Design of City Park Landscape Roaming System Based on Virtual Reality Technology

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Abstract. In the era of intelligent information, characterized by rapid advancements in electronic technology and the Internet, high-tech landscapes have emerged and fostered an increase in the demand for intelligent roaming systems in urban park landscapes. Based on the conventional image and video presentation of the urban park landscape, it appears to be less interactive and superficial. Therefore, this research incorporates virtual reality technology into the park's roaming system, thereby challenging the conventional method of landscape tour. Moreover, this paper proposes "virtual interaction + landscape roaming" as a design strategy. Using the TOF LIDAR principle to measure the 3D data of the original site, combining with computer mapping software to establish the virtual landscape environment, and using the design process of the virtual landscape environment to verify the feasibility of the application of virtual reality technology in the park landscape roaming system, in order to better realise the combination of virtual reality technology and urban landscape.

Keywords: virtual reality technology; virtual interaction; landscape roaming

1 INTRODUCTION

The concept of Virtual Reality (VR) technology has been around since the 1960s and is a combination of sensing devices that build a virtual world for the user to perceive in real time, ideally achieving a multi-sensory virtual environment that is very similar to the real world.[1] The results of the survey show that virtual reality technology is already used in the military, education, medicine, industry, tourism and other fields and has a strong applicability. For the creation of roaming scenarios in urban park landscapes, virtual reality technology provides a new avenue of growth. It provides the park's landscape a new sense of experience that distinguishes it from its previous state. The urban park landscape is a thematic, functional, ornamental, and cultural urban public space for both city residents and visitors. It is not only a place where inhabitants can enjoy recreation and amusement, but also an essential location for the propagation of urban culture. As a significant form of urban landscape and urban

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tourism system, parks combined with virtual reality technology to create a landscape roaming system are garnering the public's attention due to their unique benefits.

2 Virtual Reality Technology

2.1 Virtual Reality Technology Concept

Virtual reality technology is an ostensibly realistic simulation environment created by computer and electronic technology that enables the user to perceive the virtual world as a simulation of the real world through a variety of sensing devices and a variety of senses.[2]It provides users with intuitive and natural real-time perceptions of sight, hearing, and touch. It employs realistic abilities to interact with objects in the virtual world.[3]As shown in Figure 1, the typical characteristics of virtual reality technology are summarised as Immersion, Interaction and Imagination.

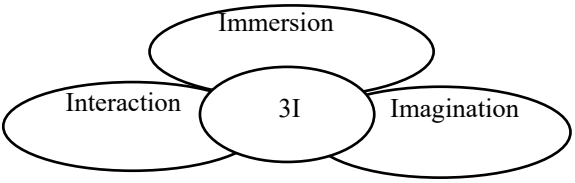

Fig. 1. Core features of virtual reality technology.

Immersion is the degree of real sensory immersion of the user in virtual world objects and virtual activities in a virtual scene. Interaction is the natural feedback that the user receives when manipulating the interface and in the virtual scene. Imagination is the user's conceptualisation of the virtual scenario simulation experience.[4]

Virtual reality is enabled by four primary technologies. One is non-contact visual modeling technology, which acquires 3D data based on the actual environment. Another is dynamic environment modeling technology, which acquires 3D data based on the actual environment. Second is the real-time generation of three-dimensional graphics, which must increase the refresh rate of images without sacrificing the quality of graphics or the complexity of the virtual environment. Third is the stereo display and sensing technology, which enables virtual perception through the use of spectacles, headgear, and other stereo display and sensing equipment. Through data conversion technology, voice recognition, and other devices, system integration technology enables user interaction with a virtual scene.[5]

2.2 TOF Lidar Principle

Lidar is an instrument that enables non-contact distance measurement and multi-dimensional scanning by measuring the transmitted pulsed laser beam against the reflected pulsed beam received by the sensor. TOF is a type of LIDAR technology, which is an optical distance measurement method using the time of flight of light and consists mainly of a transmitter, a receiver and a high-precision timer. The laser

transmitter emits a modulated laser beam, which reaches the surface of the observer and is reflected back to the receiver. [6]The schematic diagram of the TOF LIDAR is shown in Figure 2. An internal timer records the time from the transmitter to the receiver to the object, and the time difference between the two times is the optical time of flight. The time from the transmitter to the object is called t_1, the time from the object to the receiver is called t_2, the speed of light is c, the distance to the observer is d, the speed of light is a known term, and Equation (1) is applied to calculate the distance to the observer.

$$d=c \bullet \ (t_2-t_1) \tag{1}$$

Equation (1). Distance calculation.

