

HOW TO SIMULATE AND REALIZE A DISAPPEARED CITY AND CITY LIFE?

A VR cave simulation

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Abstract. Computer simulation is used well in historical architecture restoration and research in a small scale for a long time, and should be used in a larger scale to represent a city, especially a disappeared city. Therefore how to utilize computers to coordinate both architectural and cultural data of a city becomes an important issue. This study takes Chang-an City that existed 1400 years ago but disappeared now as example and tries to develop a computerized and visualized method to simulate and realize a disappeared city and its life. Finally, we represent simulations in a virtual reality cave (VR Cave) to make navigators evolving in and interacting with the virtual Chang-An City.

1.Introduction

The data of historical architecture, either the east or the west, was recorded by writing, drawing, pictures and models (Ma, 1984; Hsu, 1990; Lee, 1990; Liu, 1996). The content of these data included structure, form, scale and material of building (Fu, 1963; Guo, 1963; Lai, 1997). With respects to a historical city, the media of recording data was the same as stated above; however, the content had expanded from representing a single building to the city as a whole. Not only the design principles but also the social system, the cultural activities, and the city life at that time were recorded (Tatsuhiko,

1986, 1994, 1995, 1997, 1998). By means of these recorded data, we are able to restore the architecture and the city as well as the cultural activities and the city life of that particular time.

Due to the limitation of conventional media, the architectural data was recorded incompletely (Chiu and Lan, 2001; Potier, 2001; Tang, 2001). Therefore, mistakes often occur in the restoration. To overcome these mistakes, lots of researchers then start using computer simulation to identify the problems of restoration previously and propose alternatives (Potier, 2000; Tang and Liu, 2001; Tang 2001). Potier(2000) established a computerized procedure of restoration, which utilized computers to restore historical remains. Using Potier's establishment as the base, Tang (2001) proceeded it to actual restoration project. The discovery was that 3D visualization could solve problems and conflicts that were raised by 2D drawing and perform a more accurate reasoning. Moreover, computer was used by Tang and Liu (2001) in more detail such as solving the visual unharmony of color and material for restoration.

2. Problem and Objective

Nowadays, computers are used in historical architecture restoration and research in a small scale. After we realize the characteristics and advantages of computers, we should use them in a larger scale to represent a city, especially a disappeared city. The restoration shall include architectural data such as palaces, blocks, markets, and streets as well as cultural activities such as dancing, singing, chess, and sports. Therefore the problem of this study is how to utilize computers to coordinate both architectural and cultural data of a city? The objective of this study is to develop a computerized and visualized method to simulate and realize a disappeared city and it's life.

3. Methodology and Steps

There are four steps in this study. First, we take Chang-An City that existed 1400 years ago but disappeared now as the example and obtained information from seven sources: archeological data, historical literature, relics, remains, wall paintings, stone inscriptions and new research findings. Second, we make computer models of static buildings and dynamic activities of Chang-an city. Third, we combine architectural and cultural data to product seven major simulation sets, including foreign diplomats entering Han-Yuang Palace, banquets in the Palace, ladies playing chess, polo game, drinking in Li-fun, camel caravans in the market, and trades in the market.

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Finally, simulation is represented through a virtual reality (VR) Cave in order to make navigators evolving in and interacting with the virtual Chang-An City.

3.1. RELEVANT DATA OF CHANG-AN CITY

3.1.1 Architectural Data

After collecting plenty of data that were recorded by seven resources we mentioned above, we can not only outline the layout of Chang-An city but also realize the typical types of architecture. Generally illustrating, the form of Chang-An City is a rectangular which wide is 9 kilometers and length is 8 kilometers, and inside the rectangular was crossing street system (Figure 1). The street in the middle of the system is the main street, which wide is 155 meters and is called Chu-Chuai Street (Figure 1a1). Min-Da Gate locating at the south of Chu-Chuai Street is the main gate of the city (Figure 1a2). The blocks separated equally by crossing street system were the basic living units named Li-Fun (Figure 1b). Especially, two of these blocks mirroring by Chu-Chuai Street and called East Market (Figure 1c1) and West Market (Figure 1c2) are the main business sections of the city. The trapezium on the top of the rectangular area is Da-Min Palace where many palaces locate and the imperial family live (Figure 1d). In conclusion, gates, palaces, markets, and residences are the four typical types of architecture we want to discuss this time.

