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Three-dimensional landscape modeling of Quancheng Square in Jinan city

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Abstract. Nowadays, with the booming of tourism industry and the rapid development of modern urban construction, two-dimensional scene expression is quite far from satisfying people's requirements for travelling, sightseeing, shopping and other aspects. Compared with the two-dimensional scene expression, three-dimensional scene expression can provide people with more realistic scenes display and more quality services. Therefore, we carried out three-dimensional landscape belt modeling in Quancheng Square for delivering people more vivid scenery and more details of the sights of Quancheng Square. The modeling procedure consists of three major parts, including the iconic objects modeling by SketchUp, the entire three-dimensional scene modeling and three-dimensional spatial analysis by Skyline. People can clearly learn about the landscape of Quancheng Square through the 3D models and obtain more travelling information of the landscape. Thus, it has been widely applied in many fields, such as virtual tourism, tourism resources management, urban planning and the study of dynamic changes in urban environment.

1. Introduction

In the past, people just could find a few pictures and travelling notes for learning about the situation of the scenic spots or obtain a few of travelling guidelines. With the development of the three-dimensional modeling technique, it makes it possible for people to enjoy the real three-dimensional landscapes in the city. Recent years, the creation methods of 3D city virtual scene was researched and developed by numerous researchers. The procedure of creating the 3D city model based on SketchUp was illustrated by XU Hanwei through a practical digital city project construction^[1]. Chen Hong et al. realized 3D landscape model of strait tea expo park construction based on SketchUp^[2].

Nowadays, 3D modeling technology of 3D digital campus was studied by many colleges and universities as well. Beijing university of Civil Engineering and Architecture is considered as an example, the 3D scene was established by ZHANG Ruiju^[3] based on SketchUp and by HOU Miaole et al.^[4] based on Skyline, respectively. SHI Shengchun et al. introduced the procedure and technology method of 3D modeling based on SketchUp, and the feasibility can be demonstrated by the construction of the virtual campus of Kunming University of Science and Technology^[5].

In this paper, we introduced the procedure and methods of 3D landscape modeling of Quancheng Square in Jinan city based on SketchUp and Skyline.

2. Systematic designing for modeling

There are several tools for 3D modelling, such as SketchUp, Skyline and 3DS MAX, CityEngine.



Among them, SketchUp is suitable for both modeling of buildings and 3D landscape. It has a wealth of modeling plug-ins, and its own material library has a very rich texture materials. Moreover, Skyline software has more applications in 3D modeling, which rely on its powerful functions for models data management and 3D spatial analysis. Therefore, we chose SketchUp and Skyline as the modeling tools in this research.

Some data preparation work was required before modeling. The remote sensing images of Quancheng Square needed be obtained to generate digital line graphs of this scene through vectorizing the square borders, roads, etc. Meanwhile, we also required a DEM (digital elevation model) data of Quancheng Square, and the all-around pictures of buildings and features as texture maps.

The specific modeling procedure included data collection and preparation, the generation of 3D terrain model by Skyline, the creation of 3D model for iconic objects by SketchUp, texture mapping, 3D scene model generation and 3D spatial analysis. The flow charts of the modeling procedure was shown in figure 1

