RESIDENTIAL BUILDINGS IN GUANZHONG

A. *Architectural characteristics of residents in Guanzhong*

The regional environment of Guanzhong area is tightly locked with 800 miles of fertile lands. This kind of natural landform has contributed to the appearance of Guanzhong traditional houses in the form of secure and private courtyards. As shown in "Fig. 3", affected by geographical location and climate, in order to achieve the purpose of housing insulation and cold protection, a typical "narrow courtyard" dwelling compound form has been built in Guanzhong area. The homestead is relatively narrow, the width is generally 9.9 meters, and the depth of the length is uncertain but certainly larger than the wide size. Its characteristics are the full use of the area, and there is no space waste. The layout of traditional houses in Guanzhong is closely related to the feudal traditional ideas of people. Houses rise with the courtyard floor, among which the

lowest is gatehouse, followed by the hall room, and the highest is the main room. The combination of the house height and the function of courtyard show the strict hierarchy and the thought of inferiority and superiority in Guanzhong area.

Fig. 3. Traditional dwellings in Guanzhong.

B. *Interior decoration of residential buildings in Guanzhong*

The decoration style of the traditional folk houses in Guanzhong is bright, and its main forms are simple and elegant, which is mainly manifested in the gables, the lintel and the top parts of the traditional buildings. All of them intuitively show the aesthetic pursuit of people as well as the high-standard skills of brick, stone and wood carving art in architectural design and architectural art. The carving type, content, and subject of Guanzhong traditional residence are unparalleled to the architectural decoration in many other places. However, the carriers of these architectural decorations are not rich and colorful. In the decoration of Guanzhong folk houses, they mainly use brick, stone and wood engraving. This is the main decoration technique of Guanzhong traditional residential buildings. There are no gorgeous colors, only the strong cultural flavor of carving art itself. The fine architectural decoration art of Guanzhong traditional residence courtyard can reflect the exquisite craftsmanship and the utility, and reflect the cultural connotation of the courtyard master and the prosperity of the dynasty at that time. As shown in "Fig. 4", the architectural layout of the whole village house is strict and orderly, with wood, stone and brick engraved on the architectural decoration. The gatehouse has brick carved parts with fortune, the Book of Changes, the Eight Diagrams, flowers, fruits and vegetables, people and exotic animals as the theme. The house has exquisite stonework and drum stone and so on, and door hairpin, lintel, and so on are all wood carving decoration. The fine architectural decoration art of Dangjia Village has left valuable architectural materials for the posterity and laid a reference foundation for the residence of the later generations.

Fig. 4. Guanzhong ancient village.

IV. Application and Research of Immersion Virtual Reality Technology in Guanzhong Residential Building Interior Decoration

A. *Implementation of virtual interior scene*

The design of virtual interior scene includes wall, TV, sofa, chair, and lamp and so on. In this paper, the whole coordinate system of the virtual scene is modeled in blocks, and then assembled together to establish a unified standard in data style, standard image format and texture processing. In the process of modeling, the simple modeling is built with VRML, and the complex modeling is designed and built with 3DS MAX and other software. The model is imported and adjusted appropriately. Finally, the VRML file with the extension of wrl is exported. "Fig. 5" is the modeling combining these two modeling tools. The whole model of Guanzhong resident building is shown in "Fig. 6".

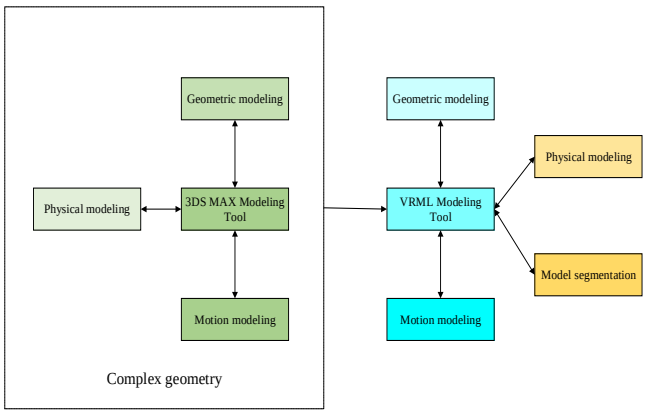

Fig. 5. Modeling in combination of two modeling tools.

Fig. 6. Integral model of residential building in Guanzhong.

B. Real-time interior design element editing

Compared with traditional design software, immersive VR system provides powerful technical support for real-time change editing module of interior design. When users use immersive VR system to observe the space, they can use the system to modify the unsatisfactory place in the indoor space and change the environment and decoration of the indoor space at any time. The designed virtual space will simulate the natural light in real time in the virtual space. It can be said that the virtual space of the user can be simulated as long as the program of immersive VR technology is carefully written (As is shown in "Fig. 7").

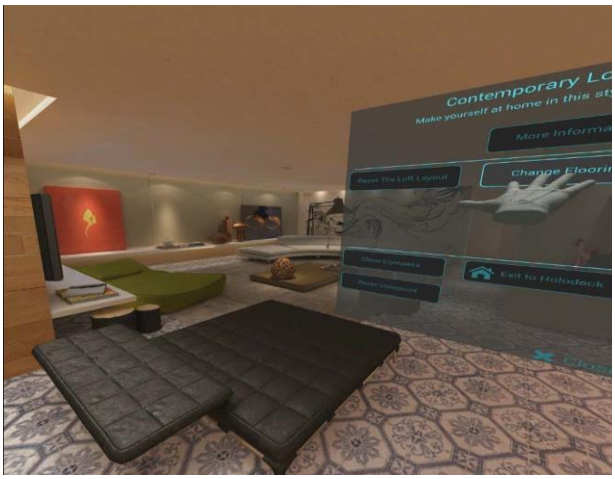

Fig. 7. Users use immersive VR devices to edit indoor materials in real time.