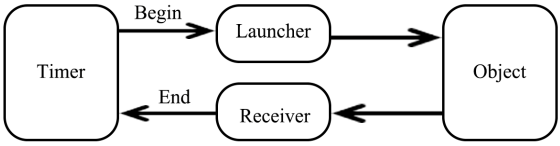

Fig. 2. TOF LIDAR schematic diagram.

3 The Application of Virtual Reality Technology in City Park Landscape Tour

The combination of virtual reality technology and urban park landscape design significantly enhances the convenience of park excursions and provides residents and visitors with a unique theme space. It breaks the phenomenon of traditional park landscapes with singular performance and low technological content, which is conducive to promoting the transformation and upgrading of urban parks as well as satisfying residents' and visitors' sense of scene experience and interaction.[7]Virtual park landscape tour system, particular performance in the following areas:

3.1 Realistic Reproduction of the Park Landscape

Using virtual reality technology to create a photorealistic recreation of a park's landscape is an updated recreation of the real world environment. During the design phase, designers not only have access to an abundance of resources, but they can also perceive the design site's spatial qualities in real time. In addition, it can intuitively forecast the viability of a site's reproduction in the real world, enhance the accuracy of the site's landscape elements, and save time and money on scene production. Through the actual acquisition of three-dimensional data utilizing dynamic modeling technology, a real model is created, and its material and texture mapping are assigned. Then, it is coupled with various lighting effects for dynamic rendering and combined with multimedia interaction and other computer technologies to produce three-dimensional, interactive, and realistic virtual scenes. This technology is already utilized in virtual visits and museums. You can appreciate the scenery and visit historical

relics regardless of when and where you visit, and you can genuinely experience the dynamic scene.[8]

3.2 Roaming Paths for Virtual Scenes

Using virtual reality technology to create virtual scenes of the park landscape, the designer conceptualises the site and creates a complete virtual world based on popular demand and subjective awareness. The design of park scene themes can be diverse, such as cultural themes, forest themes, marine themes and various fantasy themes, etc. It cannot be limited to traditional themes, and designers can be creative in the virtual world in a flowing manner. Users can dominate the time of the virtual world through virtual reality equipment, and can switch spatial scenes at will to deepen the immersion of users experiencing the virtual environment.

3.3 Virtual Roaming Interaction

Users can navigate the virtual environment in roughly three methods. The first is that the designer plots the optimal roaming path in advance and the virtual scene automatically navigates to provide the best view of the human body. This is a passive method for the user, who cannot interact with the virtual environment.[9] The second is for the user to determine their own path for roaming. The users freely navigate the virtual environments and subjectively interact with the virtual environments. The third is the interactive roaming path of real-time user-manipulated virtual instruments. Enhancing the experience and immersion, the user can interact with the 3D objects in the virtual scene.

4 Virtual Park Landscape Intelligent Roaming Design Process

4.1 Framework for an urban park landscape effect simulation system based on virtual reality technology

As shown in Table 1, the collection equipment, which provides information collection technology, collects site data and transmits it to the computer for effect simulation.[10] The master control device is the computer technology used to generate the 3D landscape environment in accordance with the data. The output device is the use of computer technology to generate animations to simulate the effects of the site. Display equipment i.e. transform the presentation of virtual scenes and experience virtual scene roaming.

Table 1. Landscape Effects Simulation System Framework.

	Technology & Equipment	Data
Collection equipment	Lidar, Sensors, GIS, etc.	Site data on topography, climate and temperature, vegetation, buildings, etc.
Main control equipment	Computer, CAD, SketchUp, Lumion	Floor planning, 3D model building and rendering
Output devices	Computer, Lumion animation	Virtual animation scenes
Display equipment	Stereo display systems, stereo headphones, stereo glasses, head-mounted displays, etc.	Virtual scene roaming experience

The ideal effect of virtual scenes in urban parks is to make it impossible for users to distinguish the difference between virtual and real, however, the experimental results show that it is not yet possible to achieve 100% of the same effect, and the performance of the computer system also affects the establishment of virtual landscape planning, as shown in Table 2, which is the computer hardware and software used in this experiment.

