

Innovative Research on Interior Space Design Method Based on Virtual Reality Technology

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Abstract: Aiming at the limitations of traditional indoor space design methods, such as long design cycle, high cost and low user participation, this paper makes a comprehensive and in-depth analysis of indoor space design driven by VR (Virtual Reality) technology. In terms of methods, this paper first combs the core components of VR technology and its application potential in indoor space design, and then shows how VR technology can reconstruct the design process and enhance the interactive experience. The research shows that VR significantly improves the efficiency of interior space design, reduces the design cost and risk, and enhances the user's immersion and participation. In addition, VR technology also promotes the integration of interior space design and other art forms, and promotes the innovation and development of the industry. Therefore, this paper believes that VR technology is an important innovation in the field of indoor space design, and its application prospect is broad.

1. Introduction

With the swift advancement of information technology, VR technology stands out as a pioneering digital interactive tool, progressively penetrating diverse industries and revolutionizing traditional sectors [1]. Interior space design, a conduit between art and everyday life, has historically been constrained by the confines of 2D drawings and physical prototypes, making it challenging to fully and intuitively convey designers' creativity and the spatial impact [2-3]. Hence, the exploration of VR technology in interior design aligns with technological progress while also aiming to transcend traditional design constraints, elevate design efficiency, enrich user engagement, and foster innovation within the industry [4].

This study's importance lies in its provision of novel design instruments and perspectives through an exhaustive examination of the fusion of VR technology with interior space design. It further aims to steer interior design towards a smarter, more personalized, and sustainable trajectory. Primarily, it delves into the innovative application of VR technology in interior design, addressing the drawbacks of conventional methods such as prolonged design cycles, elevated costs, and limited user involvement.

2. VR technology foundation and interior space design principle

2.1. Overview of VR technology

VR technology represents a sophisticated computer simulation approach, immersing users within a computer-crafted 3D environment that either mimics reality or conjures up imaginary realms [5]. It integrates principles from computer graphics, human-computer interaction, sensor technology, and artificial intelligence to deliver a multi-sensory, interactive encounter.

Within the VR realm, users, equipped with a VR headset and interactive devices like handles, gain the liberty to observe, navigate, and engage with virtual objects [6-7]. This immersive experience makes users feel as if they are in a real environment, thus enhancing the authenticity and participation of perception.

The core components of VR technology include hardware devices and software systems [8]. These components work together to realize the construction, rendering and interaction functions of virtual world.

2.2. Basic principles of interior space design

Interior space design is a comprehensive process, which involves many aspects such as space layout, function division, color matching, material selection and so on [9]. When designing indoor space, the basic principles should be followed as shown in Figure 1:

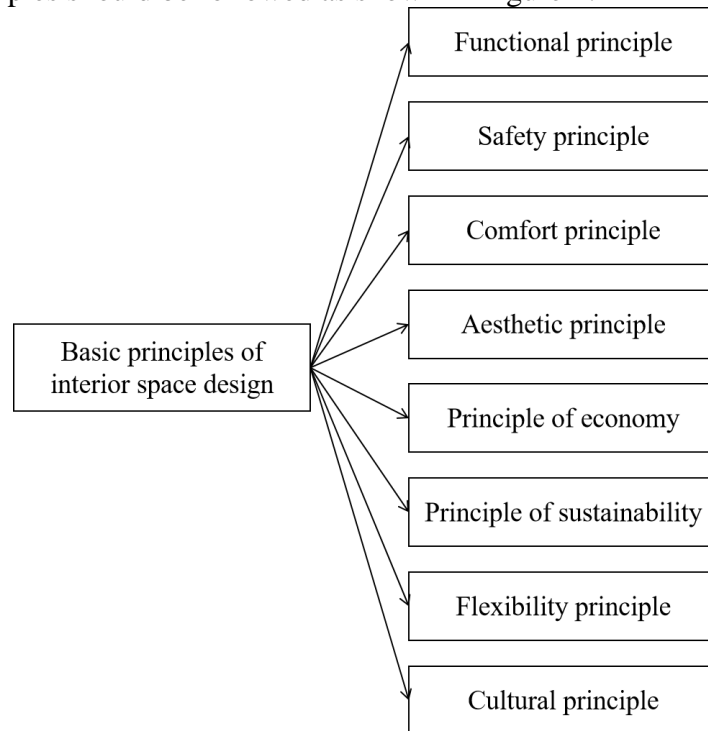


Figure 1 Basic principles of interior space design

The integration of VR technology and interior space design provides designers and users with a brand-new design experience and display mode [10]. The following are the main paths for the integration of VR and interior design: design conception and preview, interactive experience and evaluation, construction simulation and training, exhibition and marketing.

