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The virtual reality technique of landscape architecture reconstruction

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ABSTRACT

With the flourishing development of the electronic techniques, all sorts of computer virtual technology have become the important parts of our daily life. It is the study point of many experts and scholars to use this technique to reconstruct Chinese ancient architectural complex and let people feel the charming of those ancient architectural complex. And it is also an important tunnel for normal people to know ancient history. The old summer palace is the world culture art treasure. But because of the aggression of eight-power allied forces, the most scenery of it had been destroyed. This article took the example of ancient landscape architecture reconstruction of old summer palace, and explained the whole process to reconstruct landscapes with virtual reality technique which mainly includes the data acquisition and processing, visualization of 3D landscape and decoration of virtual reality technique professional software. In addition, this text studied the quality evaluation criterion of reconstruction of ancient landscape. With the example of Shang Gan village, to evaluate it with model number, number of textures and average FPS three aspects. So the evaluation criterion is to ensure the weights of the three aspects. And by the means of fuzzy comprehensive evaluation method, we can make sure the reasonable weights.

KEYWORDS

Virtual techniques; The old summer palace; Landscape reconstruction; Evaluation criterion; Fuzzy comprehensive evaluation.





INTRODUCTION

The 21 century is the era of science information. All kinds of electronic computer technologies develop boomingly. And the virtual reality technique is one of the emerging technologies. The virtual reality technology (VR) uses the computer as carrier and develop auditory, visual and olfactory sense by plenty of technique to make participants feel personally on the scene. Nowadays, this technique has been applied in a lot of fields wildly, such as the restoration of cultural relics, indoor decoration design and landscape design and so on.

In 2013, Yu Yu compared the main engine systems and picked up the virtual reality system combining with the characteristics of the local landscape in the article <The application of the virtual reality technique in landscape design at the rail transportation exit and entrance>. And Yu Yu established reasonable three dimensional landscape virtual environment. The text pointed out that the core of virtual reality technique was the space interaction technique. Author said that virtual reality technique could reflect the real condition of buildings. Through the 3D images, users would have the real experience to be in the buildings. As the same time, author studied the application of virtual reality technique in landscape design. According to the demands of planned project, the technique could display the overall effect and the details clearly and stereoscopically. Virtual reality technique can express author's design philosophy and concepts so that it can be applied as design technique to achieve propaganda purposes.

In 2012, Qian Jing instructed that with the public demand on building diversification increasing, the preparatory present work is more and more essential according to her article < The reconstruction of space and time of virtual reality technique to landscape architecture design >. In that virtual reality technique will become the important auxiliary means of the architecture design industry. The author put forward a new concept-reconstruction of space and time. Through analyzing exiting cases, author concluded important steps of virtual reality technique in the architecture design application process. Her studied deeply the difficulties to apply this technique into architecture landscape design and did brief illustration in view how to apply the technique to improve design level.

In 2011, Gao Hui pointed out that reproduction of streetscape was the vital constitution of virtual reality technique study field in his text < the study of parallel mosaics technology to be used to reproduce streetscape>. Reproduction of streetscape had great influence on the development of car navigation, electronic tourism and entertainment games and the protection of cultural relics. The streetscape reproduction technology mainly included two dimensional reconstruction technique and three dimensional reconstruction technique. But both had advantages and disadvantages in the practical application. The two dimensional reconstruction technique deeply, the display effect of two dimension was not ideal. The three dimensional reconstruction technique could make the sight more stereoscopic and realistic. But if the data size of the landscape was too large, the effect wasn't satisfying. So the author found out three method to reproduce and repair the street scape, the jigsaw technique of two dimensional parallel, the jigsaw technique of three dimensional parallel and the repair technique of street view images of space. Author respectively studied deep and explained in details in light of the three method.

This text will explain the process to reconstruct cultural relic landscape with the example of the winter place and illustrate the evaluation of landscape reconstruction.

LANDSCAPE RECONSTRUCTION OF OLD SUMMER PALACE

The old summer palace is one of the famous Chinese ancient royal gardens as well as the world culture are treasure. It contains the essence of several famous gardens of southern changjiang delta, combines extravagant of western palaces. Its total area is more than 5, 000 mu and had been built more than 150 years. It can be called "the king of gardens". There are not only beautiful scenery in the old summer palace but also lots of historical relics and treasures. It is the palace for emperors of several generations of Qing dynasty where the emperors can work and relax. But after the aggression of eightpower allied forces and plunder of British and French allied forces, the big fire that burning for three

days and nights had destroyed everything of the old summer palace. Nowadays the scenery of old summer palace is the western house ruins (as Figure 1). in order to personally feel the view of old summer palace, tourists can appreciate it through computers by the means of virtual reality technique.



Figure 1 : Western House ruins

Data acquisition and processing

The number of data to reconstruct the old summer palace is many, including geographic coordinates (the geographic location of ancient compounds), spatial data (the physical dimension of compounds), Hollerith data (the historical background of compound), voice data (tour description and direction) and so on.

