Application of Computer Technic in the Reconstruct of Chinese Ancient Buildings

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ABSTRACT:

This paper offers an introduction of computer assemble and simulation of ancient building. A pioneer research work was carried out by investigators of surveying and mapping describing ancient Chinese timber buildings by 3D frame graphs with computer. But users can know the structural layers and the assembly process of these buildings if the frame graphs are processed further with computer. This can be implemented by computer simulation technique. This technique display the raw data on the screen of a computer and interactively manage them by combining technologies from computer graphics and image processing, multi-media technology, artificial intelligence, highly parallel real-time computation technique and human behavior science. This paper presents the implement procedure of simulation for large-sized wooden buildings as well as 3D dynamic assembly of these buildings under the 3DS MAX environment. The results of computer simulation are also shown in the paper.

1 INTRODUCTION

The art of ancient Chinese architecture is the essence of the Chinese cultural heritages. It has important significance for the studying and learning Chinese culture and civilization. It's of great difficult, however, to learn the complicated structure of ancient Chinese architecture due to the lack of reference data because of the factors of time and natural or human-made disasters. In the project of reconstruction of Zhi-Lian Nnunnery, the Tang Dynasty Temple Reproduction, Hongkong, the architectural supervisor, Wuhan Technical University of Surveying and Mapping, reconstructs the sampled data of the building by using a 3D model with a computer, and use it for quality checking as well as used for the reference data for forever preservation of the building. This will provide accurate, objective and detailed line and frame data of the building for the studying, maintaining and reconstructing it in the future. It also provides a new method for protecting ancient cultural heritages. However, though the graphs of line and frame of a building are convenient for surveying and mapping, it is not for architects to study it profoundly. Computer simulation is a vivid research field developed in the 1980's. It combines of several key techniques from computer graphics, multi-media technology, artificial intelligence, highly parallel real-time computation and human behavior science. Computer simulation displays data flow on a computer screen, managing these data interactively by means of simulated graphs and images, so as to provide the end users a virtual realistic experience in order to provide convenient way for observing and studying macro- world and micro-world which are impossible for direct observation due to various of influences. If this technique is combined with virtual simulation technology, creating various layers and virtual models rich of details, then it is convenient to common users to see the structure layers and interior feature of the building. This is also useful to archaic culture experts, ancient architects and construction engineers to locally or globally observe, analyze and study the building upon a computer. For instance, the re-occurring of how the pillars, horizontal tablets, square wood that connects two pillars, DOU , GONG, FU, ANG, QI, LIANG (all in Chinese Pinyin), etc. are connected by mortises and tenons, and then mounted them to setup palaces, great halls, mansions, pavilions and pagodas will provide intuitive materials to study ancient buildings[1]. If the computer simulated re-occurring procedure is coordinated with dynamic simulation and commentary, music, then the explanation of the characteristics of ancient Chinese architecture will be not only visually but also in an entertainment environment. This paper studies wood texture simulation and dynamically virtual simulation and provides our primary results.

After carefully learning the structure of ancient buildings, knowing the order and regulations for mounting a building, we employ AUTOCAD12.0, 3DS MAX and OpenGL as the basic tools for the simulation process. A series of small programs have been developed to implement this study.

2 THE MAKING PROCESS

Collection of original data → Making of separate parts of the building → Combination of part structure drawings → Combination of the whole building.

2.1 Collection of Original Data

There are four methods of collection required by different practical conditions.

2.1.1 On the practically measure. The original data of the example of Pagoda of Thousands of Buddha is obtained by measuring the actual parts of the building.

2.1.2 Making of 3D drawings based on plane figure. Under the condition that no processed actual part has been made, the 2d data can be transformed into 3d data according to the design drawings.

2.1.3 Obtaining 3D data of parts with complex surface by

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converting the results from PhotoModeler into AutoCAD.

