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VR and Physiological Assessment Technologies Applied on the Touring Perception of Chinese Classical Gardens

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Abstract: ***This paper reviews on the research status and new progress in the field of Chinese classical gardens by the application of new technologies including virtual reality and physiological measurements. Firstly, it introduces the background and significance of current research in the field of spatial creation in Chinese classical gardens. Then, this paper combs relevant literature on the application of VR and physiological research methods on landscape and architectural studies in recent years. Finally, the possibilities of applying physiological data and virtual reality in the exploration of the spatial perception of Chinese classical gardens is discussed. The results could provide inspiration sources and technical references for the empirical studies of future landscape research on Chinese classical gardens.***

Keywords: Virtual reality, Eye Tracking, Physiological assessment, Spatial perception, Chinese classical garden.

1. Introduction

Chinese classical gardens aim at creating an environment for people to rest, view, and live in, which is composed of elements such as rocks, water bodies, buildings, and plants through construction methods and vegetation planting. As a treasure of Chinese civilization and architectural art, it has extremely high research value. As an important direction and component of the research on Chinese classical gardens, spatial creation based on touring perception has increasingly become a research hotspot. The garden space is interpreted and studied from multiple perspectives. Graphic methods used to be the main strategy on explaining the spatial creation of Chinese classical gardens [1], but according to the latest theorical critics, only by abandoning the graphic perspective of gardens, studying their spatial creation from the perspective of phenomenology and focusing on the role of people in garden space design, could the essence of Chinese classical gardens get achieved [2]. Large number of theoretical explorations in previous studies are made, but they were not satisfactory on explaining the environmental behavior and not conducive on providing comprehensive assistance to practical design. In recent years, new technologies such as virtual reality technology and physiological measurement technologies including eye tracking, skin conductance and electroencephalogram have made up for the previous experimental methods and can better realize the successive perception of landscape space [3]. Based on these technologies, human body data can be collected more intuitively and objectively, which directly builds on the research paradigm of Chinese garden spatial creation aimed at touring perception. Through VR technology, experiment participants can walk freely in the 3D garden model, breaking the shackles of two-dimensional and space. At the same time, by connecting physiological sensors, the electroencephalogram, skin conductance, and eye movement data of the subjects can be obtained to more intuitively show the connection between garden space and people, to better explore garden space. The article explored the current use of VR and physiological in the field of landscape and architecture, intends to provide a new paradigm for the scientific interpretation and contemporary translation of traditional Chinese garden culture and promoting the development of localized architecture in China.

2. The Use of Virtual Reality Technology in Spatial Studies

Virtual Reality (VR), a rapidly developing information technology since the 1990s, is characterized by its core features including immersion, interactivity and imagination. Users can immerse themselves in a fully computer-generated three-dimensional environment through devices like Head-Mounted Displays (HMDs), creating a sense of being physically present within the virtual space. Users can also interact with objects in the virtual environment in natural ways, such as through gestures, voice, or body movements. VR technology as well allows users to create and experience scenarios that would otherwise be impossible or difficult to achieve, stimulating creativity and imagination. Virtual Reality presents real environments in a digital and networked form. This technology breaks the traditional limitations of space and time, providing a multidimensional platform for display, reflecting virtual cognition, and aiding research centered on human cognitive abilities.

Virtual reality technology has been applied in multiple fields in recent years. It has the advantage of breaking the limitations of time and space, making it possible to conduct dynamic visual perception evaluation in a laboratory environment. For example, Ruth Pijls et al. tested whether different hotel entrance designs affect guests' experience of staying in hotels by setting up virtual building spaces at hotel entrances and surrounding environments. In addition to simulating the virtual hotel environment, their experiment also added matching sounds from the environments and set up virtual staff to respond to participants to create a more realistic space [4]. Similarly, Peeter Vassiljev used virtual experiments to study how ski slopes are scientifically and healthily distributed and the impact of landscapes on human health. In

the virtual reality experiment design, the experiment time was deliberately lengthened to be closer to the real skiing time, which can also make the subjects more immersed in the virtual space [5]. Though rare VR experiments are made on the touring perception of Chinese garden, we can obtain some strategy on simulating a more immersive touring scene in VR environments. On creating virtual reality environments, adding environmental sounds and virtual character interactions in future garden space experimental designs can make the experimental environment more realistic, lengthening the time of subjects in the garden virtual space to be more immersive and closer to the real time of touring gardens, thus giving people a more real experience.

