Design and Research on Virtual Reality Roaming System of "Tongguanshan 1978" Cultural and Creative Park in Tongling City

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Abstract. This research studies the design and implementation of the roaming system of "Tongguanshan 1978" Cultural and Creative Park based on virtual reality technology. The core technologies involved in the system development process include virtual reality, 3D digital modeling and WebGL publishing. The virtual reality roaming system based on WebGL can display interactive three-dimensional scenes in the computer browser, which is a better immersive communication method. The investigation and development of the virtual reality roaming system of the "Tongguanshan 1978" Cultural and Creative Park can achieve a more attractive publicity effect than traditional news organizations. It plays a very good role in continuing the historical blood, preserving the memory of the city, protecting the cultural roots, and promoting the copper cultural industry of Tongling City.

Keywords: virtual reality; roaming system; "Tongguanshan 1978" Cultural and Creative Park

1   Introduction

Because of the continuous updating and development of HTML5 and WebGL technologies, the realization of 3D web page virtual reality system has become technically feasible gradually. At present, WebGL 3D web page interaction technology is widely used in roaming systems, 3D games, etc. In March 2011, the WebGL standard specification 1.0 was published by the Khronos Group, an open standards industry association. Since then, all major web browsers are compatible with WebGL technology. More importantly, when Unity 5.0 was born, it announced that it officially supported the publishing of the WebGL platform [1]. This means that developers can use Unity software to implement WebGL-based 3D interactive web pages without having to master complex WebGL technology.

"Tongguanshan 1978" Cultural and Creative Park is located in Heping New Village, Tongling City, Anhui Province, and officially opened on December 18, 2020. The park covers an area of 48.88 mu, with a total construction area of 15,500 square meters and

a total investment of about 170 million yuan. "Tongguanshan 1978" Cultural and Creative Park was built by Tongling Cultural Investment Company in four years. Using the resources of the miners' residences in the Tongguanshan copper mine in the 1960s and 1970s, the real production and living scenes of the copper miners were protected and reproduced through selective preservation, restoration, transformation and reconstruction [2]. The park integrates the functions of heritage protection, cultural creativity, craft production, art exhibition, cultural exchange, tourism and leisure, experience consumption, and characteristic operation. It was listed in the 2017 China cultural industry key project list.

With the development of computer information technology and virtual reality technology, the digital research on the relics of miners' residents in Tongguanshan copper mine is an inevitable demand for cultural preservation under the development of the times. The most important significance of this paper is that the virtual reality system realized by the WebGL platform can introduce and publicize the "Tongguanshan 1978" Cultural and Creative Park more conveniently and intuitively, and gain the attention of a wider audience [3]. Traditional audio and text publicity methods are not intuitive, and video or picture information is not interactive. If the park is only promoted in these ways, users cannot obtain the interior detailed information and overall topographical features of the "Tongguanshan 1978" Cultural and Creative Park. However, users only need to open a web browser that supports WebGL technology, "walk" in the virtual reality roaming system of "Tongguanshan 1978" Cultural and Creative Park, tap the keyboard, move the mouse slightly. Then, they can immersely observe the work and life scenes of copper miners from various angles, and interactively obtain various information. Undoubtedly, this will contribute to the dissemination and preservation of the cultural heritage of the "Tongguanshan 1978" Cultural and Creative Park, and it will also have a good propaganda effect on the copper cultural industry in Tongling.

This paper makes a detailed exploration of the virtual reality roaming system of "Tongguan shan 1978" Cultural and Creative Park from the aspects of technical analysis, data collection, design and development. First, relevant technical analysis and selection are performed. The various software involved in the roaming system are deeply studied, and the similarities, differences and advantages of each technology are compared and weighed. By investigating the research and development examples of WebGL-based roaming system, each link of software development is smoothed out. Secondly, the architectural appearance, photos of cultural relics, and topographic data of the Cultural and Creative Park are obtained. Using literature review and field investigation, all the materials required for the project are collected and analyzed. Finally, through the conclusions and data obtained, the design of virtual reality roaming system based on the improvement and optimization of the real scene is carried out. Using 3DMax and Unity, the entire system is finally implemented.