Table 2. Computer experiment parameters.

	Experimental platform	Parameters
Hardware platforms	CPU	Intel 15-13400F
	GPU	RTX 3060Ti-8G
	RAM	32GB
	Hard Disk	1T
Software platforms	2D software	AutoCAD
	3D software	3DMAX、SketchUp
	Virtual software	Lumion

4.2 Virtual scenography process

Mapping of site dimensions in terms of length and width using LiDAR technology. Accurate measurement of the site in the use of AutoCAD to draw the site plan, and then transferred to the modeling software such as 3DMAX, SketchUp to build the model. Finally, render it with Lumion or make a roaming video and use VR equipment to roam the virtual environment. (As in Figure 3)

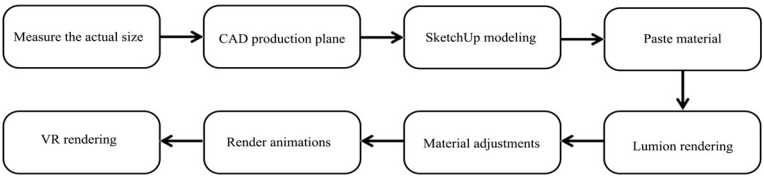

Fig. 3. Landscape roaming design process.

Regardless of the virtual approach chosen, the first step is to create a model of the virtual environment using three-dimensional modeling software.[11]A combination of AutoCAD and SketchUp modeling and Lumion rendering is utilized as an example in this paper. The first step was to measure the site in 3D, resulting in a length of 179,760m and a width of 55,911m, which was converted into AutoCAD to design the theme park zoning and plan the location of the buildings, roads and infrastructure within the park. (As in Figure 4) The second stage is to import the planned planar lines into SketchUp in order to press and drag the ground, sky, major structures, roadways, etc. in order to transform them into 3D objects. (As in Figure 5) The surface modeling is based on topographic maps and satellite images in order to accurately represent terrain, sea area, etc.[12]On the interior surface of the sky model, hemispherical or cylindrical surfaces are combined with hemispherical models. It employs texture mapping to generate all-weather sky backgrounds to prevent roaming that cannot be interacted with in real time due to a fixed perspective, which diminishes realism.[13]The primary structure is modeled using accurate measurements of the actual structure. The dimensions of the road model should match those of the genuine site.[14]Additionally, animated characters and other objects should be incorporated to the virtual environment. Unlike inert effects, the virtual environment's characters have the human autonomy to walk, halt, observe objects, and engage in other physical activities. Therefore, it is necessary to use a model of 3D characters with other moving creatures.

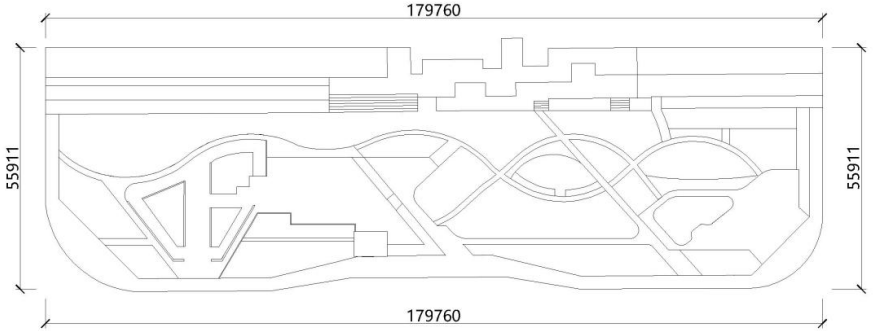

Fig. 4. CAD floor plan.

