

THE TECHNICAL FRAMEWORK OF DIGITAL TANG CHANG'AN CITY

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Abstract: Presently, the idea of Digital Earth that Gore envisioned (1998) has become increasingly available by the supports of advances in GIS technology, Internet and high-resolution satellite imagery. However, these huge data models always place emphasis on describing the natural and scientific elements but ignore the humanity factors that are equally weighted. The paper aims at providing a technical framework on implementing Digital Tang Chang'An City (A.D.618-907) to restoring the most magnificent time in Chinese history. As a result, the study of the framework is mainly represents as a proposed three-layer system architecture. In addition, the paper specifically introduced the related technologies and the methodologies based on GIS in handling culture and history. It can be concluded that under this technical framework, Digital Tang Chang'an City is not only to set up a scientific digitized model, but also ground on the humanity perspective to make the digitized model "full of vigorous".

Keywords: Digital Tang Chang'An City, Technical Framework, GIS, Methodologies, History, Culture

1. Introduction

From the year of 1998, the notion of the Digital Earth was surprisingly transported to all over the world. As one important component of this concept, Digital City was also highly concerned. With the support of increasing large amounts of geo-spatial data have been accumulated and the development of IT technology, new survey methods and high-resolution satellite imagery in the past 12 years, its application fields are enlarged to nearly all sides of people's life including tourism, commerce, urban planning, health control and politics etc. Therefore, it can be proved that the idea is technically feasible that Gore envisioned.

However, in the process of building digital city, especially in China, most of the projects of the digital city always put the eyes on the hardware investments such as the constructions of database, infrastructure and bandwidth etc but cannot be aware of the importance of existed history and cultural heritage. It is needless to say that humanity factors and scientific elements are equally weighted. Regarding as a particular fortune to every city, Digital City should contain this kind of information for not only providing more comprehensive public information services but also being "more vigorous".

Ancient Tang Chang'an City, as the national cultural, political and economic center in Tang Dynasty, is the most famous cosmopolitan city in the world. In this context, this paper aims at providing a technical framework on implementing Digital Tang Chang'an City (A.D.618-907) to restoring the most magnificent time in Chinese history. The paper is structured as follows: the next section discusses the designed functional system and the technologies in modeling the digital Tang Chang'an City; chapter 3 provides methodologies on representing and analyzing the historical and cultural information; the final section summarizes the paper's conclusions.

2. Technical Framework in Digital Tang Chang'an City

From the system architecture perspective, Digital City has an explicit organizational structure. But at the technical angle it is a complex system which highly integrated multi-disciplinary techniques. Thus, to design the technical framework of this digitized model, the study should discuss from these two aspects as figure 1 illustrated.

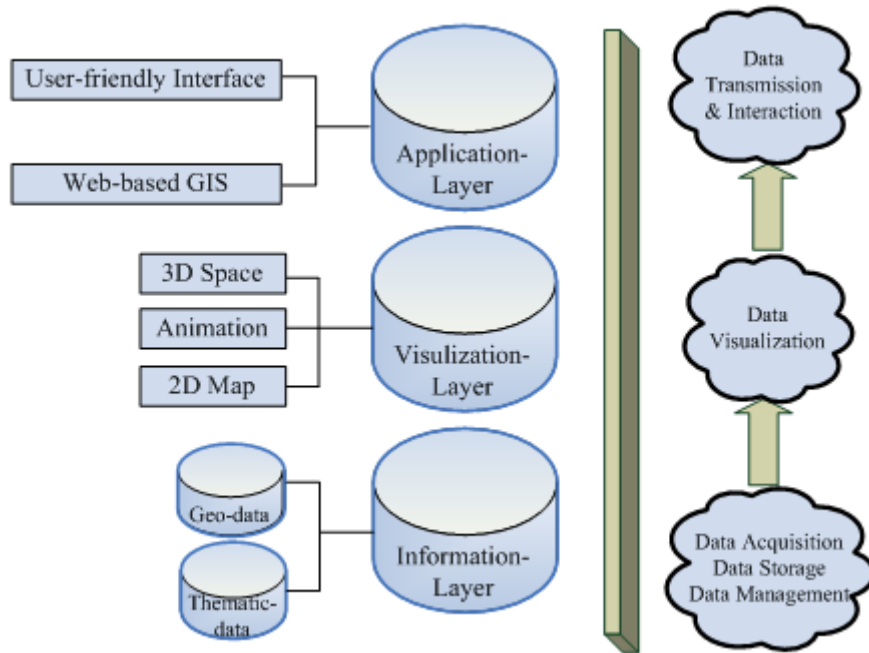


Figure 1. The Technical Framework of Digital Tang Chang'an City

2.1 Three-Layer System Architecture

As figure 1 shows, the architecture of this digitized model can be mainly divided into three layers. The first layer, named Information-Layer, is composed of geo-referenced data which describe the multi-dimensional spatial information and thematic data which depict the historical and cultural events from the archives or the Internet and the attributes of the geographical entities. These different types of data should be integrated and managed in a geographic database to make sure they can be regularly organized.