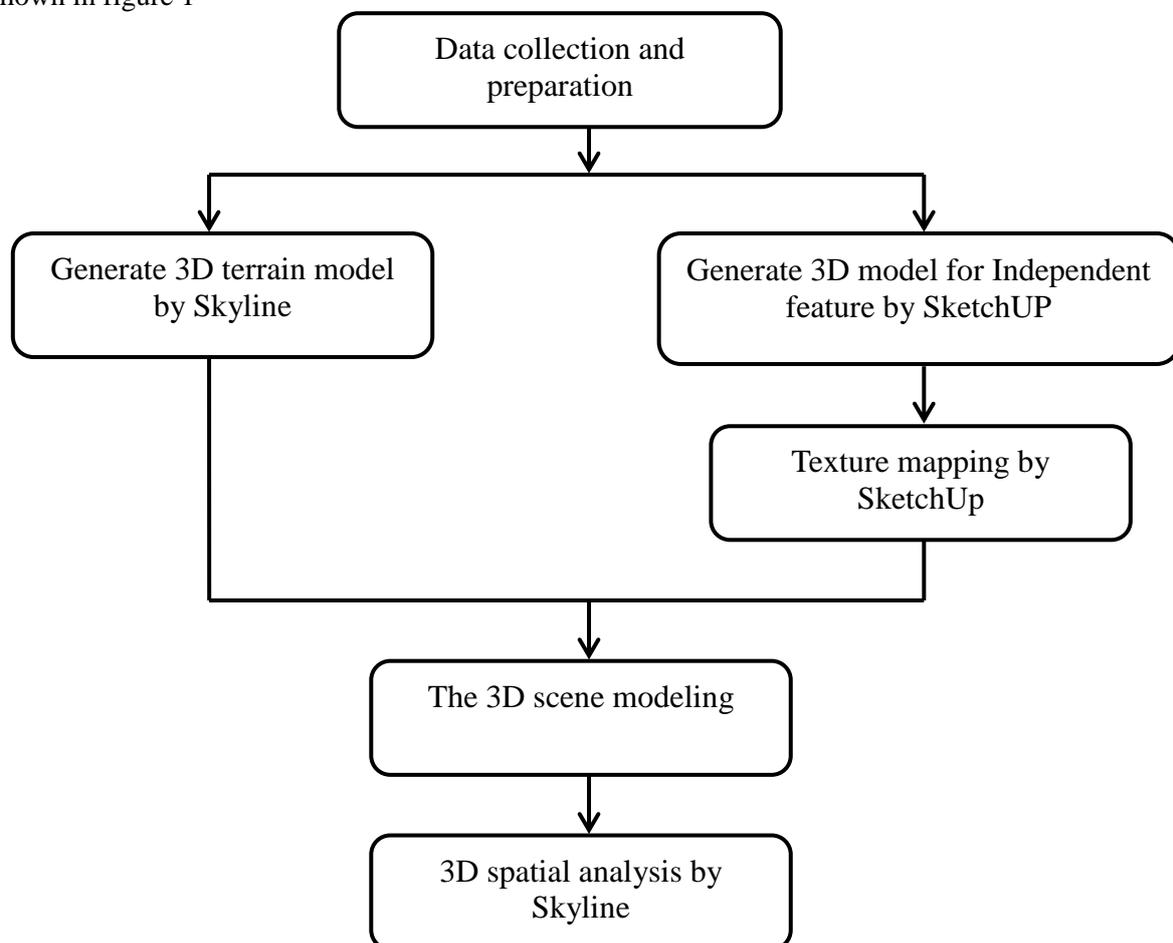


Figure 1. The procedure of 3D modeling

3. 3D landscape modeling of Quancheng Square

3.1 Study area

Quancheng Square, a famous scenic spot, is located in the center of Jinan, Shandong Province. It covers an area of 220,000 m², and attracts hundreds of thousands of people all over the world every year. On the Quancheng Square, the main components of Quancheng Square include the Spring Mark, the Lotus Music Fountain, the Culture Gallery and the Ginza Shopping Plaza, etc.

3.2 3D terrain model construction based on Skyline

The first step of 3D modeling was generating the 3D terrain model by the TerraBuilder. It is a component of Skyline. The image data, DEM and vector data can be coalesced by TerraBuilder for creating the MPT file with accurately geographical coordinates^[6]. Then the MPT file can be browsed smoothly in the TerraExplorer Pro. For the scene with large terrain fluctuations, such as mountains, 3D terrain model generation through DEM and remote sensing is speedy and accurate.

