The Application of Virtual Reality in Building Design

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Abstract. With the dramatic development of information technology, science and technology have been changing our lifestyles and environments profoundly. As social places providing cultural, recreational, and show functions, buildings have already under through many transformations in design, from merely visible into invisible, reality into virtual reality, and physical into spiritual. New technology brings in new ways of artistic expression and new possibilities of expressive forms; hence, building design ought to keep pace with the times. This paper aims at analyzing the features of Virtual Reality and its application in building design, exploring the relationship between science and art, as well as predicting future trends for the technology in the building design field.

Keywords: Information Technology, Science and Technology, Building, Virtual Reality.

1. From "Made in China" to "Wisdom in China"

Since the 70th anniversary of the founding of New China, China has achieved tremendous advancements in manufacturing. For instance, the shifts from manned to unmanned driving, 4G to 5G network, tangible products to intangible Big Data, physical design to virtual design, and the traditional artificial computing to the precise BIM parametric design have witnessed China's unprecedented development in science and technology.

Manufacturing has always been the backbone of the national economy, while science and technology are the first productivity on which to build up a nation and to promote the national economy. According to the "13th Five-Year Plan", China aims to upgrade the plan of "Made in China" into "Wisdom in China." The expression "wisdom" conveys numerous and profound meanings. It expects not only the technology up-gradation or the enterprise transformation but also the synchronous improvements in design-related fields and achievements in collaborative work of creative ideas.

Currently, technologies like GIS, Parametric Design, Nonlinear Design, BIM, and Virtual Reality have been widely applied to the design field and have made some progress.

2. Features of Virtual Reality

Virtual Reality was first advocated by the VPL corporation in America, which was purposed to create an interactive, immersive virtual environment with three Dimensions produced by computers. Virtual Reality is a collection of computer technology, information data, and simulation techniques, capable of simulating the real situation. And the most prominent feature of it lies in its immersive, interactive, and autonomous performance.

2.1 Immersion.

Architectural space collectively refers to the interior and exterior of a building constructed by various material, information and mode elements to meet people's material and spiritual needs [1].

It is difficult for us to precisely imagine the feelings of being in a completed building through the traditional building design activity, while the Virtual Reality technology can indeed realize the idea. Because the real space environment can be simulated and reduced by computers and then converted into visual messages, effectively connecting people with the virtual space environment. The method mentioned above ensures designers to accurately realize their ideas from the design to the completion of construction.

2.2 Interaction.

The interaction of Virtual Reality technology relies on computers and stereo display devices. Man-machine conversations and interactions can be achieved in Virtual Reality technology in that the image formation of three-dimensional figures can deliver visual messages, and a person's actual operation can have following real-time feedbacks by the pressure-sensing technology. For example, applying Virtual Reality to rendering software would assist designers in changing the layouts of objects, modifying models, or arranging lights in virtual scenes by using virtual handles.

Furthermore, Virtual Reality also can be applied to three-dimensional graphing software. After a building is generated in the software, when the building parameters are input, we can use the virtual handles to control the layout of the external wall as well as to change its material. The interaction of man-machine is far more convenient and time-saving than traditional modeling software. Meanwhile, it enables customers to participate in designing together with designers, which allows designers to mostly satisfy their customers in that the designers can have immediate communication with customers and receive revisal suggestions from them.

2.3 Imagination.

The emphasis on Virtual Reality technology leaves us promising imaginations with its ability to extend the recognition boarders of mankind. Because it can restore the real environment and randomly create a world that is not objectively existent or impossible to exist, which are the most dominant specialties of Virtual Reality[2], through the immersive and interactive characteristics, we can make use of the technology to design building spaces, to experience design, and to express design ideas in virtual reality, improving customers' experience on the space design. Generally, various design plans about imaginations on the scenes of future buildings will be put forward in building design. Virtual Reality allows these different proposals to be switched synchronously for the purpose of comparing the strengths and weaknesses of various schemes to make further decisions [3].