2   Key Technology

In the system research and design, this paper uses the following development technologies: Unity virtual reality development, 3Dmax digital 3D modeling, Altizure reality modeling, and WebGL web page publishing [4].

2.1   Unity

Unity is a cross-platform 2D/3D game engine developed by Unity Technologies. It takes an interactive graphical development environment as its primary approach. The compiler runs under Windows or Mac. Unity can publish games to many platforms such as Windows, Wii, iOS or WebGL. In addition, Unity also provides powerful and easy-to-use tools for developers in a wide range of fields such as auto, construction engineering, film and television animation.

2.2   3Dmax

3Dmax is a PC-based 3D modeling, rendering and production software developed by Discreet, which can be used to design and produce 3D animations. It is mainly used in architecture, film and television, games, animation and so on. 3Dmax has relatively low requirements on the hardware system, and the general configuration can already meet the needs of learning. In addition, its price is moderate, and ordinary companies can afford.

2.3   Altizure

Altizure is a 3D reality modeling platform for photography enthusiasts, photogrammetry experts, architects and more. The platform provides cloud services to convert photos into 3D models of objects. It has multiple functions such as automatic modeling with pictures as input, cloud processing, and online publishing. It is mainly used in the construction industry.

2.4   WebGL

WebGL is a technology for displaying interactive 3D graphics in a web browser. WebGL is embedded in the browser, and developers can use it directly. In addition, because it is based on the web browser, users can run WebGL programs on multiple operating system platforms. Therefore, WebGL is cross-platform.

3   System design and publishing

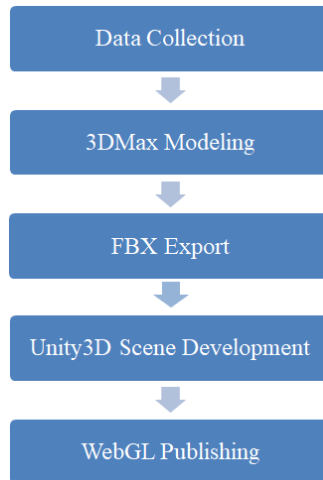The process of system design and publishing is shown in Fig. 1.

Fig. 1. Design process.

3.1   Data Collection

Through literature research and field inspection, the "Tongguanshan 1978" Cultural and Creative Park has been deeply studied, and various data required for project development have been collected. It mainly includes the field measurement data of the park, on-site photos, and photos of production and daily necessities.

3.2   Modeling in 3Dmax

The first step in designing a virtual reality roaming system is to create a 3D model of the object in 3DMax software. Then, according to certain technical requirements, the model is UVW mapped. Finally, the data in FBX format is exported from the 3DMax modeling software for use by Unity [5]. The detailed working steps are as follows.

1) 3D Modeling: When the object model required for the virtual scene is constructed in the 3Dmax software, the first step is to select a unit that matches Unity. Because the "Tongguanshan 1978" Cultural and Creative Park has larger buildings and a wider area, the unit setting of "meter" is adopted in the project.

The next step is to start modeling. Due to the complex structure and various shapes of the buildings in the "Tongguanshan 1978" Cultural and Creative Park, each building is made as an independent model in its own data file. Subsequently, the related buildings are combined into one file. This "divide and conquer" approach can reduce the complexity of software programming on the one hand, and reduce the computer memory occupancy rate during program operation on the other hand.

2) UVW Mapping: This paper uses "Standard" material and "Multi/Sub-Objject" material to UVW map the model. Additionally, normal mapping is also used in Unity. Normal mapping can better show the bumps and textures of the material, reflect more

realistic effects, and are more intuitive. For the case that different patches of the object have different materials, these patches are separated in 3DMax.

