The Research of Real 3D Modeling in the Digital Heritage Protection of Ancient Architecture

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Abstract. Digital preservation of ancient architecture cultural heritage has become a global problem. This paper presents a new way to construct the real three-dimensional model of an ancient architecture and proposes a frame that can construct an architecture model simi-
automatically. The idea of component oriented is used in this framework. This framework has been used in practice. In the end of this paper, two examples of the architectures of the potala palace are provided.

Keywords: component, digital heritage preservation, real three-dimensional model, ancient architecture, component oriented.

Introduction

Ancient architecture plays an important role in the cultural heritage protection in the world. Digital historic buildings are important in that it preserves information for future generations to learn from the past. A rich architectural heritage provides design solutions to various problems for future architects and planners. In addition, many cities gradually lose their rich artifacts and history, as historic buildings are destroyed to make room for new projects. Architecture represents a result of the interaction between different cultures throughout history such as the social values, political strategies, economic situations, and behaviors of a particular time. People take all kinds of protection measures to repairs, reconstruct and recovery the ancient architectures in order to inheritance and carry forward these precious cultural heritages. The real digital modeling for the ancient building based on 3D GIS technology has some features. It not only can represent the ancient buildings, the structure, but also store and manage the function, the installation process, various pictures, text information and other art details[1]. It provides important data and the model support for restoring or repairing architecture[2-3]. It occupies very important position in the construction of cultural relics digital.

In this paper, a frame that can construct an architecture model simi-automatically is proposed. It applies the idea of component oriented and parametric design to provide real 3d, real size and real texture digital model and makes the model process easy and fast.

Relate works

Digital CAD Modeling can create visual geometric models that simulate the three dimensional form of a building or architectural detail or even help resolve ambiguities and inconsistencies in the raw data and drawing.

In recent years, the 3D modeling in the digital heritage protection of ancient Architecture is a hot topic problem in domestic and many foreign scientific research institutes. Gong Jianya puts forward to a 3d data model which integrated vector and grid by object-oriented ideas in mining and geological background[4]. Chang Ge divided 3D into two kinds. One is expressed based on body, another is expressed based on the surface. Among them the most representative is the structure
entity express and the boundary express method\cite{5}. They put forward nine categories of building geometry structure to model\cite{6}. This model method is widely used by CAD model workers. The university of Rome, Italy Antonicelli Angela who is engaging Plinius engineering to study and establish the model of virtual reality of Pompeii city.

Once a digital model is constructed it can be used to generate elevations, sections, plans, and perspective views. It can also serve as a base for walkthroughs, flybys, and virtual reality tours. An architectural model includes recorded features of measured drawings, photographs, and videos as well as accurate dimensions of buildings. In addition, computer generated renderings can provide realistic representations of buildings. Furthermore, text can be linked with those architectural models, establishing a comprehensive database that merges visual and written information about a building.

**Architectural Heritage Model Design Frame**

According to the component oriented design concept, programmer gave has mined the frame as follow.

In this frame programmer divide the architecture into three kinds. The first kind is the architectures of less culture value. The second kind is the architectures have culture value but they are similar. The last kind is the architectures is unique and complicated. According to those three kind architectures, this paper gives solutions respectively.

**A. The architectures of less culture value**

In the digitization process of a scenic spots, there is no need to build every model with real 3D. Because the culture value of most of them is so low that programmer do not worth cost so huge effort to build it. In view of this kind of circumstance, this paper draw a 2D graph accord the building’s size, shape and position at first, and then set up regional attribute for every house and store it into architecture library. According to those data this paper can generate simple 3D model architecture at last. The frame shows as follow.

![Frame of the architectures of less culture value](image)

**Figure 1.** Frame of the architectures of less culture value

In this frame the area is the border of a house. It can be any shape but it must be closed. Area attribute includes name of architecture, foundation elevation, height, ground floor height, top height, number of layers, roof type, color of walls, remark. Roof type includes flat-roofed, spire and enclosure. All area attribute data is stored into Architecture library.
This paper can use 2D data position, foundation elevation and height to calculate the corresponding DEM data to establish the architecture’s real digital model.