Indoor space sentiment provides a link among the design unit, the user and the construction side to ensure the effective cooperation of the three parties, so as to ensure the success of the space design. Thus, users can get the most suitable space. The emergence of immersive VR technology provides communication tools for designers and users to communicate more effectively and ideally. It allows users to keep track of the progress of interior space design, and more easily communicate with designers about the current design, so that users can directly participate in the design process and become an integral part of successful design. They can assist the designer in making decisions during the design process, as shown in "Fig. 8".

Fig. 8. Users use Oculus immersive VR helmets for participation and decision support.

C. Experiment and result analysis

By using immersive VR technology to evaluate the indoor design of Guanzhong residential buildings, users can feel the design in the virtual simulation indoor space. Based on the interior space emotional design elements, the shortcomings and problems in the space emotional design are analyzed, and the spatial emotional design is modified and optimized in time.

1) Experimental preparation: Host system Windows 7 and above, virtual reality system Vizard 5.0, action capture system PPT studio, physiological data acquisition and analysis system Ergo Lab2.0, indoor space modeling software 3D maxs, and map processing software Photoshop are used. The software application development adopts Python language. This experiment will be divided into three sub-experiments according to the different types of indoor space used in the experiment to collect data. Each experiment needs to select 10 subjects randomly, of whom 5 are male and 5 are female. To ensure that the experiment results are scientific and truthful, the selected subjects should satisfy the following conditions:

- Be able to correctly feel the space and evaluate the space independently;
- Have no serious 3D dizziness (slight dizziness is a normal phenomenon) in 5 minutes after wearing the immersive VR helmet;
- Have correct psychological and physiological responses to stimuli, and be able to coordinate with the experiment to test EDA data;
- Be willing to conduct immersive VR equipment operation training before the experiment;
- Belong to undergraduate or graduate students.

2) Experimental process: The first step is to determine the type of the experiment item, and make the model with Auto CAD and 3D max software according to the emotional design requirement of its type, and save the model as the source file format of [.osgb], so that it can be imported into the Vizard system for editing. This paper takes the indoor space of Guanzhong residential building as an example to

carry out immersive VR space experiment. Before making the model, the space function of each type should be divided reasonably to meet the needs of the experiment. The modeling process is not restated in this paper. The second step is to set up immersive VR scene roaming, edit the running script in Vizard, relate hardware equipment with the software model according to the requirements to ensure the normal operation of the experiment. The third step is to carry out the evaluative experiment of immersive VR indoor space emotional design, and open Vizard model display system, PowerPoint Studio system and Ergo Lab system. At the same time, the subjects wear immersive VR helmet, handle and wearable EDA detection device. In the first minute after the experiment, the model picture is not displayed in the helmet, and the change of the EDA value of subjects is recorded. In the second minute of the experiment, the helmet begins to display the corresponding picture of the model and the EDA value change of the subjects is recorded until the end of the fifth minute of the experiment, as shown in "Fig. 9".

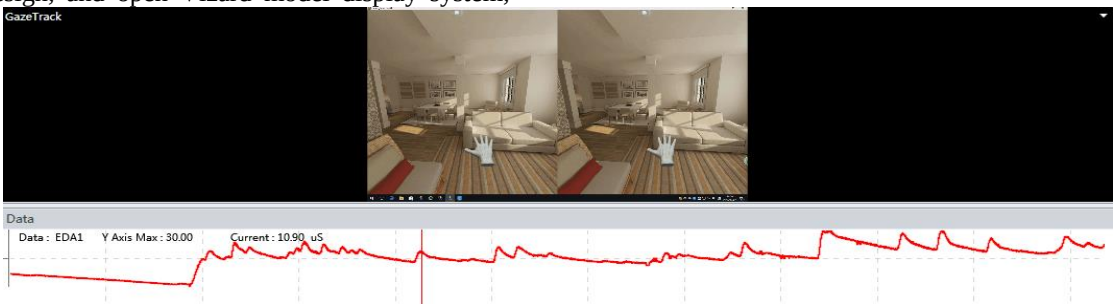

Fig. 9. Helmet screen and EDA value change recording screen in the experiment.

Through immersive VR experiments, one can intuitively see the real-time behavior and response of users in different positions and different visual angles in virtual space. According to the behavioral response, we can pay attention to or weaken the design of some areas to meet the psychological and physiological needs of users.

V. CONCLUSION

With the improvement of people's aesthetics and the demand for the innovation of indoor space emotional design, the evaluative experiment and analysis of interior decoration design can be conducted by immersive virtual reality technology, so as to effectively figure out the deficiencies and problems in the interior space decoration design process and make timely modification and optimization. Therefore, this paper makes theoretical and experimental research on the indoor space design of Guanzhong residents based on immersive virtual reality technology, and has achieved certain results.

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