

Hybrid Design Strategy: Innovative Applications of Interactive System and Augmented Reality in Architectural Design

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ABSTRACT

With the rapid development of information technology, traditional architectural design methods are facing the challenges of efficiency and personalized needs. Interactive design systems and augmented reality technology provide new ideas to solve these problems. The paper first outlines the basic concepts of interactive design systems and augmented reality, and analyzes their practical applications in interior design, cultural heritage conservation, and participatory housing design. By elaborating on the technical platform and implementation mode, this paper shows how these technologies can promote effective communication between users and designers at the early stage of design, and enhance the visualization and collaborative efficiency of design.

KEYWORDS

Hybrid Design Strategy; Interactive System; Augmented Reality; Architectural Design.

1. INTRODUCTION

With the rapid development of digital technology, the traditional architectural design methods have been difficult to meet today's efficient and personalized needs. Interactive design system and augmented reality technology, as new digital tools, have brought revolutionary changes to architectural design [1]. By optimizing the human-computer interaction in the design process, the interactive design system enhances the collaboration between designers and users, and improves the design efficiency and personalization level. Augmented reality technology integrates virtual reality and reality, provides a more intuitive design experience, and enhances the user's sense of participation and immersion. This paper aims to explore the application and innovation of these technologies in architectural design, and analyze their practical significance in interior design, cultural heritage protection and participatory housing design.

2. CONCEPTS OF INTERACTIVE SYSTEMS AND AUGMENTED REALITY

Interactive design system is a cross-domain system which realizes human-computer interaction and product interaction on the basis of people-oriented. It is the need of era development and economic development to incorporate the interactive design system into the design of the indoor environment of the housing construction, which can make the indoor design image more visual through the network technology, subtly merge the technology and environmental art together, and quickly transmit the relevant design information between the designer and the user, so as to meet the needs of the user and continuously improve the design efficiency of the designer. Thereby improving the environmental quality of the residence and promoting the sustainable development of the residence.

XR for short, the "X" in "XR" is a placeholder-like existence, which can be V (R), A (R) or M (R), or even any point on the "real-virtual continuum" model. So XR actually covers all the hardware, software, methods and experiences that can merge the immersive technology of physical and virtual worlds. XR combines physical objects with simulated scenes to create an experience of the boundary between reality and virtual, with four characteristics of situational awareness, sensory substitution, intuitive interaction and editing reality [2]. In an ideal world, virtual objects in a computer are fully capable of interacting with human operators and real objects.

3. APPLICATIONS OF INTERACTIVE SYSTEM IN ARCHITECTURAL DESIGN

3.1. Interactive Design System for Indoor Environment

The application of interactive design system in the construction of indoor environment of residential buildings can enhance the communication and exchange among design units, material supply units, construction units and owners, and each unit can timely and accurately obtain other information, so that the value and role of interactive design system can be fully developed to better meet the individual needs of users in design. Highlight the characteristics of environmental design [3]. Taking the menu design as the origin of interactive design, the interactive design system is used to lay a good foundation for the construction of indoor living environment, and at the same time to realize the guidance and planning of the whole construction process. Interactive design system includes design, manufacturing, equipment, management and other aspects. At present, the residential interior design industry attaches great importance to the menu design, which can not only guide users to participate in the whole design process, but also facilitate other units to obtain information, laying a good foundation for the maintenance and renewal of residential buildings in the future. Through the menu design, the management of residential building interior environment design is optimized, and the level of construction is significantly improved. In addition, the menu design also includes drawing management, process management, quality supervision and other aspects, which can make the project design management more rapid, efficient and accurate.

3.2. Interactive Design System Technology Platform

The construction of interactive design system technology platform can provide a platform for good communication between users and industries, and realize the effective integration of all kinds of information and processes. The realization of interactive design system technology platform must be supported by advanced digital technology, the first is the application of three-dimensional building information model technology, the second is the establishment of human-computer interaction interface, the industry and users can obtain the required data under their respective authority. Finally, the network information technology is used to realize the organization and management of all aspects of data information, and to maintain the consistency and sharing of product data in the life cycle. In the aspect of three-dimensional building information model, the digital information simulation technology is used to simulate the real information of the building and establish a fully parametric three-dimensional model. The relationship and geometric shape of the relevant positions are changed by means of parameter adjustment. When the data of a certain position changes, the data of other places will change accordingly, and the whole project is completely related. In addition, it can also transform the three-dimensional solid model into plane information, obtain all kinds of data needed for product manufacturing and documentation, and realize information sharing between manufacturing and design departments. Three-dimensional solid model data can also be applied to numerical control processing, which significantly improves the processing efficiency and accuracy, and promotes the integrated development of product manufacturing process. In the aspect of network information technology, network information technology is the operation basis of interactive design

system. The database established by computer three-dimensional model not only contains the relevant information of architects, but also contains all aspects of information from design to use. The information can be used in the communication between users and designers, designers and manufacturing enterprises, users and developers, etc. The realization of these functions needs to be supported by network information technology.

4. APPLICATIONS OF AUGMENTED REALITY TECHNOLOGY IN THE FIELD OF ARCHITECTURE

4.1. Cultural Preservation

The decaying state of the apartment has led to public discussion about the meaning of its existence and its future. However, the discussion has been unable to find a balance between the historical impact and practical value of the building. Schnabel and others use augmented reality technology and 3D modeling to provide the public with an opportunity to enter the apartment and understand the history behind the decaying appearance of the building, so as to study how cultural heritage conveys architectural significance in a multi-dimensional virtual environment in the digital context [4].