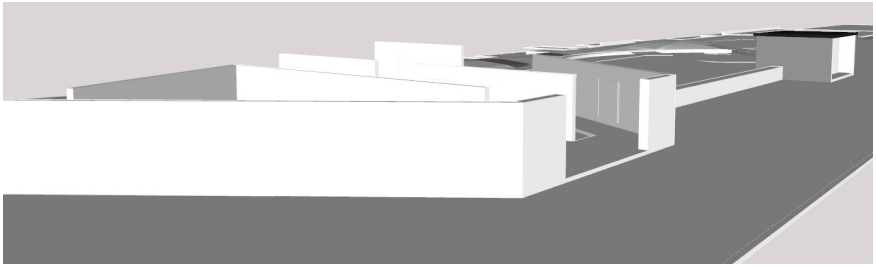

Fig. 5. SketchUp modeling diagram.

Upon completion of the preliminary scene modeling process, the next stage is to apply materials to the models of roads, plants, terrain, water bodies, structures, squares, and vignettes to enhance their realism. The Lumion software is a 3D visualization utility that works in real time.[15]It is able to render high-quality images and utilize Lumion software for further image processing. The ability to exchange the mapping and materials of a model in real time drastically reduces production time. It makes precise modifications to the texture shading, gloss, reflectivity, and parameters of wood, stone, metal, and other materials until the parameters are accurately established. In conjunction with illumination and the inclusion of ambient light and sunlight, it concludes the creation of the virtual animation scene. (As in Figure 6) Using the animation mode for recording, utilizing the arrow keys to control the shooting position, selecting the camera angle and position for the creation of the animation path, the preview is accurate after the generation of the virtual roaming path, and a series of steps are repeated until the most realistic feeling of the virtual scene is achieved.

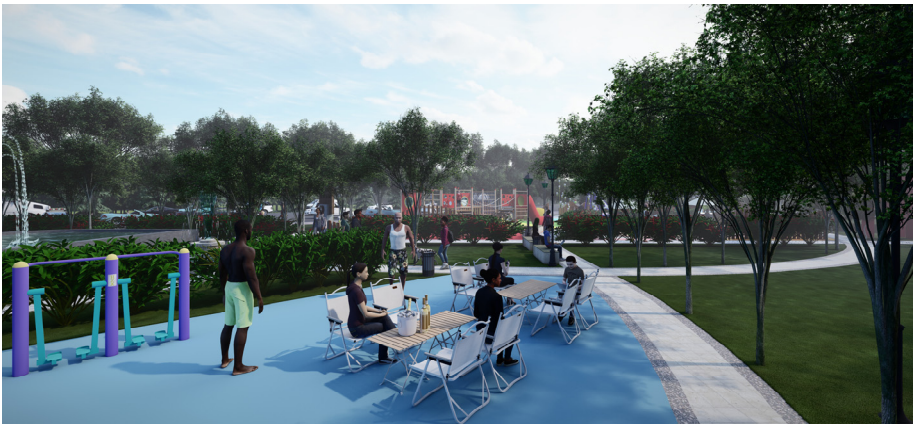

Fig. 6. Rendering effect.

The virtual environment synthesised by computer technology is a complete interactive platform for the user to roam through virtual scenes. With the completed virtual scenes and the use of VR equipment, users can independently experience the landscape theme features and cultural attributes in the virtual scenes, as well as the park's entertainment projects and amusement facilities. All objects in the virtual scene can be interacted with by users. For instance, it can readily swap between day and night, sunny and rainy, sunny and snowy, windy and calm, and so on. Currently commonly used VR devices mainly have headset products, handles and other conventional products to interact with. In the future, smarter sensing devices such as eye tracking, voice recognition and head motion tracking will emerge, and these technologies will make it easier for users to interact with virtual reality.

5 Conclusion

The virtual environment created through the use of modeling and visualization technologies has a high degree of similarity to the actual environment, and its realism exceeds 95%, making it highly applicable to the simulation of the landscape. Therefore, the use of VR equipment in urban park landscapes is not only a common application of VR equipment, but also the development of urban parks themselves. This is now prevalent. The incorporation of virtual reality technology provides a new experience for urban park strolling and an update to the extant park scene. It offers users a virtual environment that is real-time, authentic, and engaging, thereby enhancing the user experience. It enables users to completely release themselves and immerse themselves in the virtual environment's ambiance. However, there are still shortcomings in the research on virtual reality technology in this paper, such as the accuracy of the virtual environment, the naturalness of user interaction and the real time display issues without degrading the image quality. Based on this, the combination of virtual reality technology and a city park is not only an innovation of the park scene, but also a prediction regarding the application of virtual reality technology to other disciplines in order to perpetually improve virtual reality technology.

