

Exploration and application of mixed reality technology in modern home design

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Abstract: The exploration and application of Mixed Reality (MR) technology in modern home design has become a research field that attracts much attention. MR technology has brought unprecedented innovation opportunities for home design. By integrating virtual elements into the real environment, designers can cooperate with customers in a more interactive and visual way, making it easier for them to understand design concepts and choices. This improves the customization of the design, strengthens the user experience and is expected to improve customer satisfaction. MR technology also plays a key role in the visualization of the design process. Designers can create virtual models to present different design schemes in the actual environment, thus reducing the number of design modifications and saving time and resources. This is expected to improve the efficiency and accuracy of the design. This paper first introduces the concept of MR technology, then summarizes the application of MR technology in modern home design, and finally discusses the challenges and future prospects of MR technology for reference by peers.

1. Introduction

In modern society, home is not only a practical space, but also a symbol of lifestyle and taste. With the rapid development of science and technology, Mixed Reality (MR) technology has become an eye-catching innovative tool in the field of home design. MR technology combines the virtual world with the real world, which brings unprecedented possibilities for home design and provides a more intelligent, convenient and innovative living experience [1].

Home design has always been a field of continuous evolution and improvement. Designers pursue the best way to meet the needs of families, while considering aesthetics, functionality and sustainability. The brand-new vision of MR technology provides a new creative platform for designers, which can solve design problems in an unprecedented way [2].

This paper will discuss the application of MR technology in modern home design, focusing on its principle, application fields, challenges and future prospects. Through in-depth study of MR technology, we can better understand how to use this technology to create smarter and more innovative homes to meet the evolving modern lifestyle and needs. The future of home design lies in the integration of traditional aesthetics and modern technology, and MR technology just provides the possibility to realize this vision. The goal of this paper is to provide a starting point for home designers, technology developers and decision makers to deeply explore the application of MR technology in modern home design, so as to stimulate innovation and improvement and create a

more comfortable and intelligent living environment for families.

2. Overview of MR technology

MR is an evolution form of augmented reality (AR) technology, which integrates the virtual world and the real world, making the virtual objects interact and coexist with the real environment. The working principle of MR technology involves many key elements such as perception, calculation and display, so as to realize the interaction between users and virtual content and make users feel that virtual objects are really around them [3-4]. The main contents of MR technology are shown in Figure 1 below:

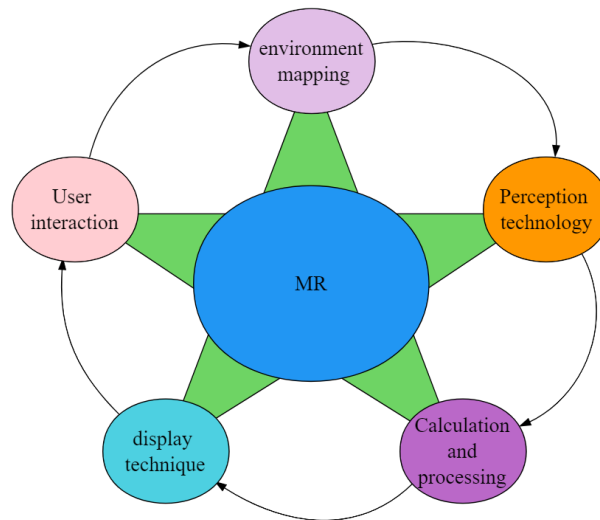


Figure 1: MR technical content

Sensing technology: MR systems use various sensors and devices to sense users and the surrounding environment. This includes cameras, depth sensors, gyroscopes, accelerometers, etc., which can capture the user's position, direction, gestures and information of surrounding objects [5].

Environment mapping: MR system will create a virtual environment mapping, which will correspond the virtual content with the real world. This usually involves spatial positioning and object recognition to ensure that virtual objects can interact with real objects.

Calculation and processing: Based on the perceptual data, MR system will calculate the position and direction of virtual objects in the real world, and decide how to present these virtual objects, so that they appear to blend in with the surrounding environment. This includes calculation and processing steps such as graphic rendering, physical simulation and user interface interaction.

Display technology: MR systems usually use head-mounted displays (such as smart glasses) or other display devices to project virtual content into the user's field of vision. These display devices can be transparent or translucent, so that users can see the real world and interact with virtual objects.

User interaction: Users can use gestures, voice, controllers or other input devices to interact with virtual content. MR system will update the virtual environment according to the user's actions and instructions to reflect the user's interaction.