3.3 3D modeling based on SketchUp

Without loss of generality, the modeling procedure consists of three major parts, including the iconic objects modeling, the entire three-dimensional scene modeling and three-dimensional spatial analysis. Among them, precise modeling of iconic objects should be given priority. On the Quancheng Square, the iconic objects mainly include the Spring Mark, the Lotus Music Fountain, the Culture Gallery and the Ginza Shopping Plaza, etc. In the procedure of modeling the iconic objects, we made full use of the various modeling tools in SketchUp software to make the models as realistic as possible.

The Spring Mark is an important visual center in the Quancheng square. The sculpture of the Spring Mark overall appears blue; the shape of the sculpture represents the surging spring, and the profile of the sculpture looks very smooth; and every surface of the sculpture is a different curved surface, so that it has a rather strong three-dimensional effect. Obviously, it is impossible to be created only through the combination of planes.

In view of that, the move tool has to be fully utilized when creating the Spring Mark model. In SketchUp, the function of the move tool includes move, stretch, copy and array selected entities. If two surfaces are connected to each other, there will be a bonding effect between them, i.e. once the line or the surface that connects two surfaces is moved, both of them will change simultaneously. In fact, we took full advantage of the bonding effect of the move tool to create irregular surfaces of the Spring Mark sculpture. Then, we carefully observed the three-dimensional shape of the sculpture and achieved the most realistic three-dimensional effect by repeatedly moving the common lines or surfaces. Besides, it is rather vital to create groups or components for complex model since there are many advantages, such as speedily selecting a whole model, segregating one model with others, and making models hierarchical, improving the speed of modeling and displaying.

The Spring Mark sculpture consists of three separated three-dimensional structures, so we modeled them separately and then created them into groups. Eventually, they were successfully combined into a whole sculpture model. The procedure of creating the Spring Mark was shown as figure 2. Then the Spring Mark square model need be created. After these departments of Spring Mark square were completed respectively, integrating them together. The result of the Spring Mark square model was shown as figure 3.

