Indoor Virtual Modeling Design Based on Computer 3D CAD Processing Technology

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Abstract. In order to solve the problem that the traditional interior scheme display cannot meet the needs of the increasingly progressive environment, an interior decoration method based on computer Virtual Reality (VR) and 3D CAD processing technology was proposed. This method starts from the interior design process and takes several project designs as examples to compare the traditional interior design CAD scheme with the interior design method based on VR technology. The results show that the interior design method based on computer VR technology is more efficient and can greatly meet the needs of users. For the switching effect of decorative elements, the user satisfaction is 100%. The test results show that the effectiveness and practicability of the VR technology in this paper will greatly improve the efficiency of interior design and promote the development of the interior design industry. The experimental results show that the proposed method is feasible and can achieve better virtual simulation effect of interior design.

Keywords: Virtual reality; Interior design; 3D processing technology.
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1   INTRODUCTION

Under the background of the Internet era, people's life, work and study have changed to varying degrees. In particular, the emergence of virtual reality technology can realize the organic integration of multiple information and three-dimensional simulation of real objects, and bring users multiple sensory experiences [1]. The application of virtual reality technology in interior design and decoration can better meet people's growing requirements for home environment decoration design and improve the effect of interior design and decoration [2]. In the past interior modeling, design and decoration, a series of risk events were induced due to unreasonable quality indicators, irrational customer decisions, or asymmetric communication between the two sides, which not only affected the effect of interior design and decoration, but also caused a lot of waste of resources. In this regard, through the application of virtual reality technology, this problem can be effectively improved, the simulation design scheme shows the effect, and the deficiency can be

improved in time before the construction, so as to provide guarantee for the final decoration effect.

With the development of computer science and technology, it is quietly affecting our daily life. At the same time, computer science and technology have changed the traditional architectural design methods in many aspects [3]. In particular, three-dimensional virtual reality (VR) technology is considered to be one of the most likely technologies to change the world in the 21st century. Virtual reality technology integrates computer graphics, computer human-computer interaction, sensor technology, artificial intelligence, robot technology, etc. to provide users with realistic images, sounds and other feelings that can simulate the virtual environment, so that users feel that they are in the physical environment [4]. Generally, interactive software and hardware are used to create a real and realistic three-dimensional environment simulation, Markov Model, and then the user can experience or control it through the movement of the body [5]. The user can touch the environment like the real environment [6].

Computer virtual reality 3D processing technology has good interactivity, immersion and real-time, which provides us with a virtual world as the real world. With the application of virtual reality technology in architectural design, architectural engineers can realize their works in the 3D virtual world. Virtual reality technology can not only provide a new artistic expression for architectural creation, but also make great changes in architectural design methods and concepts. In recent years, virtual reality technology has been widely used in the field of architecture, especially in the field of interior modeling design and decoration [7]. Using virtual reality technology, designers and customers can have a distinct feeling about the interior layout. With the development of computer hardware, many indoor modeling and design methods based on computer 3D processing virtual reality technology have been proposed in recent years [8, 9].

2 LITERATURE REVIEW

The three-dimensional design software used in China is mainly computer software based on three-dimensional simulation. In the domestic interior and landscape design industry, 3D software is the most widely used industry. 3D software is mainly reflected in computer-aided interior and landscape design. For designers and customers, such applications can meet the requirements of "fine and accurate" design. It is a comprehensive and powerful scene modeling and rendering software, which has a very wide range of applications and covers almost all fields. It can create a lifelike scene object [10]. Such software technology can be used to create and complete the building facade, indoor scene and decoration, and can also express the surrounding environment. Compared with traditional hand-painted renderings, the application of this software technology makes the scheme display more comprehensive clearer, and the whole scene space can be observed at the scheme stage of the project [11].