3) FBX Model Export: After completing the construction of each model in 3DMax, the data in FBX format is exported. When exporting, "Embedded Media" is checked in the export panel so that the texture information of the model can be saved for use by Unity. Next, it is imported into Unity.

3.3   Create A Virtual Scene in Unity

Designing a virtual reality roaming system in the Unity development platform first requires building a virtual scene. This includes operations such as importing FBX files. The detailed design steps are as follows.

1) Import of FBX Files: FBX type model files can be used in Unity. The specific process of importing FBX files into Unity is as follows. First, in the "File" menu, "New Scenes" is clicked. Then, in the "Project" window, "Assets" is clicked. Next, the mouse is right-clicked and "Import Package" is selected. Thus, the import of the FBX file is complete.

2) Lighting Settings: "Tongguanshan 1978" Cultural and Creative Park roaming system is equipped with indoor lighting and outdoor lighting. The indoor lighting is designed as "Spot Light". The outdoor lighting settings are as follows. First, the "Directional Light" in the "Hierarchy" window on the left side of the screen is clicked. Next, in the "Inspector" window on the right side of the screen, the property value of "Directional Light" is set. "Type", "Color", "Mode", "Intensity", etc. of "Directional Light" can be adjusted. "Shadow Type" can also be set to "Soft Shadows".

3) Skybox Settings: Next, Unity's own skybox resources are imported into the virtual scene of the roaming system. The operation steps are as follows. First, the "Rendering" submenu in the "Window" menu is clicked. Then, "Lighting Settings" is selected. For the "Source" item in the popup menu, "Skybox" is selected. So it can be applied.

4) Using Normal Mapping in Unity: After the UVW maps made in 3DMax are imported into Unity, some may not be displayed correctly. This paper uses Unity normal maps to solve this problem. Specific steps are as follows. First, the materials needed for the model are placed in the "Textures" folder in the "Project" window. Then, the "Texture Type" of these materials was changed to "Normal Map". After completing the modification, "Apply" is clicked. Second, "Materials" is clicked, then "Normal Map" in the "Inspector" panel on the right is clicked, and the normal maps created in the previous step are selected. Finally, the finished shaders are assigned to different faces of the model.

5) Drawing Terrain: In the "Tongguanshan 1978" Cultural and Creative Park project, the following work is mainly done in drawing the terrain. First, the terrain is created. In Unity, the "GameObject" menu is clicked and "3D Object" is selected. Then, "Terrain" is clicked to create a terrain. Through various terrain drawing brushes in the "Terrain" component of the "Inspector" panel on the right, the terrain is raised or lowered to draw different terrain features of the park. Second, the surface texture is drawn. Material brushes and imported grass, mud, sand, gravel and other textures are

used to paint the details of the surface. Finally, vegetation is added. "Paint Trees" and "Paint Details" are used to add flowers and trees to the terrain.

6) Creation of the First Person Perspective: The system uses the mouse and the keyboard to roam in virtual reality from the first person perspective. In the first step, a "First Person Controller" is added to the scene. The "First Person Controller" is composed of "Capsule Collide" and "Camera". The second step is to write a C# script to realize the walk, jump and speed of the "First Person Controller" in the roaming system.

7) Physics Collision Settings: During the design of the roaming system of the "Tongguanshan 1978" Cultural and Creative Park, the "Rigidbody" component is added to the "First Person Controller". In addition, the "First Person Controller" and various models are added with a "Collider" component.

8) Placing Scene Material: In the roaming system project, the scene materials that need to be placed are mainly models reflecting the production and life of miners. In order to speed up the modeling and reflect the local subtle features of objects more faithfully, the traditional modeling method of 3DMax software is not adopted. This paper uses the Altizure platform and use multi-angle photos to achieve model reconstruction on the Internet [6].