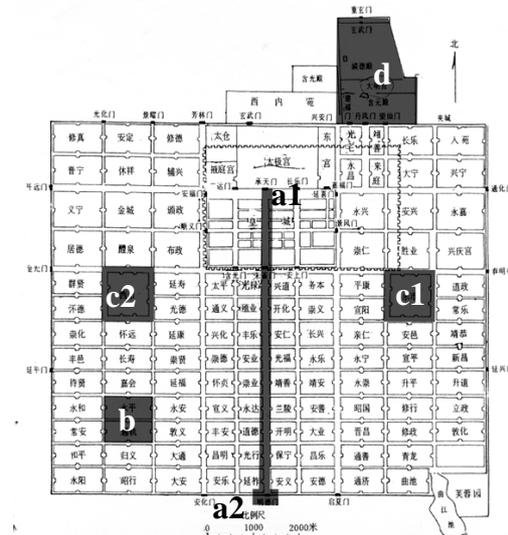


Figure 1. The plan of Chang-An City

3.1.2 Cultural Data

In addition to architectural data, we can also gather cultural data from collections of seven resources. In other words, besides typical types of architecture, we can also represent typical parts of city life in Tang dynasty by analyzing wall paintings, underground relics, and well-protected relics mainly. For example, the circumstances of foreign diplomats paying tribute (Figure 2a), ladies dancing, and banqueting are revealed by wall paintings in graves. Pottery figurines and golden implements that were stored underground show what the diet habits were and how people played polo (Figure 2b), which was the famous sport at that time. To deserve to be mentioned, plenty of well-protected relics, such as equipments of chess (Figure 2c), musical instruments and furniture that were presented to Japan by Tang dynasty 1400 years ago, also hint many activities in Chang-an City.

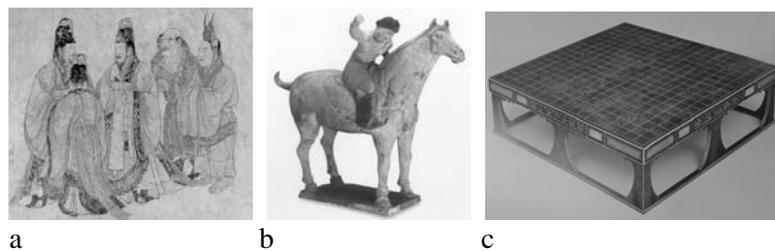


Figure 2. *Cultural data: (a) Wall painting (b) underground relic (c) well-protected relic*

3.2. COMPUTER MODELING AND REASONING

3.2.1 Architectural part

Although we have already analyzed the data we collected, and confirmed the typical types of architecture including their plans and sections. We still have to reason when we model them. Take Lin-Da Palace for example, measuring the remains, using the drawings that archeologists have already reasoned and surveying relevant research papers still can't support us to make a completed 3D model. We can only make a framework (Figure 3a) and indicate a basic form of it (Figure 3b). In order to make the model more detail, more data available are necessary. In other words, after collecting more relics such as tiles of roof and ground, observing buildings which imitate the style of Tang dynasty such as the detail of structure, and analyzing the color of building on several wall paints can make the model more real (Figure 3c).

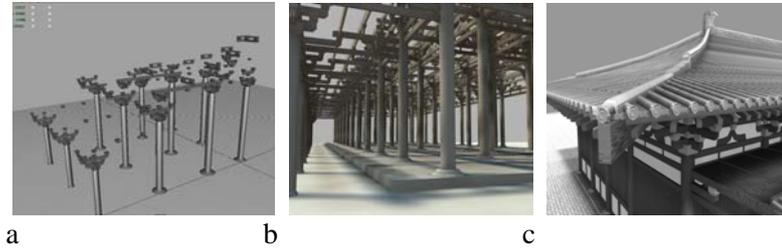


Figure 3. *Computer model of Lin-Da Palace: (a) Framework model (b) Basic form model (c) Detail model*