3. The Application of Virtual Reality in Building Design

The Optical Glass House, located on the street of Hiroshima, Japan, standing among city buildings, is the design work of Hiroshi Nakamura, a Japanese designer. The exterior facade of the building is composed of more than 6,000 pieces of glass bricks and particularly shining under the sun. Compared with the two-dimensional interface, the three-dimensional one provides more visual, auditory, and feeling effects with designers. The application of Virtual Reality plays a crucial role in how to demonstrate building more desirably and how to convey design conceptions. Moreover, it allows customers to experience the real effect before a project is completed at the creation stage. Also, communications in virtual reality can avoid information losses more effectively, compared with the traditional way of communication.

An IVRNATION company in the UK built a Virtual Reality model based on a residential project designed by TyHendfan company in South Wales, which restored the real world for 90 percent by using Virtual Reality. Therefore, the practical effect generated by Virtual Reality can theoretically replace the two-dimensional interface design plan after years, considering the modern science and technology is developing, so does the Virtual Reality technology.

Mortenson Construction is one of the largest private construction enterprises in America. What distinguishes the company from its opponent is that the company developed its virtual reality software targeted at construction projects. When helping hospital design their operating rooms, the company utilizes Virtual Reality to show the surgeons the layout of the places to ensure all tools and devices are within reach. The visualized design shortens the distance between designers and customers, also avoid some unwanted problems in the design. What's more, it improves the design modification cycle, which makes it feasible for building users to get the first-hand experience and to give reasonable modification advice.

In the process of virtual reality design, designers first import the CAD files created advance into the three-dimensional software. Then to confirm the unit set is in accord with size set before starting with the next step of modeling. After the basic model being improved, the CAD file should be imported into the virtual reality system to have detailed design. With the help of active-shutter glasses, users are supposed to have an enhanced feeling of wandering immersion. Besides, the head tracker would produce virtual scenes containing various images after switching to a three-dimensional stereoscopic film effect.

The personalized operation provided by the three-dimensional lever makes users feel like they are there in the virtual world. Even better, they can have more in-depth interactions with the virtual scenes. In this case, elements like walls and floors can all be changed based on needs. The surroundings in virtual reality are also real-time changeable in terms of users' personal choice, which is also in line with requirements, aiming to have users immersed in virtual environments. Moreover, the virtual reality software also has a complete weather system, light power system, and Virtual Reality ranging and marking functions. Even those who have never been to Hiroshima can experience the feelings of being there.

At the same time, the seamless merger between real scenes and virtual information, such as three-dimension models and videos, can upgrade the visualization and interactivity of two-dimensional messages in three-dimensional way and present designs more directly and comprehensively. All in all, virtual reality design is most adopted in the building design.

4. Advantages of Virtual Reality

4.1 Digitization.

In the building design, Virtual Reality collects and integrates information by using the information model. At the time when models are finished, we can directly obtain the information of all spaces from the model created. Then these digital model information would be transferred to the following design with data chain, which will form the BIM data to construction management, reducing the chances of making mistakes in data translation, thus improving efficiency.

4.2 Flexibility.

AR brings virtual scenes into reality. MR provides a platform blending the digital world into reality with people, views, and objects, allowing both worlds to communicate within the same environment. While VR deals with the relationship between man and computers, placing users in a virtual environment, which lays more emphasis on the overall experience. The critical point of VR lies in the flexibility of mixing up the reality and virtual world. It is the users' body parts that trigger the man-machine interaction. The real-time update on people's actions produced by sensory devices will promote the improvement and modification of building design.

4.3 Virtualization.

Virtual Reality is a computer simulation system with an ability to create and experience the virtual world, where users can immerse themselves in. The signals transmitted by computers integrate the data in reality with all kinds of output devices and convert the data into phenomena that can be felt, which are objects and invisible things, in three-dimensional models. The building design is also the virtualization of information that needs to integrate modeling data. All designs must be presented in some way, such as images in two dimensions, spaces in three dimensions.

5. Summary

The time of intelligence, information, and parameterization has come. It is quite apparent in building design. The fact that art should keep the same pace with science requires us to foresee the promising future of the application of Virtual Reality in the building design.

References

[1]. Jingtao Ji, Jianqun Lin, Bo Song. Building Space Environment Creation----from the Perspective of Virtual Reality. Architectural Journal. Vol. S1 (2014).

[2]. Xunxiang Li. Virtual Reality and Art. Wuhan University of Technology Press, 2017.

[3]. Li Yang, Bingen Xiang. The Application of Virtual Reality In Architectural Design. Huazhong Architecture. Vol. 09 (2008).