(1) Using Google Earth as the tool to get old summer palace's geographic coordinates, and using GPS to locate the coordinates of key positions. Then applying Arcgis to process data to ensure the exact location of old summer palace and providing basis for late period navigation picture.

(2) On-the-spot investigation. To measure the existing building, and referring historical data, with the help of relative historians and ancient architecture experts to design the physical dimension of old summer palace's buildings in the brilliant period.

(3) Using *PhotoShop* to deal with existing buildings in order to unit with virtual ones. And processing voice data and others to synchronization images and voice.

Visualization of 3D landscape

There are so many pavilions, bridges water and treasures that it will be difficult to restore one by one in light off economy and construction. So visualization of 3D landscape is an important method for people to feel ancient architecture buildings. Visualization is based on the image processing technique, and through scientifically calculation process to achieve drawing image information and to display clearly on the data terminal. In order to make sure the stereo perception of images, the process data process is as Figure 2.



Figure 2 : The processing data process diagram

During this process, we used 3DMAX, Creator, Skitchup to realize visualization. 3DMAX is mainly applied to process the pavilions (as Figure 3) and cloisters and also applied to improve the stereo perception. As for the building that has strong shape rules, Creator is used to cut down source waste. And Skitchup is used to those comparatively simple ancillary buildings to draw fats.



Figure 3 : Virtual pavilions landscape plan

Application of Converse3D

Converse3D is a professional software of virtual reality technique. It is very popular in tourism, and it plays an important role in tourism propaganda. In the aspect of old summer palace's 3D virtual display, it can show exactly the original scenery and reconstruct the glorious of the palace (as Figure 4)



Figure 4 : Virtual Summer Palace landscape plan

The project's relative workers put forward the idea to use electronic ticket. One piece of CD which carries the old summer palace's ups and downs illustrates the main cultural relics and important viewpoints with relative digital model, and shows aerial view and some viewpoints of old summer palace in front of the world in the form of 3D film. And it proves favorable guarantee to enrich the office website of summer palace.

EVALUATION METHOD OF LANDSCAPE RECONSTRUCTION

Through plenty of reference documentation, we find out that there is no unified standard for the reconstruction quality evaluation of each view. This model took the Shang Gan Tang village as the object of study to probe the criterion of reconstruction quality and to provide guarantee for further improve the quality of reconstruction landscape.

Shang Gantang village is site in Jiangyong County, Hunan Province. It has glorious history of more than 700 years. There are lots of historical relics in the village and they are reserved comparatively well. But because of some reasons, the temples has been destroyed in some degree. With the improvement of the people life standard, the tourism develops boomingly. People in the village did the commercial reform for the economic benefit so that they broke the ancient buildings. Nowadays, using scientific method to reconstruct ancient buildings becomes an important way for people to know the ancient cultural buildings. But we still do not make sure whether the fidelity of buildings and trees and water and other outbuildings' immersion have reached people's demand. So this model will establish evaluation criterion according to the fuzzy comprehensive evaluation method.

Fuzzy comprehensive evaluation

Under normal conditions, the fuzzy comprehensive evaluation involves three measures. Assumed that there are n factors that are relative to the evaluated object called as factor set and written as $U = \{u_1, u_2, \dots, u_n\}$. Then assumed that there are m common called as evaluation set and written as $V = \{v_1, v_2, \dots, v_m\}$. Because every factor's position is different, and the function is not the same. So the evaluation criterion is the weight, written as $A = \{a_1, a_2, \dots, a_n\}$. Steps are as following:

(1) Setting factor set $U = \{u_1, u_2, \cdots, u_n\}$.

- (2) Setting evaluation set $V = \{v_1, v_2, \dots, v_m\}$.
- (3) Doing single factor evaluation to get $r_i = \{v_{i1}, v_{i2}, \dots, v_{im}\}$.
- (4) Establishing comprehensive evaluation matrix:



(5)Comprehensive evaluation: As for weight $A = \{a_1, a_2, \dots, a_n\}$, calculating $B = A \circ R$. And giving the evaluation according to maximum membership degree law.

Data acquisition

Data of TABLE 1 comes from the article <The study of application of virtual reality technique in the planning of architecture and city>

Construction scene	Model number	Number of textures	Average FPS
Wenchang Pavilion single scene	44270	161	23.3
Step Win Bridge single scene	2162	29	27.6
Shouxuan Pavilion single scene	7090	135	24.8
Auditorium single scene	15931	97	25.6

TABLE 1: Quality data of single scene

Evaluation process

5.

From data of TABLE 1, we can see that the evaluation objects are Wenchang Pavilion, Step Win Bridge, Shouxuan Pavilion and auditorium. Factor set $U = \{u_1, u_2, u_3\}$. Therein, u_1 is model number, u_2 is number of textures, u_3 is average *FPS*. And after normalization processing data of TABLE1, we can get TABLE 2.