3. The Use of VR and Physiological Measurement Technologies

3.1 The Use of VR and Eye Tracking

Eye tracking technology mainly realizes human-computer interaction to judge people's focus and characteristics of attention on experimental objects and their collections in real or virtual scenes. This technology can intuitively reflect the visual focus of the subjects [6], thus more objectively perceiving the connection between landscape architecture and people. Zhang Ruoshi et al. used virtual reality technology and VR glasses with eye tracking instruments to obtain more objective experimental data and discuss people's subconscious and conscious preferences for landscape space elements and characteristics, providing new inspiration sources for the design of various landscape spaces [7]. Currently, eye tracking method is applied to several spatial experiments on Chinese garden. For example, previous research used eye tracking technology to collect the eye movement data of the subjects in the experiment to explore the impact of soundscape in garden space on people's psychology and emotions [8]. Another research studies the landscaping techniques of framed views and depth of field in garden space from the perspective of the subjects' microscopic visual behaviors [9]. Lu Shaoming explored the visual interpretation deviations of people from different cultural backgrounds on garden space through eye movement experiments and put forward valuable suggestions for future designers in designing human living environments and modern garden spaces [6]. Zheng Yanyan et al. took the perspective of tourists as the theoretical framework and conducted narrative analysis on travel blogs to explore tourists' touring gaze in Chinese classical gardens, providing a new perspective reference for the future development of garden tourism and also providing a basis for the research direction of how to improve tourists' garden touring experience in the future [10]. Shen Muhan et al. used virtual reality technology to let the subjects view landscape pictures of Saihō-ji Garden in Japan and collected their eye movement data with an eye tracker to analyze the spatial visual characteristics of continuous landscapes [11]. The combination of virtual reality technology and eye tracking technology makes the visual perception more intuitive and objective, providing a new perspective for the future garden research closely related to visual perception.

3.2 The Use VR and Other Physiological Measurement Technologies

Virtual reality can break the limitations of time and space to conduct experiments, while eye tracking and physiological measurement technologies such as skin conductance and electroencephalogram can obtain more scientific and data that is more in line with the human physiological structure based on human physiological data. Skin conductance measures the electrical conductivity of the skin, which changes with sweat gland activity, is an indicator of autonomic nervous system activity and can reflect emotional arousal, stress, or excitement. EEG measures electrical activity in the brain and can provide real-time data on cognitive processes, such as attention, memory, and emotional responses. This makes the experimental data more rigorous and intuitive and makes the research more in-depth. Therefore, in recent years, more and more architectural space research has used multiple technologies to assist experiments, and it has many reference meanings for research directions and experimental design of garden space. For example, Kim Hakpyeong et al. used virtual reality technology to simulate indoor environments with and without green walls and large and small green walls, and detected the heart rate, skin conductance, and electroencephalogram data of the subjects. The study found that small green walls can more effectively reduce the stress level of residents [12]. Shemesh et al. used physiological sensors to collect more objective data from subjects experiencing virtual environments and focused on examining the connection between architectural space and human emotions from a geometric perspective. It is concluded that in spaces with simple shapes, large spaces can increase people's interest and mobilize people's emotions more than small spaces, providing a reference for the experimental design of studying the size of internal spaces in gardens [13]. The integration of these physiological measurement technologies into the study of landscape architecture and architectural spaces offers a comprehensive approach to evaluating environmental design. By combining objective physiological data with subjective experiences, researchers and designers can create more effective and responsive environments that cater to human needs and preferences.

4. Discussion

The paragraph discusses the integration of Virtual Reality (VR) technology with physiological measurement technologies, such as eye tracking, skin conductance, and electroencephalogram, to study human perception and interaction with landscape architecture and architectural spaces. The method involves using VR to create immersive and controllable experimental environments. This is combined with eye tracking to measure visual attention and other physiological measurements to assess responses such as stress levels and emotional reactions. Though eye tracking is mostly applied to the current garden research, the combination of various physiological methods allows for a more comprehensive understanding of how individuals perceive and interact with their surroundings. The materials used in these studies are diverse and include virtual representations of real-world environments. These virtual environments are designed to simulate the conditions that would be found in actual architectural and landscape settings. The samples in these studies are human subjects who are exposed to virtual environments. Their reactions and behaviors are measured and analyzed to draw conclusions

about the effects of different landscape elements and architectural designs on human perception and emotion. The subjects are participants who are likely recruited based on specific research questions. For example, in studies examining cultural differences in garden space perception, subjects from different cultural backgrounds might be included. In other studies, the subjects might be tourists or residents to understand their specific experiences and preferences.

5. Conclusion:

The use of VR in combination with physiological measurement technologies offers a robust approach to studying human perception in landscape and architectural contexts. This method allows researchers to control and manipulate variables in a way that would be difficult or impossible in real-world settings. The integration of eye tracking provides insights into visual attention and cognitive processing, while physiological measurements like skin conductance and EEG offer objective data on emotional and stress responses. Overall, the integration of VR with physiological measurement technologies is a powerful tool for advancing our understanding of human-environment interactions. It offers a more nuanced perspective on how design elements influence perception and emotion, which can lead to more effective and responsive architectural and landscape designs. At present, research on such new research technologies in the field of spatial perception of Chinese classical garden is still relatively rare. However, the existing research provides excellent theoretical viewpoints and empirical analyses for the subsequent exploration of this field. As the approach of VR combined with physiological measurement becomes more prevalent, it is likely to shape future paradigm of empirical studies on touring perception of Chinese classical gardens.

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