In many developed countries, the virtual reality technology has developed to a certain height, and is no longer limited to indoor or architectural landscape design. More research institutions and companies have seen the good prospects of the virtual reality technology, and quickly entered the research of the virtual reality technology and the development of related products [12]. They include computer-aided design, education, graphics and images, various machine simulation and operation training, intelligent robots, entertainment and art, urban planning and design, real estate projects, architecture and cultural relics protection, medical treatment and military exercises, etc. The integration of virtual reality technology and three-dimensional holographic projection technology will produce more powerful sensory effects, and 4D film is a representative of its application [13]. Therefore, the application of computer 3D virtual reality technology in foreign countries is very extensive. The survey results show that: in terms of entertainment, education and art, virtual reality technology accounts for 21.5% of the mainstream of application technology, followed by military and aviation accounts for 12.8%, medical treatment accounts for 6.2%, robot technology accounts for 6.5%, film technology accounts for 4.96%, and also accounts for a considerable proportion in graphics and image design and manufacturing [14].

In today's urban planning field, virtual reality technology can be applied in many aspects, and it can effectively improve work efficiency and bring real returns [15]. In the display of urban planning scheme, the immersion feeling is generated by the interaction in the virtual reality system. It not only provides users with a large amount of real information, but also provides comprehensive and effective experience in the environment [16, 17]. According to the needs of users, it can also be designed to retrieve relevant data in the virtual environment. The application of virtual reality technology can also avoid some design risks. As the virtual reality technology is based on the composition of real data, it is a real three-dimensional visual scene built according to the design requirements and relevant specifications. This feature can enable design researchers to find subtle design vulnerabilities, thus greatly improving the efficiency and quality evaluation of the project by reducing the losses caused by these design vulnerabilities [18]. The application of virtual reality technology in planning and design can not only improve the design speed, but also facilitate the design modification. For example, changes in building height, materials and colors of building appearance and facade, and changes in greening in architectural design can be quickly adjusted in virtual reality technology to improve work efficiency and quality [19].

Starting from the reality of the interior design industry, combined with the characteristics and system of VR technology, this paper expounds in detail, starting from the interior design process, and taking the interior design of several projects as examples, compares the traditional interior scheme design method with the interior scheme design method under VR technology.

3   RESEARCH METHODS

3.1   VR Technology Software and Hardware Conditions and Requirements

3.1.1   VR technology system software and hardware tools

In interior design, we must first create a real interior scene. The creation of indoor scenes requires corresponding software tools, including CAD drawing tools, 3D modeling tools, Photoshop Image processing tools, and simulation software for real-time rendering and display. These tools can complete the functions from design to modeling, from material interaction to real-time display [20].

The virtual 3D interactive system used in this paper is based on GLVR and VDP platforms. GLVR platform is the platform for project preview, and VDP is the platform for project management and editing. Platform hardware includes VR screen, VR training kit, 3D glasses, etc. 3D glasses are used together with VR screen, and users can display and report; VR training package is mainly used for immersive experience to achieve 360-degree interactive experience; With the help of VR training kit, the experience effect of "one person immersing, many people watching" can be realized. In interior design, the most important function is that when the customer puts on VR glasses and "walks into" the scene, the virtual interior scene he sees is consistent with the scene seen by the designer who does not walk into the scene [21]. But the feeling of entering the scene is more real and intuitive, which can be better integrated into the design thinking and more deeply feel the design atmosphere. Therefore, the system platform can better shorten the distance between customers and designers, and facilitate the communication between them more conveniently and quickly.

According to the computer graphics model, the product feature model passes through the geometric model, the patch, and then renders and visualizes. Along this transmission channel, the volume of graphic data continues to increase. Both systems have complete transmission channels. At a certain level, one channel can be cut off to transfer data to another system. The choice of connection level also determines the way of vertical integration.

It is not advisable to connect at the raster image data level. Although the CAD system provides scene rendering function, it is not real-time and does not support interactive mode. This is also an important factor to promote the integration of CAD and VR.