Firstly, the researchers constructed a three-dimensional digital CAD model based on the original construction drawings of the apartment, reproduced the original state of the apartment in detail, and then obtained the three-dimensional data of the current situation of the apartment through laser scanning and photogrammetry technology, recording the dilapidated state of the apartment today, which is in sharp contrast to the original state of the CAD model. After the creation of the virtual heritage space, the first scene of its digital narrative is the construction site of the apartment. The system first shows the scene of the construction of the apartment in 1957 in a scale of 1:1, explaining what the foundations of the building look like and how they function, thus marking the beginning of an exhibition about the structure of the building. It then engages users with scale models, photographs, and other forms of documentation to guide them through the depth of each apartment and the various spatial qualities of the building. The model shows the building from the aspects of section, plan and elevation, which is convenient for the public who have not received architectural training to obtain building information. The system allows users to push and pull any unit in the digital model to study the modular characteristics of the structure. Through interaction, users can participate in it according to their past experience, thoughts and learning ability, view the details they are interested in from the model or document, and thus make a personalized interpretation of the heritage value of the apartment [5].

After the exploration of the construction site, the user is moved to the next stage, which is the scene of the apartment. Users can explore the building's entryway and any apartment from a first-person perspective, and switch between the apartment's past and present States. In order to further enhance the user's understanding and participation, users can also hear "oral history" about specific parts of the building from headphones as they pass through various spaces of the building, such as hearing residents talk about their experiences as they enter the room to increase immersion. In addition, the project also designed a flight scenario that allows users to fly around a 1:1 apartment model and observe the building in a way that can not be imagined with documentary records.

The concept of virtual museums is not new. It has been developing with the innovation of interactive media since the 1990s. Museums such as the Louvre Museum in Paris, the San Francisco Museum of Modern Art and the Karlsruhe Center for Art and Media are all pioneers in providing digital collections. From the initial click of a mouse, to data visualization, to today's immersive technology that provides an immersive experience. The development of digital technology has an important role in promoting the virtual museum, and the progress of theory, such as literature classification, reproduction and dissemination, is also the three main activities that affect the creation of the virtual museum.

The creation of early virtual museums was mostly limited to the characteristics of the three-dimensional physical world, such as static space constrained by gravity and one-way corridors. This study shows that the introduction of extended reality technology is conducive to enriching the possibilities of virtual museums, not only rebuilding the tangible virtual space according to the intangible documentary records, making the intangible real and sensible, but also generating user-oriented digital story narration through the multi-dimensional interaction between users and content, and promoting the public. And participate in relevant discussions.

4.2. Residential Design

Participatory housing design should be a co-creation process based on communication, sharing, cooperation and coordination. The form of design participation should have the characteristics of interest, ease of use and semi-openness, and emphasize the information output and definition needs of participants. However, in the early stage of participatory design, it is impossible to reach a consensus on design strategies in a short time, whether between residents or between residents and architects. Therefore, how to promote communication on the basis of seeking common ground while reserving differences is the key to improve the effectiveness of participatory design for high-density residential buildings. However, as non-professionals, residents often do not have the knowledge of drawing design, software drawing and structural mechanics. Due to the lack of common language, there are often communication barriers between participants with different knowledge backgrounds.

In order to solve the above problems, the author developed a participatory design platform Module based on augmented reality. The platform aims to explore the application of virtual environment as a common language in the participatory housing design process, so as to promote non-professional participants to conceive, communicate and negotiate according to their own ideas, and ultimately achieve the feasibility of cross-professional and multi-type cooperation. In the past cases, the auxiliary role of virtual reality technology in architectural design is mainly reflected in the later stage of design, which is used to enhance the visualization effect and display the design results in an all-round way. But on the module platform, the users of the building can communicate with the architect at the early stage of the design, and effectively communicate and negotiate their needs and desires.

Module is a 3D visual design platform for the Internet of Things based on Java script-based code WebGL architecture, which is inspired by simulation construction games and integrates the elements of games into the participatory design process, making the bottom-up collaborative approach easier to understand. The design tools in the platform can generate a variety of design options for individual users, and resolve conflicts of interest among users by setting rules and parameters. The system of module is divided into three main modules, namely, 3D design module, data management module and real-time communication module. The 3D design module first takes the STL file as the input, and then converts it into a triangular geometric model. The model will then be manipulated by the architect in the background of the system using an open structure (digital) that will allow the architect to set design constraints and design degrees of freedom. The physical and environmental parameters will be mapped into the geometry accordingly and then act as a "scoring" system for the user during the design process. Data containing user profiles is stored in a data management module using "Redis", an open-source data structure server. In the communication module, the system uses open-source code Node.

5. CONCLUSION

In contemporary architectural design, the innovative application of interactive systems and augmented reality is gradually changing the design method and user experience. By combining virtual and real interactive technologies, these tools not only improve the visualization of design, but also enhance the user's sense of participation and collaboration efficiency. This paper explores the optimization of interactive systems in interior design and management processes, as well as the

application prospects of augmented reality in cultural heritage conservation and residential design. The application of these technologies not only promotes the digitalization and intellectualization of architectural design, but also meets the needs of users for personalized and immersive experience. In the future, with the continuous progress of related technologies, interactive systems and augmented reality will be more widely and deeply used in the field of architecture, providing support for more efficient and intelligent architectural design.

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