Generally speaking, the working principle of MR technology is to integrate the virtual world with the real world, and provide users with an enhanced interactive experience with the real world through key technologies such as perception, calculation and display. This technology has a wide application prospect in the fields of education, entertainment, medical care, military and industry, and can create rich virtual experiences while retaining the real world environment and interactivity.

3. Application of MR technology in modern home design

The application of MR technology in modern home design can improve efficiency, reduce mistakes, and provide better communication and cooperation opportunities for designers and residents. This helps to create a more satisfactory home design, while reducing wasted time and resources. MR technology has great potential in modern home design, which can improve the design experience of users, enhance the decision-making process and provide highly personalized solutions. The following is the application method of MR technology in home design:

3.1. Virtual home roaming

Virtual home roaming is an experience that allows users to roam and explore virtual home space as in the real world through virtual reality (VR) or MR technology. This concept is very valuable in the field of home design and real estate, because it can provide a more realistic and immersive way for designers, developers and potential buyers or tenants to better understand and evaluate the unfinished or modified residential space [6-7].

Users can enter a virtual home space through head-mounted VR devices (such as VR helmets) or MR glasses and feel that they are in it. This immersive experience allows users to better understand the room layout, sense of space, furniture placement and so on. Usually you can move freely in a virtual environment, similar to walking in the real world. They can roam between different rooms, observe the details, open doors and windows, and even interact with virtual furniture to better understand the design details [8]. Virtual home roaming usually has real-time interactive function, and users can interact with objects in the virtual environment, such as turning on lights, changing colors, moving furniture, etc., so as to conduct experiments in actual decision-making. Virtual home roaming can also allow remote users, such as potential buyers or tenants, to conduct virtual roaming and evaluation from remote locations through the Internet without going to the property in person.

Virtual home roaming technology provides innovative tools for home design and real estate field, which enables relevant parties to better understand and interact with design, thus improving and optimizing residential space. This also helps to speed up the sales process, improve customer satisfaction, and reduce the risks related to the actual real estate transaction.

3.2. Real-time design preview

Using MR technology, designers can show different design schemes in real time. Residents can view the virtual presentation of furniture, wallpaper, colors, etc. through smart glasses or mobile applications, so as to quickly compare different design options. Designers need to create or import virtual models, including house layout, furniture, decorations, etc. These models need to match the actual home design. Before using MR equipment, map the environment of the design space. This is achieved by sensors and cameras built into the device, which will capture and map real-world spaces and objects in real time [9]. Using MR equipment, the content of virtual home design is projected into the user's field of vision, making it look like it really exists in the real space. This requires accurate spatial positioning and tracking technology to ensure that the virtual object matches the actual home.

By using MR technology, users can get a more realistic design preview in the real home, so as to better understand and evaluate different design options, reduce unnecessary design changes and costs, and improve the communication and interaction of home design. This helps to achieve more satisfactory home design results.

3.3. Spatial survey and plan

Using the spatial sensing function of MR equipment, accurate floor plan can be easily measured and created. This helps to ensure that the design conforms to the actual space size and reduces the time of measurement and drawing. MR technology can use cameras and sensors to measure the size and shape of home space. Designers can wear MR devices, such as smart glasses or helmets, and then observe the home space through these devices to obtain accurate dimensional data in real time. This eliminates the tedious steps of traditional measurement and improves the accuracy.

Using MR technology, designers can create virtual floor plans in real space. They can view the real-time floor plan through MR equipment, and put elements such as furniture and decoration directly on the virtual drawing to better understand the design layout. Such a virtual floor plan can be shared with customers for feedback and real-time modification.

3.4. Virtual furniture layout

In modern society, home design becomes more and more important, and people pursue innovative and personalized home experience. Furniture layout is a key link in the design process, which determines the style and comfort of a room. Traditional furniture layout methods usually involve moving and adjusting furniture in real rooms, which is often a time-consuming and laborious process. However, the rise of MR technology has brought new possibilities for virtual furniture layout and provided users with more intuitive, convenient and innovative experiences [10]. Residents can use MR application to virtually display furniture and decorations, so as to better understand layout selection, how to optimize space utilization and the spatial relationship between furniture (Figure 2).



Figure 2: Virtual furniture layout

MR technology allows users to view virtual furniture in their real rooms in real time, so as to better understand their appearance and suitability in space. Users can try different furniture layouts in the virtual environment and adjust the size, color and style of furniture to find the best solution for their tastes and needs. Traditional trial and error methods may lead to expensive design errors. MR technology allows users to find and correct problems before buying actual furniture, thus reducing costs and waste. Users can use gestures, voice commands or controllers to interact with virtual furniture, making the design process more intuitive and interactive.