The connection at the patch (usually triangular patch) level is very beneficial for the design demonstration because the patch objects can be displayed in real time without expensive computer overhead. And because the level of detail can be controlled as a function of time, algorithms such as progressive thinning or viewpoint thinning can be used to achieve adaptive visualization.

Designs in CAD systems are usually composed of several basic elements. If you select the level of the element as the connection point, all related elements of the model must be imported from the CAD system into the VR system. However, the VR system does not understand the subordinate relationship between the design object elements. The model only contains geometric elements but has no design attributes and associated attributes. Therefore, it is difficult to perform synchronous design operations on CAD models in the VR system. For example, because the relationship between elements and components cannot be established in the VR system, the updated elements must be re-exported from the CAD system after changing the position of elements in the components. At this time, all forms of entities, such as curves and faces, must be represented by the VR system. Parts and assembly sets abstract the matching relationship between elements. The concept of an assembly represents parameter and property data as semantically related information. For CAD models, semantic description is more refined than geometric description. In many cases, it is not necessary to design objects with complex geometric model data, as long as the category and shape of object features are given. If the two levels are integrated, in order to achieve the consistency between VR and CAD models, the model in VR should also "understand" the meaning of object features and realize feature-based model establishment and update with the help of extended information and functions.

3.1.2 Requirements for applying VR technology in interior design
In the creation of interior design, we should master the process of project production. The process of VR technology in indoor creation is as follows, as shown in Figure 1.
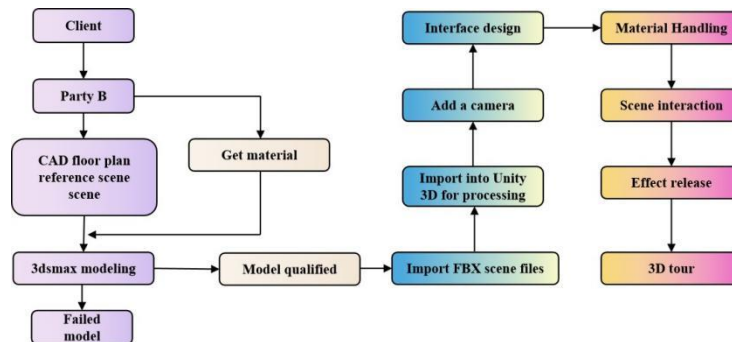

Figure 1: Project flow based on VR technology.

3.2 Process Construction of VR Technology in Interior Design

3.2.1 Interior design creation process
According to the market research, the business process of architectural interior design includes as shown in Figure 2. The scheme design stage is the foundation of the whole design. The interior decoration scheme includes CAD drawing design scheme, computer three-dimensional model design, effect drawing, and finally the design scheme presented to customers.

The interior scheme production process includes four aspects: hard decoration design, soft decoration design, visual design and aesthetic design. In the early stage of hardware design, actual survey is required to record all dimensions of the space; The sketch scheme design part includes hand-painted sketch, sketch, and preliminary planning of the whole design scheme;

Spatial planning, such as personnel use analysis, spatial zoning and functional requirements analysis, is completed through CAD drawing.
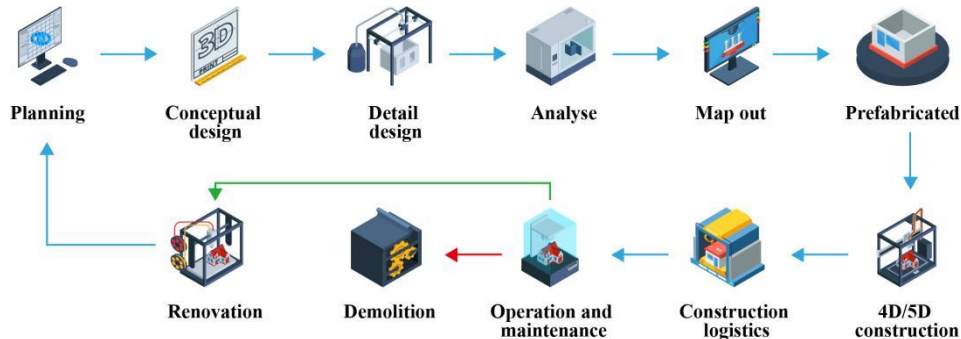

Figure 2: Business process of interior design.