9) Setting Ambient Music: In the virtual roaming system, the addition of background music and scene sound effects can significantly enhance the interactive experience of the system. A relaxing and soothing piece of music is selected as the background music of the roaming system of the Cultural and Creative Park to increase the immersion of the system. In addition, some shorter audio is selected as some special sound effects in the system. In Unity3D, the steps for adding audio files to the system are as follows. In the first step, a "GameObject" needs to be created in the roaming system. In the second step, an audio functional component is bound to the "GameObject". In the third step, in order to facilitate the control of the audio resource, a script file that controls the looping of the ambient music is added to the component. Finally, the audio file is drag and drop to the corresponding position in the "Inspector" window on the right.

10) Design of Interaction Points: According to the analysis of all the items and locations that need to be introduced in the Cultural and Creative Park, all the interaction points are mainly divided into two categories: item introduction and scene introduction. The interaction mode is mainly based on the mouse click to trigger the interactive interface or video playback. The principle of interactive interface design is to allow users to quickly understand the information of items and operate different functions in the system. At the same time, the overall UI interface design should also be beautiful and simple. When designing the interactive interface in this paper, Unity's GUI class is used. GUI classes contain different styles of interface elements. It is flexible and rich in material, which allows users to freely develop a distinctive interface.

11) Dynamic LOD Scene Optimization: In this paper, the dynamic LOD technique is used when modeling. In the first step, the accuracy of the LOD hierarchical model that needs to be generated for the current scene is estimated. In the second step, based on the estimation results, the required LOD model is directly generated. Finally, dur-

ing subsequent walking process, the sophistication of the model will be changed in real time according to the distance of the object's position. In this way, the overall geometric complexity is reduced, the memory consumption is reduced, and the efficiency of real-time image display and rendering is improved.

3.4   System Publishing

The steps for system publishing to WebGL are as follows. "File", "Build Settings", "WebGL" are selected in order. Then, "Player Settings" is clicked, and various parameters are set. Finally, "Build" is clicked, and the publishing of the roaming system is realized. Fig. 2 is the slogan at the entrance of the roaming system of the "Tongguanshan 1978" Cultural and Creative Park.

Fig. 2. The slogan at the entrance of the roaming system.

3.5   System Test

On the basis of the relevant testing principles, this paper conducts a system test on the virtual reality roaming system of "Tongguanshan 1978" Cultural and Creative Park. First, for the test content, an appropriate test method is selected and a reasonable test procedure is designed. Then, the results of the test are analyzed and the test conclusions are drawn. The test content includes roaming test, information presentation test and performance test.

The first step is a roaming test. When entering the roaming system, the characters first appear at the entrance of Cultural and Creative Park. At this point, the character's perspective can be changed by dragging the mouse. Users can observe their surroundings from all directions. After a certain visual angle is determined, the user can control the movement of the character in different directions by tapping the keyboard. The second step is the information presentation test. The user can click the information prompt button of the interaction point, and the item information or scene information will appear, which may be a text introduction or a video introduction. After testing, 97% of the experiencers feel very good overall, they are satisfied with the realism of the picture, and feel that the design of the interface is more scientific. A very small number of subjects experienced slight dizziness after the operation. The

third step is performance test. It mainly analyzes system performance through the following two methods. The first is to utilize the "Stats" button in the upper right corner of the "Game View" window. The second is to use the "Profiler" button in the "Analysis" submenu of the "windows" menu. After testing, the main statistics are all within a reasonable range.

4   Conclusions

In this paper, the research background and research status of the roaming system are discussed, and the advantages of different development software and technologies are compared. Aiming at the problems that need to be solved urgently, the development process of Cultural and Creative Park roaming system is proposed. Compared with the traditional propaganda model, the virtual reality roaming system of the "Tongguanshan 1978" Cultural and Creative Park based on WebGL technology can achieve vivid, convenient and immersive promotion effects. It is beneficial to the protection and inheritance of the Tongguanshan copper mine site and cultural relics in Tongling City. It also has a good publicity effect on the local copper culture industry in Tongling City. In the future, more device interfaces will be provided to incorporate somatosensory devices into system control mode. In this way, a richer user experience will be achieved.

Acknowledgement

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