2.1.4 Making of 3D according to designs directly in case of lacking plane figure An instance of this model

2.2 Making of Drawings of Separate Parts of the Building

The establishment of 3D models starts from the individual part reasonably in response to the property of ancient buildings that the whole body is occluded compactly through rabbets and mortises of each single part.

A closed and independent 3D drawings, its shape, direction, size total consistent with its equivalent actual object reflect each model of the part. Such as Figure 1 is the 3D-drawing of Dou and Gong.

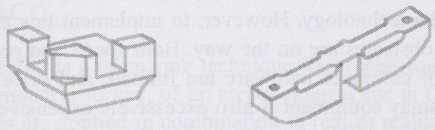


Figure 1

2.3 Assemble of One Floor

In view of the fact that the wood ancient building is combined through rabbets and mortises of many sub-parts, it is usually divide into Columns, Dougong Layer, Roof frame, Eave Layer and Tile. The simulating process manipulated by AutoCAD must stick to the principle of compact assemble. Only in this way can the drawings reflect the exterior appearance and internal structure truly. After the 3D drawings of each part have been made, computers begin the organization layer by layer. Figure 2 shows the organization of part of the Dougong; Figure 3 shows the organization of the whole body of Dougong; Figure 4 shows the organization of the floor.

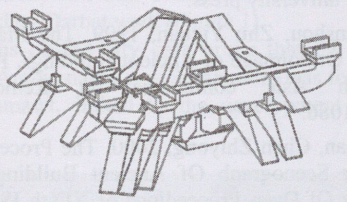


Figure 2

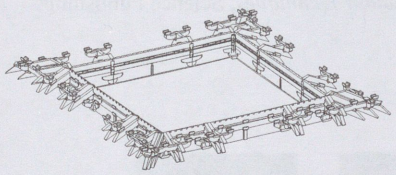


Figure3

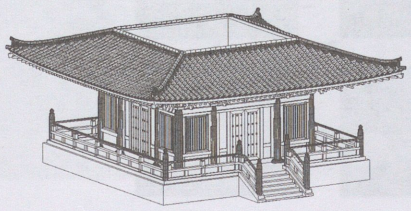


Figure 4

2.4 Assemble of the Whole

With assemble of each floor finished, AutoCAD begins the assemble of the model of the whole building

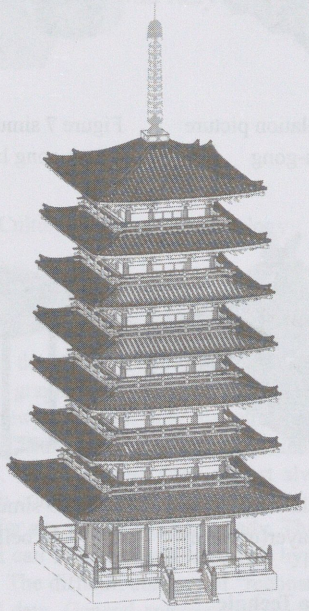


Figure 5 Surface model of pagoda

3. COMPUTER SIMULATION

Because ancient building is built of wood, lignification is one of its characteristic. In order to generate satisfactory and virtual realistic images of a timber building by the 3D computer simulation system, it needs to simulate the surface material of each component besides the establishment of correct model. Other component of ancient building is connected by mortises and tenons. During the mounting of ancient building, the order of mounting of different components is vitally important and restricted by their shapes and physical characteristics. Position of each component is measured by surveying. So those positions must be set up key frame during dynamic virtual simulation.

3.1 Making Material

The main task of generating material texture is to determine the color, texture and light and shade pattern of the material. The color of a material can be divided into three categories: ambient-----the color of the shading part of an object, diffuse----the color of an object under lighting, specular----the color of an object under strong lighting.

Texture describes the natural characteristics of the surface of an object, it can be generated by a 2D random function f(u,v)……Let $N(\mu,\sigma)$ denotes a normal distribution function, μ represents the mean value.σrepresents the standard deviation[2]. Its value relays on pattern of material. Besides, the texture can be from a scanned image or generated by a graphic package.[2] The following figures show the result.