The modeling part is mainly completed in 3ds max; Hydropower design belongs to concealed works, which shall be fully considered in the scheme design. The soft decoration part includes furniture, curtains, decorative small components, etc. it is particularly important for material texture mapping, which mainly plays a role in beautifying the space. Visual design starts from the overall layout, such as the selection of furniture, the collocation of materials, the collocation of household decorative items, the design of lighting, etc. The beautification design is drawn from 3ds Max and finally processed by Photoshop [22].

3.2.2 VR indoor scheme design

Different from traditional interior design projects, this project realizes resource optimization on the basis of effective integration of relevant resources, and uses VR technology to effectively show the design concept. Through effective operation, users can feel the gist of the design in the virtual environment, and then modify it as needed to avoid multiple design modifications caused by communication problems between designers and users [23].

Preliminary design stage:

(1) Project background

The project is a three-bedroom apartment in a real estate with a total area of 130 m^2. The owner is over 40 years old. He likes the heavy color atmosphere and pays more attention to the home environment. In order to enable the owner to select the appropriate scheme, the communication was conducted in the early stage to clarify the owner's requirements for style, spatial layout, color, furniture function, etc. The purpose is to plan and design the scheme according to the needs of customers in the design process. The main features of the project are: the house type is relatively square, and each regional division is obvious. The house type is equipped with an entrance garden, a living room and a dining room with floor to ceiling windows, with good ventilation and lighting in the front and back. Three bedrooms are used as master bedroom, children's room and elderly room respectively. The toilet is divided into primary and secondary toilets.

(2) Plane scheme design

Based on the early communication, data collection, survey, etc., the original plan was drawn. According to the orientation and internal structure of the house type, the indoor planning has been preliminarily completed, including functional zoning, wall structure, furniture placement, ceiling form, and the selection of all wall and ground materials. Finally, the plan is drawn.

(3) VR technology application

3D modeling is the basis of the whole virtual technology and the key to construct panoramic display. The construction of space is mainly based on 3DS MAX modeling, and the purpose is to truly reflect the 3D virtual scene. The quantity and quality of 3D models have a direct relationship

with the operation of virtual interactive system. In this project, the geometric modeling method is used to build a virtual 3D scene. First, the modeling data is obtained from CAD and the spatial scene is built through the geometric modeling method. Then, the hard and soft decoration design is carried out on the model, and then the scene model is optimized to complete the final virtual 3D space scene [24]. The specific process is shown in Figure 3.
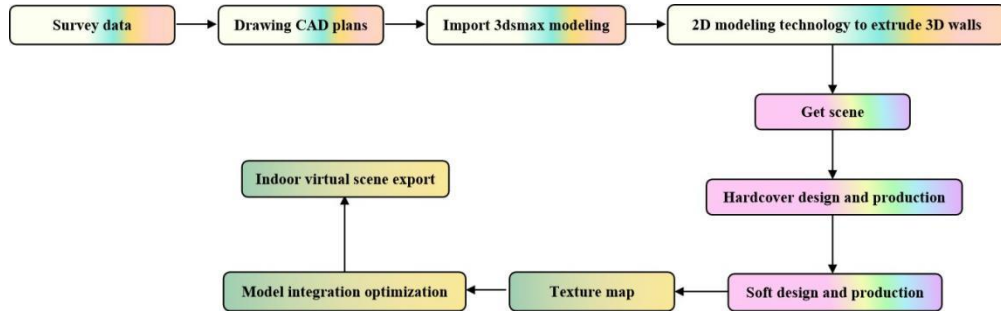

Figure 3: Technical process of indoor modeling.