3. Innovative practice of interior space design driven by VR technology

3.1. Reconstruction of design process

Driven by VR technology, the interior space design process has undergone profound changes. Traditional design processes often rely on hand-drawn sketches, two-dimensional drawings and physical models, which are not only time-consuming and laborious, but also difficult to fully show the design effect. With the introduction of VR, the design process can be reconstructed and become more efficient and intuitive.

First of all, in the conceptual stage, designers can use VR technology to quickly create three-dimensional models and make preliminary spatial layout and style setting. In this way, designers can freely move, observe and adjust design elements in the virtual environment, so as to capture inspiration more quickly and realize instant visualization of creativity.

Secondly, in the detailed scheme design stage, VR technology provides powerful simulation and preview functions. Designers can simulate different lighting conditions, material texture and furniture placement to evaluate the feasibility and aesthetics of the design scheme. In addition, through VR technology, designers can also simulate the user's behavior path and line of sight flow, thus optimizing the spatial layout and dynamic line design.

Finally, in the stage of effect display and evaluation, VR technology provides an immersive

experience environment for designers and customers. Customers can wear VR helmets, enter the virtual space, experience the design effect and give feedback. This method not only enhances customer participation and satisfaction, but also improves the efficiency and accuracy of design decision.

3.2. Innovation of interactive experience

VR technology has brought unprecedented interactive experience innovation to interior space design. Traditional design methods often lack interactivity, and it is difficult for customers to intuitively feel the design effect [11]. And VR technology enables customers to experience the design space by simulating the real environment and interactive behavior.

In VR environment, customers can walk around, touch and operate virtual objects freely, and feel the scale, material and atmosphere of space. This interaction not only enhances the immersion and participation of customers, but also enables designers to capture customers' needs and preferences more accurately. In addition, VR technology can also simulate different scenes and situations, such as day and night changes, seasonal changes, etc., to provide customers with a more comprehensive and real experience.

Through the interactive experience innovation of VR technology, the communication between designers and customers becomes smoother and more efficient. Customers can better understand the designer's intention and creativity, and designers can more accurately grasp the customer's needs and expectations, so as to jointly create more satisfactory design works.

4. Analysis of the influence of VR technology on indoor space design

4.1. Cultural and aesthetic trends

The wide application of VR technology has a far-reaching impact on the cultural and aesthetic trends of interior space design. On the one hand, VR technology provides designers with richer design elements and expression techniques, enabling them to create more diverse and personalized design works. These works not only meet people's needs for beauty and comfort, but also reflect different cultural characteristics and aesthetic concepts.

On the other hand, VR technology also promotes the integration of interior space design with other art forms. Through VR technology, designers can integrate music, painting, sculpture and other art forms into indoor space, creating a more artistic and cultural environment. This cross-border integration not only enriches the connotation and extension of interior space design, but also provides people with a more diversified and comprehensive aesthetic experience.

4.2. Socio-economic effect

The application of VR technology in the field of interior space design has produced remarkable social and economic effects, as shown in Figure 2:

First of all, it improves the design efficiency, and reduces the design cost and risk. Through VR technology, designers can respond to market changes and customer needs more quickly, shorten the design cycle and improve the design success rate. At the same time, VR technology can also reduce the production cost of physical model and model room, and reduce the design cost.

Secondly, VR technology promotes the innovation and development of interior space design industry. It provides designers with new design tools and ideas and stimulates their creativity and inspiration. At the same time, it also promotes the cooperation and exchange between the design industry and other industries, such as the integration with real estate, home furnishing, science and technology, and brings new growth points and development opportunities to the industry.

Finally, VR technology also enhances the social value and economic benefits of indoor space design. By optimizing the spatial layout and functional settings, improving the utilization and comfort of space, VR technology has created a more livable and suitable environment for people. At the same time, it has also promoted the development of related industries and increased employment opportunities, and contributed to the prosperity and development of social economy.