3.2 Moving Control Technic

All the graphs and images generated up to now are stationary. The kernel of our project is dynamic virtual simulation, so computer animation technique is a must. Though many techniques of animation can be considered, the key-frame based method is adopted here.

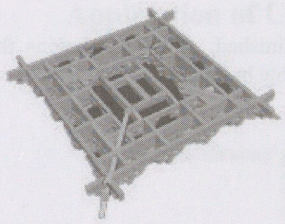


Figure 6 simulation picture of Dou-gong

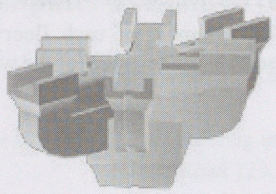


Figure 7 simulation picture of Dou-gong layer(planform)

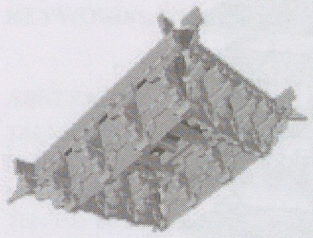


Figure 8 simulation picture of Dou-gong layer(upward)

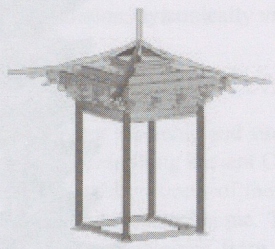
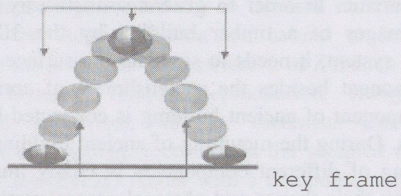


Figure 9 simulation picture of bell tower

3.2.1Key-frame Technic

The most popular computer animation technique is based on key-frame technique. The core of this technique is to fix the so-called key-frames, and then let 3DS MAX software system to interpolate to generate those between key-frames. The B spline function is used.[2,3]



Insert frame among key frame
Figure 10 movie of key frame

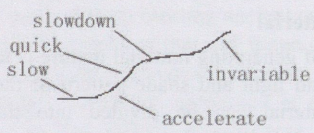


Figure 11 slope and speed of movement

After the attribute values of key frame is given, they will be stored in a structure named curve node and will be controlled by the node. These curves are defined by the attribute data of the key frame, the speed of the animation then can be adjusted by the tangent of a curve.

Usually, (Fig 11)the gradient of a curve indicated the speed of an object. Steep curve indicates high speed, while flat for slow. Consequently, horizontal curve indicates the object stopped. Pictures(Fig.12) is build-up process of timber component□

4 CONCLUSIONS

Computer simulation is a hot research field in computer science. It provides a novel environment for people to explore macro-world and micro-world. It is also the superb stage of multi-media technology. However, to implement this technique perfectly, obstacles are on the way. Both speed and processing capacity of computer hardware are limited, and price of high quality display equipment is also excessively expensive. On the other hand, expense of software development is also out of tolerance. Many works are still waiting people to do.

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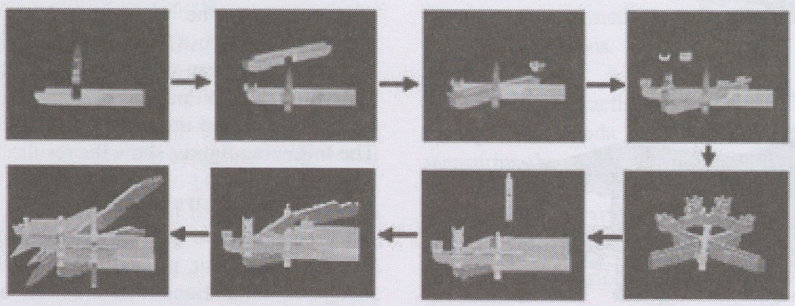

Figure 12 movie of a series of Dou-gong