3.2.3   Scheme deepening stage

There are two main interaction modes of VR system, one is entity manipulation interaction based on physical control, and the other is object picking interaction. The effects of entity operation include translation, scaling and rotation. The position of entities in the scene can be changed through translation, such as moving furniture to observe the position change of space; changing the size of some decorative structures in the scene by scaling, such as adjusting the scale relationship of space objects; the direction change of scene objects is realized by rotation. Another operation is to pick objects in the virtual environment to achieve interaction, such as picking fruits, kettles, cups, and even furniture in the scene. The type and style of furniture can be changed by picking. The interaction method selected in this case is object picking. System interaction includes switching lights, opening, and closing doors, moving path, material replacement, playing video, sound, etc.

3.3   Design Method of VR Technology in Interior Design

3.3.1   Software architecture

The software architecture of the indoor virtual design method based on 3D vision in this paper is divided into six parts, namely, Internet sales, model room preview, overall indoor virtual tour, and customer basic information summary and sorting. Use the virtual design of 3D vision to improve the real immersion of the interior.

4   RESULT ANALYSIS

4.1   Comparison Between VR Technology and Traditional Technology

The comparison between VR technology display and traditional indoor scheme display is shown in Table 1.

Comparison between VR technology display and traditional indoor scheme display							
Vision	Hearing	Tactile sensation	Existing space	Virtual space	Static state	Dynamic	Real time interaction

Hand sketching	Yes	No	No	Yes	Yes	Yes	No	No
CAD drawing	Yes	No	No	Yes	No	yes	No	No
Model	Yes	No	No	Yes	Yes	yes	No	No
design sketch	Yes	No	No	Yes	Yes	yes	No	No
Sample room	Yes	No	Yes	Yes	No	yes	No	No
animation	Yes	Yes	No	Yes	No	No	yes	No
VR	Yes	Yes	Yes	Yes	Yes	yes	yes	yes

Table 1: Comparison between VR technology display and traditional indoor scheme display.

It can be seen from this that the experience of interior decoration scheme space using VR technology can make users have visual, auditory and tactile changes; The scene space of VR production is based on the real space, which can show both static space and dynamic space; In all indoor scheme displays, only VR technology can achieve scene interaction. It can be seen that VR technology display reflects the characteristics of traditional indoor scheme display and is better than other schemes [25].

4.2 Designer's Evaluation on Design and Process

Through the investigation of some designers who have used VR for effect production, this paper makes a comparison between VR technology and traditional indoor scheme production methods in terms of cost, effect, production and modification difficulty. The purpose is to understand the subjective data of designers' VR technology experience from the perspective of designers. (among them, the way to purchase raw materials, generate materials and additional manual installation costs is high cost; the way not to purchase raw materials, and the way not to install is low cost. Use ★ to indicate the effect and the degree of difficulty in production. The more ★ in the effect performance, the better the effect; the more ★ in the degree of difficulty in production, the harder the production). The interior scheme making method has always been the most concerned problem of designers and researchers. Through the investigation of designers, the comparison is made from hand-painted drawings, models, computer renderings, animations and sample rooms. The investigation results are shown in Table 2.

	Cost	Effect	Manufacturing difficulty	Modification difficulty
Hand sketching	Low	★★	★	It cannot be modified and needs to be redrawn.
CAD drawings	Low	★	★★	You can modify and redraw the CAD drawing.
Model	High	★★	★★★	It cannot be modified and has been fixed.
Design sketch	Low	★★★★★	★★★★	It can be modified and takes a long time to plot.
Sample room	High	★★★★★	★★★★★	It cannot be modified and has been fixed.
Animation	Low	★★★	★★★	It can be modified and takes a long time.
VR	Low	★★★★	★★★	Modify at any time and plot in real time; It is

	convenient for customers to participate in the design.