3.5. Real-time collaboration

In the era of globalization and digitalization, distance is no longer the limiting factor of cooperation. However, in the field of design, effective collaboration between designers and

customers is still challenging. Customers and designers may be located in different geographical locations, and time zone differences and business trips may lead to delays and poor communication. MR technology provides new possibilities for solving these problems. Using MR technology, designers and customers can collaborate remotely in real time, no matter where they are. They can view the design together and discuss modifications or changes.

MR technology combines VR with the real world, and integrates digital information with the physical world for real-time interaction: MR technology can realize real-time interaction between designers and customers, so that they can jointly discuss and modify the design scheme in the virtual environment. MR technology allows the design model to be presented in three dimensions, and customers can understand the design concept more clearly, not just relying on plane drawings or text descriptions. Designers and customers can be located anywhere in the world, and they can still collaborate through MR technology, thus eliminating the limitation of geographical distance.

Designers can create virtual design models, and customers can browse and review these models through MR glasses or devices to provide feedback and suggestions. Designers and customers can modify the design together in the virtual environment, and immediately see the effect of the modification, so as to quickly iterate and improve the design. Designers can use MR technology to create virtual demonstrations, visualize design concepts, and help customers better understand and accept design concepts. MR technology provides new opportunities for remote collaboration between designers and customers, which can greatly improve collaboration efficiency and promote innovation and communication. By making full use of this technology, the design industry can move towards a more digital and global future and achieve a higher level of design results.

3.6. Custom design

Through MR technology, residents can be provided with highly personalized design solutions to meet their specific needs and preferences. MR technology enables designers to intuitively create and adjust home design schemes in virtual environment. By wearing MR helmet, designers can immediately see the effect of design concepts in real space, which accelerates the speed and accuracy of the design process. The communication between designers and customers becomes smoother. MR allows designers to visually show design concepts to customers, making it easier for customers to understand and participate in design decisions. This real-time interaction helps to improve customer satisfaction, reduce misunderstandings and reduce the number of design revisions. MR technology enables consumers to participate in the customization process, and they can choose their own furniture, colors, materials and layout in the virtual environment to meet their individual needs. This not only improves the customer's sense of participation, but also ensures that the final design meets their expectations.

Consumers can use the MR application to preview the appearance of furniture and decorations at home. This will help consumers make more informed shopping decisions and reduce the return rate, thus reducing waste and environmental impact. MR technology reduces the waste of resources when manufacturing and designing customized home products. Customers can preview the design in a virtual environment, thus reducing unnecessary manufacturing and material use and helping to reduce the environmental burden. MR technology also helps to optimize the energy utilization of the home. Designers can simulate different lighting and energy configurations to determine the most energy-efficient solution, thus reducing the energy consumption of families.

4. Challenges and future prospects of MR technology

The application of MR technology in home design has great potential, but it also faces some challenges. The cost of MR equipment, software and development is still high, which may limit the

use of small and medium-sized home design companies and individual designers. In the future, it is necessary to reduce the cost to make this technology more widely available. MR technology is still developing, including hardware and software. This may lead to technical reliability and stability problems, which need further improvement and stability. In MR home design, it involves the customer's personal information and family layout. Therefore, data privacy and security issues need to be properly resolved to prevent data leakage or abuse. MR technology requires users to accept new interfaces and interaction methods, which may take time and training. Both designers and consumers need to adapt to this new technology.

With the development of technology and the decrease of cost, MR will become a conventional tool in the field of home design, not only in the high-end market. MR is expected to make personalized home design easier to realize, customers can participate more in design decision-making, and customized home will become the mainstream. MR can help designers and consumers to better consider sustainability factors, such as energy utilization and resource use, in order to create a more environmentally friendly home. On the whole, MR technology has great potential in home design. Although it faces challenges, with the continuous progress of technology and the increase of social acceptance, it will become a key tool in home design, bringing more opportunities for more personalized, sustainable and collaborative design.

5. Conclusions

The exploration and application of MR technology in modern home design has aroused extensive interest and research, bringing new possibilities to the field of home design. MR technology can enhance the user experience of home design and enable users to interact between the virtual world and the real environment. This helps users to better understand and evaluate the design scheme and improve their satisfaction. Generally speaking, the application of MR technology in modern home design provides designers and customers with more tools and resources to improve the design process and results. With the continuous development of technology, we can expect MR to play a greater role in home design and promote innovation and progress in this field.

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