3.2.2 Cultural part

We are familiar with the process of making and reasoning architectural models but have no experiences of making and reasoning cultural models. In other words, the researchers of architectural fields neglect cultural activities of a space before, and need to propose an integrated method, which corresponds to the methodology of archeology and art history. After using this integrated method, we can combine data and reason results before making models. There are five steps of the process we proposed in this research. Take playing chess for example, we take a drawing which describe the scene of playing chess in Five dynasty as the base firstly (Figure 5a). Second, we start to replace implements of Five dynasty with those which also exist in Tang dynasty (Figure 4a). Third, we compose many parts of different implements when we discovered that the implements in Five dynasty are a little different from the ones in Tang dynasty (Figure 4b). Then we try to deal with surplus implements, which do not exist in Tang dynasty, by replacing anything suitable (Figure 4c). Finally, we draw a supposing drawing of the ladies playing chess (Figure 5b) and start to make computer model (Figure 5c).

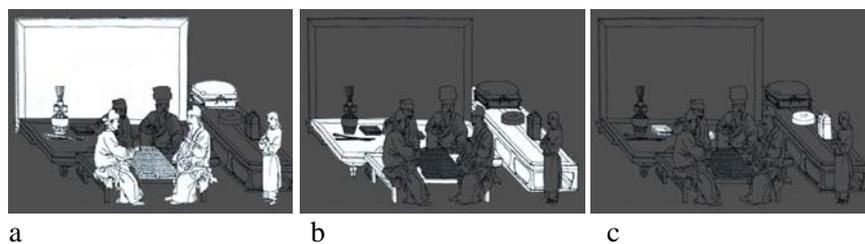


Figure 4. *The process of reasoning*



Figure 5. *The process of reasoning*

3.3. DATA INTEGRATION

However, we have to combine architectural and cultural data to produce a completed representation of a city. Integrating the right places with the right activities is the most important thing. For example, ladies playing chess can happen not only in architectural interior but also outside of it. After surveying many data and discussing with experts, we put ladies playing chess in Lin-Da palace. Because many clues such as the kinds of implements, the arrangement of furniture, and clothing of people are all reveal the result. Finally, we integrate seven major simulation sets, including foreign diplomats entering Lin-Da Palace, banquets in the Palace, ladies playing chess, polo game, drinking in Li-fun, camel caravans in the market, and trades in the market (Table 1).

Virtual Chang-An City	Architectural data	Cultural data
	Lin-Da Palace	Foreign diplomats entering Lin-Da Palace
		Banquets in the Palace
		Ladies playing chess
		Playing polo game
	Li-Fun	Drinking in Li-fun
	West Market	Camel caravans in the market
		Trades in the market
	Min-Da Gate	*Foreign diplomats entering
		*Camel caravans entering the market

Table 1. *The hierarchical data of virtual Chang-An City*

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3.4. VR CAVE REPRESENTATION

Representing in a VR Cave can make a simulation more real, because the surrounding screens can produce more sense of space than flat computer monitor (Figure 6). Furthermore, we also produce two frames with different view angles to be viewed separately by left and right eye, in order to increase the sense of space. Instead of viewing an animation, navigating in real-time render scenes and interacting with objects are also important issues to make people evolving in a virtual reality (Figure 7).

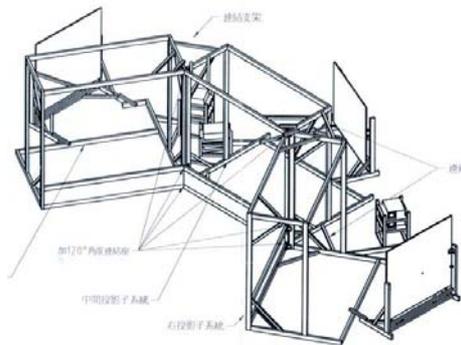


Figure 6. *A virtual reality cave*



Figure 7. *A simulation in a VR Cave*

4. Results

This study has found three phenomena. First, by means of this method of simulation and VR Cave representation, we successfully reconstruct the architecture and cultural activities of Chang-An City in Tang Dynasty, which was approved by archeologists, art historians and architects. Second, by combining the research methodologies of archeology, art history and architectural restoration with computer technology, we provide archeology with a new direction of methodology. Third, by adding the social activities into the restoration of architecture, we are able to ask new questions that were not found before.

The significance of this study is to develop a computer simulation combining the research of archeology, art history and architecture. Because of the size of Chang-An city, this study focuses only on city gates, palaces, blocks, markets, streets and their inner activities. Extending to the whole city will be the future study.

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