Table 2: Comparison between VR technology display and traditional indoor scheme production

4.3 Public Evaluation on Design and Process

Through the experience of 30 public on VR effect, the satisfaction of corresponding parameter data is tested in the experience as shown in Table 3.

Parameter	3D effect	Spatial continuity	Immersive experience	Lifelike video and audio	Switching of decorative elements	Touchable action interaction	Feeling of freshness	Operability
Satisfied number	25	28	28	20	30	28	15	15

Table 3: Public satisfaction survey on VR effect experience.

For the interaction of indoor touchable actions, users believe that this operation "feels like real". Therefore, according to the investigation and analysis table, VR technology has greatly met the needs of users, improved the participation of users, and achieved "people-oriented" in the design, starting from people's needs and feelings. After data classification, we can clearly see the satisfaction of each experience as shown in Figure 4.
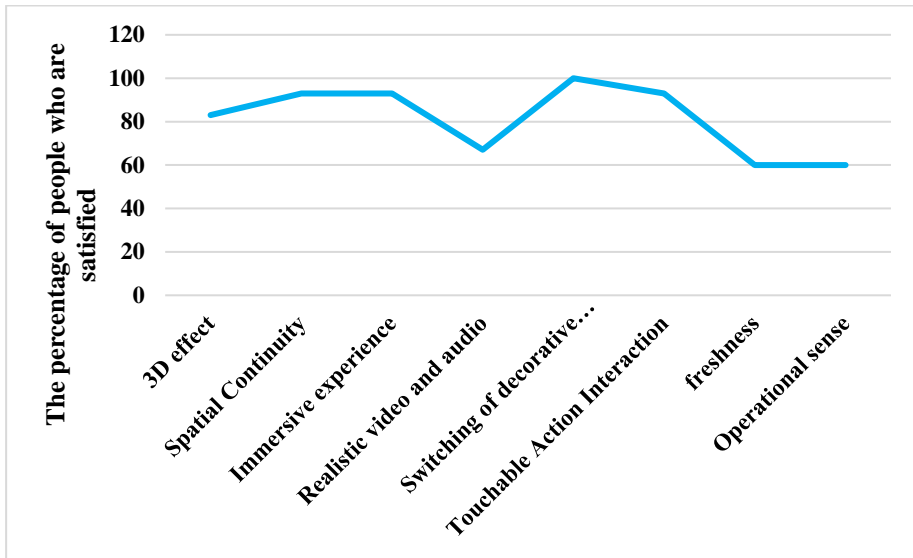

Figure 4: Percentage satisfaction level with different VR effects

5 CONCLUSION

Starting from the reality of the interior design industry, this paper expounds in detail in combination with the characteristics and system of VR technology. Starting from the interior

design process, taking the interior design of multiple projects as an example, this paper compares the traditional interior scheme design method with the interior scheme design method under VR technology, and summarizes the advantages of VR technology in the display of interior schemes. The feasibility and trend of VR technology in indoor scheme are illustrated by examples. The main results of this study are as follows: according to the characteristics of VR technology, VR technology is proposed to be used in indoor scheme design and creation. VR technology has the characteristics of immersion and interactivity. Users can "walk into" the virtual space through sensor equipment, and can view the continuous and overall space 360 ° to present users with an interactive, touchable, visual and audible approximate real space. From the actual project verification, VR technology display can help customers participate in the scheme design and help designers shorten the design time. The paper presents an indoor scheme making process based on VR technology, from CAD scheme design to 3ds Max modeling, from virtual scene model to unity3d platform setting, and from publishing and roaming experience. The feasibility and effectiveness of VR display are obtained by comparing the rendering display with VR display. The defects of the rendering are: repeated modification, long time-consuming, less visible space, etc; Through the use of VR technology to show the actual project, it is proved that the advantages of VR technology are: 360 ° immersive roaming, customers' participation in scheme design at any time, designers' reduction of modification times, users' WYSIWYG, etc. it is finally proved that VR technology provides designers with useful auxiliary design tools.

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