**B. The similar architectures**

This kind of architecture have similar configuration. This paper use parametric design to establish digital model. This paper can get the accurate architecture model form adjusting the parameters to modify and control the automatic geometry shape of the model when the size or part structure is changing. The change of the value of a parameter, either in 3D shape, or in a related 2D working drawing revision, the result is the same, will cause the 3D model and the 2D diagram line rebuild.

**C. The unique architectures**

This paper doesn’t have to carry through parametric design for the unique architecture, because it can’t be reused. This paper can use 3D controls and 3D operations to establish its model. The frame shows as follow.

**Figure 2.** Frame of the unique architectures

In this frame programmer can use 3D control to generate basic three-dimensional graphic or use 2D controls to generate basic 2D graphic and stretch operation or scan operation to get a three-dimensional graphic. And then, programmer can use these basic three-dimensional graphic to performed revolve operation, mirror mage operation, array operation, shift operation or scaling operation according to the actual need. Of course, those operations can be use repeat. In this process, programmer can use three-dimensional boolean operation which contains intersection operation, and operation and difference operation to change the shape of the basic three-dimensional graphic. After that, programmer insert the 3D graphic what programmer have got into other 3d graphic with a settled point. At last programmer save the real 3d graphic and got a real 3d model of the unique architecture.

**Application of Architectural Model Frame**
This paper developed a system according to this frame by using VB language and OPENGL. The following cases shows using the frame in modeling two houses and a pavilion in the potala palace in line with three circumstances above.

**A. The architectures of less culture value**

The process of built the 3D model of the business building in front of the potala palace was given. The 2D graphic of the business building is shown in fig 3. The parameters of area attribute are shown in table 1. The 3D model of the business building with out of texture is shown in fig 4.

![Figure 3. The 2D graphic of the business building](image)

Table 1. The Parameters of Area Attribute

<table>
<thead>
<tr>
<th>Name of architecture</th>
<th>The business building</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation elevation</td>
<td>4211</td>
</tr>
<tr>
<td>Height</td>
<td>7</td>
</tr>
<tr>
<td>Ground floor height</td>
<td>3</td>
</tr>
<tr>
<td>Top height</td>
<td>1</td>
</tr>
<tr>
<td>Number of layers</td>
<td>2</td>
</tr>
<tr>
<td>Roof type</td>
<td>flat-roofed</td>
</tr>
<tr>
<td>Color of walls</td>
<td>flat-roofed</td>
</tr>
<tr>
<td>Remark</td>
<td>The business building of the potala palace</td>
</tr>
</tbody>
</table>

![Figure 4. The 3D model of the business building](image)

**B. The similar architectures**

The process of built the 3D model of the pavilion the potala palace was given. It is the similar architecture, so this paper used parametric design to establish digital model. The design interface and parameter of the pavilion is shown in fig 5. The 3D model of the pavilion with out of texture is shown in fig 6.

![Figure 5. The design interface of the pavilion](image)
C. The unique architectures

The house in the potala palace is unique in the world. So, this paper employs the frame showed in fig 2 to establish the three-dimensional model. The process of built the door is shown in fig 7. The process of built the window is shown in fig 8. The final the three-dimensional model of the house is shown in fig 9.

Figure 6. The 3D model of the pavilion

Figure 7. The process of built the door

Figure 8. The process of built the window
Figure 9. The 3D model of the house

Acknowledgment

The authors thank Prof. Lu Xinming and Yin hong manager for valuable discussion and recommendation. Supported by the ministry of education key project of science and technology under Grant No.208137 and the National High-tech Research and Development Program of China (863 Program) under Grant No.2009AA062700.

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