TABLE 2: Data after normalization processing

Construction scene	Model number	Number of textures	Average FPS
Wenchang Pavilion single scene	0.64	0.38	0.23
Step Win Bridge single scene	0.03	0.07	0.27
Shouxuan Pavilion single scene	0.10	0.32	0.24
Auditorium single scene	0.23	0.23	0.25

In order to express clearly circumstances of each monomer scenes, drawing radar chart, as Figure

4 0.80 0.60 0.40 0.50 0.40 0.50 0.40 0.50 - Iodel Sides - Jap Number - Average FPS

Figure 5 : Circumstances of each monomer scenes

From Figure 5, "1" represents Wenchang Pavilion; "2" is Step Win Bridge; "3" represents Shouxuan Pavilion; "4" is auditorium. We can find out that the area of average FPS is bigger than area of model number and number of textures. So when we do evaluation, the proportion of average FPS should be more.

Because the proportion of average FPS is comparatively big, thus when analyzing whether there are dependent variable relationships among the three variables through data, doing curve estimation to TABLE 2, we can obtain the result as TABLE 3.

Equation	R方	F	df1	df2	Sig.
Linearity	.586	2.827	1	2	.235
Logarithm	.601	3.011	1	2	.225
Reciprocal	.616	3.209	1	2	.215
Quadratic	.752	1.514	2	1	.498
Tertiary	.752	1.514	2	1	.498
Recombination	.750	5.996	1	2	.134
Power	.750	6.008	1	2	.134
S	.750	6.005	1	2	.134
Symmetric	.750	5.996	1	2	.134
Exponent	.750	5.996	1	2	.134
Logistic	.750	5.996	1	2	.134

 TABLE 3: Results of curve estimation

Through TABLE 3, we can find out the similarities of curve estimation are all under 0.8. so there is no dependent variable relationship among the three variables. Consequently, we can process comprehensive evaluation.

According to experience, first of all, setting two weight. Although these two weights are not same, but the maximum weight is average FPS.

 $A_1 = (0.1, 0.2, 0.7)$

 $A_2 = (0.2, 0.3, 0.5)$

Referring data of TABLE 2, setting up comprehensive evaluation matrix R:

	0.64	0.03	0.1	0.23	
R =	0.38	0.07	0.32	0.23	
	0.23	0.27	0.24	0.25	

According to the type of main factor determine i.e. the calculation is $b_j = \max \{(a_i \wedge r_{ij}), i = 1, 2, \dots, n\} (j = 1, 2, \dots, m)$. Through *Matlab* programming calculation, we can gain the results:

Under the circumstance of weight A_1 , the four single scenes' reconstruction quality score is (0.23, 0.27, 0.24, 0.25)

Under the circumstance of weight A_2 , the four single scenes' reconstruction quality score is (0.30, 0.27, 0.30, 0.25)

To test the reasonability of the two weights, doing questionnaire survey to the tourists of Shang Gantang village to evaluate the best viewpoint of the four single scenes. The survey results shows that the reconstruction landscape quality of Step Win Bridge (as Figure 6) is the best. And it as same as the circumstance of weight A_1 . In that, we can know that the evaluation criterion should take A_1 as the example to compare the four single scenes, as Figure 7.



Figure 6 : Step win bridge landscape reproducibility

From Figure 6, we can clearly see the bridge's reflection in the water and mountains. The overall feeling is very realistic and natural.



Figure 7 : Four single scene comparison chart

In Figure 7, the top left corner is Wenchang Pavilion; the top right is Step Win Bridge; the below left is Xuanshou Pavilion and the below right is auditorium. We can see that the four scene can reflect the features of ancient architectures, but the Step Win Bridge has stronger sense of reality. The flowing water increases he immersion, and the haze effect is just fine.

CONCLUSION

China is an ancient and cultural country with thousands of year's cultural history. There are plenty of ancient buildings with complex structure. So it is a bit difficult for our government to restore historical relics. First it would take a long time to finish the restoration because both the material selection and union with the existing parts of ancient buildings. Second it would cost so much money. For instant, the old summer palace has millions of treasures so its restoration will spend lots of money. The next and last reason is that the restoration will occupy too many people. It will require a great number of people at both the pre design period and the later interior decoration. And virtual reality technique is the best way to solve the mentioned three problems. This technique can cut down time to construct, avoid the embarking of material and decrease the number of workers. It just maintains the normal visiting around the existing cultural relics. Under the precondition to save, State Administration of Cultural Heritage does not encourage the reconstruction of cultural relics. And it is very difficult to reconstruct large buildings like the old summer palace and the Epang Palace. While people still can visit ancient buildings' glorious scenes at brilliant period through virtual reality technique.

As for the quality evaluation of ancient buildings reconstruction, this text uses fuzzy comprehensive evaluation method to evaluate according to the model number, number of textures and the average FPS. In that, we can gain the evaluation criterion of reconstruction quality. And this text lays a solid foundation for the improvement of ancient buildings reconstruction quality from now on.

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