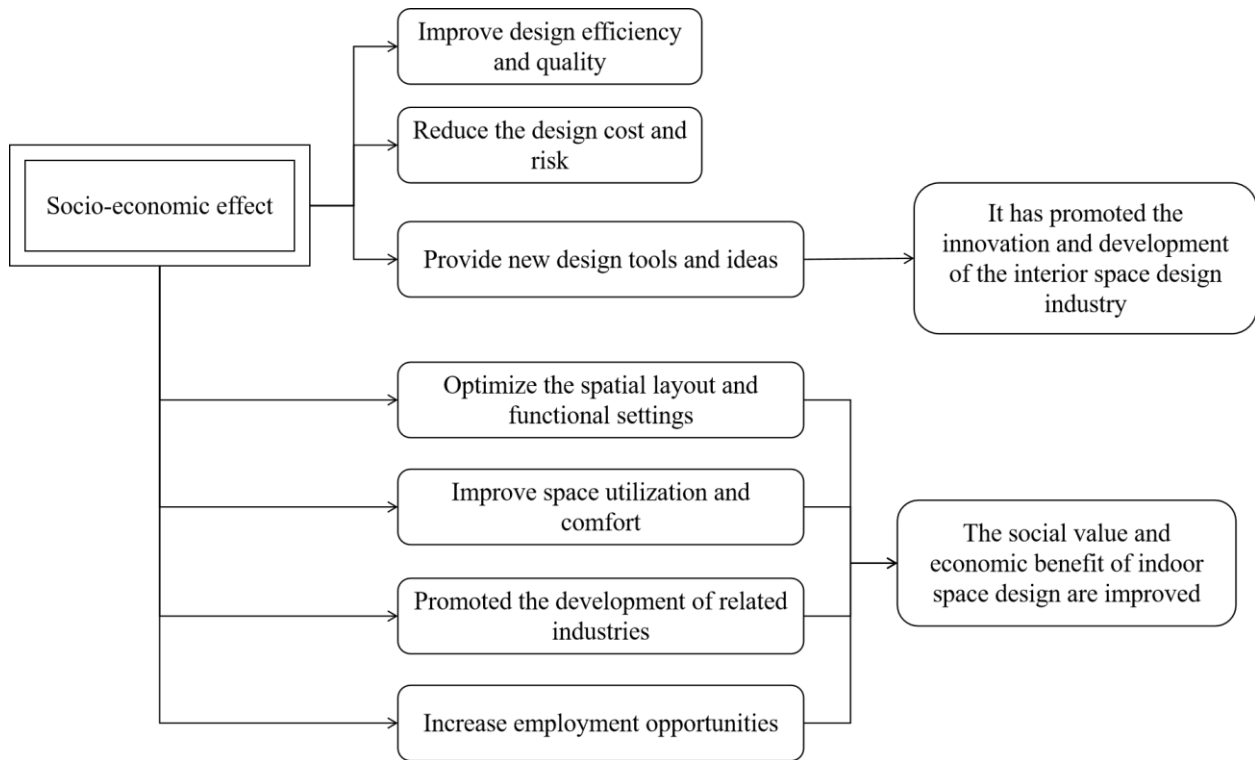


Figure 2 Socio-economic effect

5. Challenges and opportunities

Despite significant achievements, the application of VR in interior design still encounters challenges and presents opportunities. A primary hurdle is the elevated cost of VR hardware and software, coupled with a low adoption rate, which hampers widespread use and promotion in this field. Addressing these issues by lowering costs and enhancing performance is imperative.

Another challenge lies in the absence of unified standards and protocols for VR applications in interior design. Variability in software and equipment among designers and teams leads to poor compatibility and interoperability. Establishing such standards and fostering interconnectivity between different tools is crucial.

Concurrently, VR offers fresh avenues for interior design. As technology advances and applications broaden, VR's role in this domain will grow more pivotal. Integration with AI, big data, and IoT, for instance, can enable smarter, personalized design services and streamline home life experiences. These prospects introduce new growth vectors and expand the horizon of the interior design industry.

6. Conclusions

This study conducts a thorough examination of VR technology's application in interior design, overhauling the design workflow, innovating interactive experiences, and exploring its cultural, aesthetic, and socio-economic impacts. The findings highlight VR's substantial contributions to enhancing design efficiency, quality, and user engagement while cutting costs. Furthermore, VR facilitates the convergence of interior design with various art forms, spurring industry innovation.

Practically, this research offers interior designers novel tools and concepts, boosting efficiency, quality, and cost-effectiveness. It also serves as a valuable guide for the industry's innovative development.

Despite VR's promising potential, its high hardware and software costs, limited penetration, and absence of unified standards hinder widespread adoption. Moreover, VR still faces constraints in simulating realistic environments and interactions, necessitating ongoing refinement. Future research should delve into integrating VR with AI, big data, and other technologies for smarter,

personalized design services. Additionally, exploring VR's applications in smart homes and cities can broaden its reach and value.

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