References

1. Wu, D. (2019) The impact of virtual reality technology in theme park scenes. Design,32(11):150-152. https://kns.cnki.net/kcms2/article/abstract
2. Zhang F., Wang L. (2002) A study of virtual reality based on intelligent reasoning technology. Computer Engineering and Applications,23:96-97+148.DOI: 10.3321/j.issn:1002-8331.2002.23.032
3. Zhang Y. R., Yang J. (2013) Application of virtual reality technology in experimental teaching. Software Guide,12(02):150-152.https://kns.cnki.net/kcms2/article/abstract?v=3uoqIhG8C44YLTlOAiTRKgchrJ08w1e7xAZywCwkEELvTdtyw0PbZXf6LCgeSXnQJbrPncXSoaTRbixmhvYsBt17WJ_XvhcP&uniplatform=NZKPT&src=copy
4. Zhao Q P., Zhou B., Li J. (2016) Advances in virtual reality technology research. Science & Technology Herald,34(14):71-75. DOI: 10.3981/j.issn.1000-7857.2016.14.008.
5. Li M., Han F. (2010) An overview of virtual reality technology. Software Guide,9(06):142-144. https://kns.cnki.net/kcms2/article/abstract?v=3uoqIhG8C44YLTlOAiTRKgchrJ08w1e7_IFawAif0myqRvgxcfP6vRGEbHwjFdx4acCtUW5CJuAKJWapdkNJCFHtsJKxTQ5H&uniplatform=NZKPT&src=copy
6. Li X H., Guo P., Zang C., Rong H., Tang F M. (2019) Current status of Lidar technology research and its applications. Automotive Appliances, 05: 4-6. DOI: 10.13273/j.cnki.qcdq.2019.05.002.
7. Zhou K.,Fang T. H. (2018) Application of virtual reality technology in theme parks. Design, 02:142-143. DOI: 10.3969/j.issn.1003-0069.2018.02.043
8. Wu D. (2019) A study on the creation method of virtual reality technology for theme park scenes. Design, 32(12): 143-145. https://kns.cnki.net/kcms2/article/abstract?v=3uoqIhG8C44YLTlOAiTRKibYlV5Vjs7iLik5jEcCI09uHa3oBxtWoN54QQQaVxhz60VGw47Bv0BH1lCxZflXb1S4_W_ogIPa&uniplatform=NZKPT&src=copy

9. Zhang X. (2008) Talking about interaction problems in virtual scenarios. Hebei Journal of Vocational University of Technology and Engineering,03:32-35.DOI: 10.3969/j.issn.1008-6129.2008.03.014
10. Li X Q. (2019) Design of a landscape planning effect simulation system based on virtual reality technology. Modern Electronics,42(20):149-151+155.DOI:10.16652/j.issn.1004-373x.2019.20.035.
11. Zeng J. (2009) Research on product innovation design based on virtual simulation system. Wuhan University of Technology, 2009. DOI: 10.7666/d.y1653166
12. Tang, Q. H.. (2005) Research on distributed virtual environment modeling. Wuhan University of Technology, 2005. DOI: 10.7666/d.y776873
13. Wu, Y., He, L., Huang, Y.Y., Zhu, H.C., Lu, C.Q.. (2002) A review of virtual reality technology. Computer and Digital Engineering, 03:41-44. doi: 10.3969/j.issn.1672-9722.2002.03.007
14. Tan J, Li Z. L., Jiang L. J., Lin Q.Q. (2013) Application of augmented reality technology in architectural design simulation. Journal of Jilin University (Engineering Edition), 43(S1): 64-68. DOI: 10.13229/j.cnki.jdxbgxb2013.s1.055.
15. Kang Y. X. (2020) Research on the production of virtual campus roaming system based on 3DS Max and Lumion. Computer Programming Skills and Maintenance, 04: 148-150. DOI: 10.16184/j.cnki.comprg.2020.04.053.