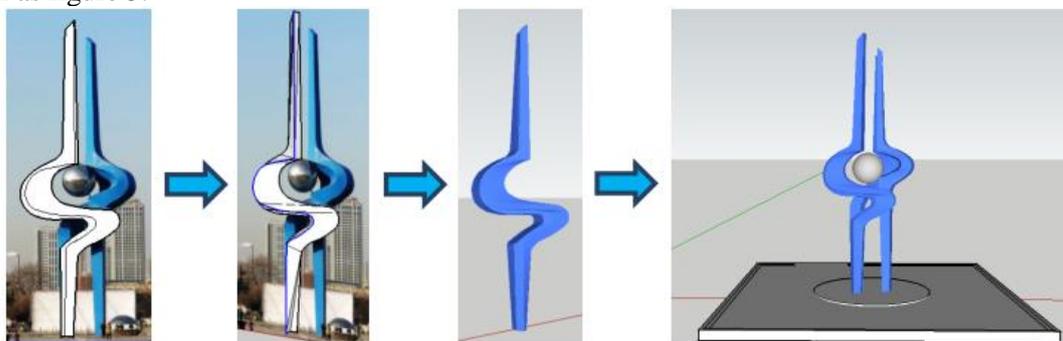


Figure 2. The procedure of creating the Spring Mark

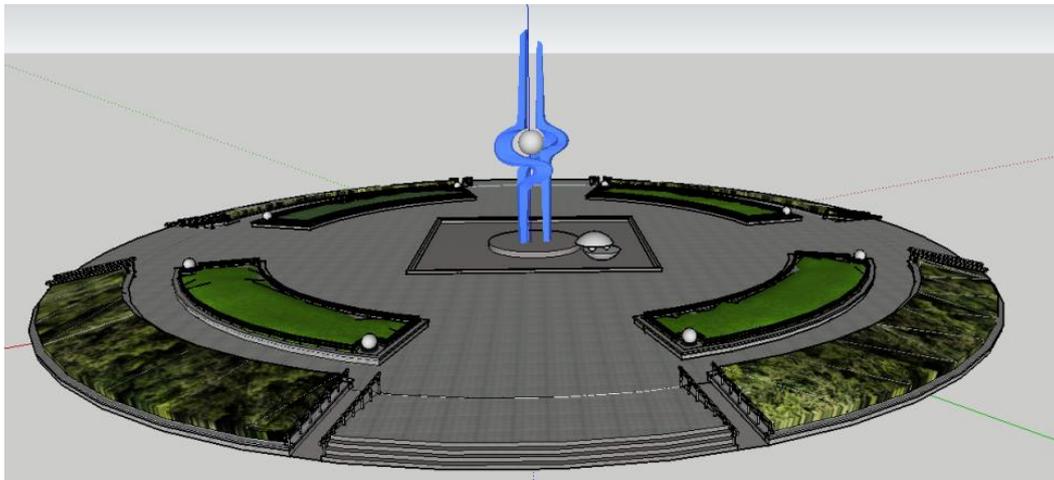


Figure 3. The Spring Mark square model

3.4 Texture mapping

In the procedure of 3D modeling, the texture maps and colors have to be attached to the object models for displaying the real visual effect of the 3D models and meeting the demands of visualization. We not only used the build-in texture material library with SketchUp but also imported the real texture maps taken in scene to make it more resemble with the real objects.

For some symbolic or significant entities, we used the photo of these objects as the texture map. It can make the models conform to the real appearance of the objects and make them more real and visible. When we used the pictures photographed by ourselves, we needed to import these pictures to the material library, and then we could rotate, move, distort and shear the texture to adapt the entities.

3.5 3D scene model creations by Skyline

The 3D scene models, such as trees, greenbelt and roads, were needed to be created for realizing the three-dimensional landscape creation of Quancheng Square. As the indispensable parts of the scene, they needed to be modeled in batches by the Skyline software. About the roads and greenbelt, we taken advantage of the DLG and assign the corresponding texture maps to them. And the trees could be created directly in the Skyline. Finally, we integrated the 3D object models and the 3D scene of the square to present the entire 3D landscape belt of Quancheng Square. The effect of 3D scene model was shown as figure 4.



Figure 4. The effect of 3D scene model

4. 3D spatial analyses based on Skyline

Apart from that, some functions, including query the information of 3D construction, browse the 3D scene, scene presentation and other 3D spatial analysis functions, were realized in TerroExplorer Pro of Skyline. By the way, the realized 3D spatial analysis functions in Skyline mainly include measure,

terrain analysis, calculating the land area covered by flooding, line of sight, 3D viewshed analyze and shadow query, etc. Besides, in order to implement the query of models properties, we added the messages and notes to the special object models. When we click one model, the information of this model will pop up in the 3D window. The result of Information query was shown as figure 5.



Figure 5. Information query with picture

To display the 3D scene model of Quancheng Square, we set up an automatic presentation path. Following the path, everyone can enjoy the panorama of Quancheng Square through this three-dimensional virtual model, and observe every corner of Quancheng Square by roaming the three-dimensional scenes.

5. Summary and conclusions

In this paper we introduced the procedure of 3D scene modeling of Quancheng Square based on Skyline and SketchUp. The 3D terrain was created by TerroBuilder. In addition, some functions include edit, browsed and analysis for data and models were realized in 3D scene by TerroExplorer Pro. Moreover, we created the 3D landscape model of Quancheng Square combining the detail modeling and the 3D spatial analysis functions, and some function such as query the information of 3D construction, browse the 3D scene, scene presentation and some sample 3D spatial analysis were realized. People can clearly learn about the landscape of this place and obtain more travelling information with the three-dimensional models of the landscape. And the method for 3D modeling has potential applications in many fields, such as urban resource environment management, digital city construction and many other fields. So the modeling of urban landscape should be greatly developed in the future.

In this modeling procedure, the model was created mainly based on remote sensing image, pictures and the results obtained by on-site inspection. Although there is no significant difference in visual effects, the precision may not be enough. In future modeling studies, if we can obtain more accurate mapping data, the modeling effect will be better.

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