The second layer called Visualization-Layer visualizes the data in 2D or 3D environment by using the relevant visualization methods and software to give the user an intuitive view. 2D maps can show the overall layout of Tang Chang'an City, 3D space can give the user directly reception of the temples, palaces and dwellings in the Tang Dynasty. These visualizations dynamically represent the former static elements involved in the database from geographical as well as the thematic perspectives. The third layer, called Application-Layer, tries to offer user a user-friendly interface by surfing on the explorer to effectively implement data transmission and exploratory analysis from the visualizations contained in the second layer. In other words, it can be considered as a web-based platform for users to interact with the Digital Tang Chang'an Dynasty thereby finding the correlations or inner schemes from the information of spatially integrated humanities.

2.2 Technologies in modeling digital Tang Chang'An City

2.2.1 Spatial Database design

As mentioned before, this digitized model contains not only spatial data (large scale vector map, location data and 3-dimensional model etc) but also thematic data about time, population, statistical sources and natural environment as well. The capability and availability of the database play a key role in the digital ancient city. Therefore, it needs to design a well-structured spatial database to effectively organize these different kinds of datasets. Computer assisted software engineering (CASE) tools can be regarded as a better choice to create the schema and dictionary or generate GIS code to complete the design inner structure of spatial database (by UML and the interfaces provided by GIS software). In addition, to increase the efficiency of data query, it is imperative to create a database for saving metadata which related to the attribute of relevant data.

2.2.2 GPS and Integrated Mapping technology

GPS (Global Position System) is able to provide extremely accurate worldwide, 24-hour, 3-dimensional (latitude, longitude, elevation) location data. Integrated mapping technology is the science and art of acquiring and processing mapping data from one source, the integrated mapping system. Mapping data, in general, comprises location-based information which comes mainly from geo-referencing, scanning and imaging sensors. Based on the archaeological studies of the layout of Tang Chang'an City (left in figure 2) by Northwestern University (China), the coordinates of the each old building in the study area can be identified by using GPS (right in figure 2). Considering that 2D digital map is fundamental for the digitized model, the first aim is to finish the work of 2D large scale topographic map of those elements by the integrated mapping technology after the geo-referenced data is collected.

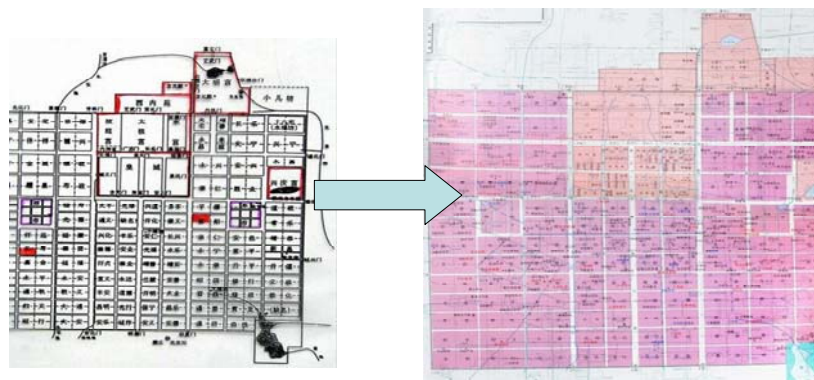


Figure 2. Using GPS to get the geo-referenced data of the old building

2.2.3 3D GIS

3D GIS come with capabilities to build, visualize, and analyze geographic data in three dimensions. The building can be extruded to the required height and width and added onto the landscape to project a more realistic look based on the 2D GIS data. Undoubtedly, the immersive 3D environment can greatly enhance the interactivity of the Digitized model. User can get direct visual information of the settings of the ancient buildings which followed Tang Chang'an palace style. There are too many ways to carried out 3D GIS but most of them are time-consuming job especially when conduct 3D modeling. The study introduces a relatively fast way that mainly uses AutoCAD, ArcGIS and Sketch up software (see figure 3 below).

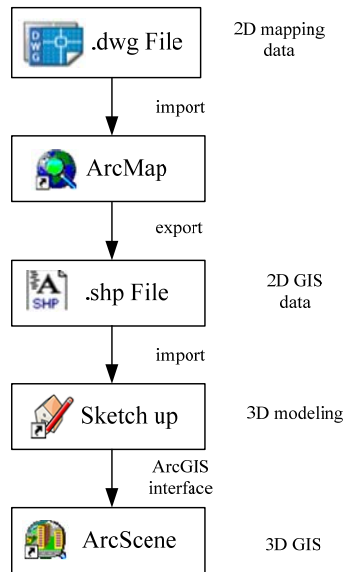


Figure 3. 3D GIS process flow in this research

From figure 3, it can be seen that the first stage is dealing with 2D mapping data in AutoCAD, then adding the attributes by ArcMap according to the type of geo-referenced data (point, line and plane). The 3D modeling software Sketchup can process the GIS data from ArcMap and it also provides an interface to ArcScene for importing the 3D spatial data. Finally, we can use ArcScene implement data visualization and analysis. Based on this process flow, the research finished some work of modeling Tang Dynasty towers and city gates of the palace. As figure 4 shows, the 3D Tang Dynasty models cannot only be navigated by the user, but also provide the query tools to get the basic information such as building name, construction style and building time etc. Furthermore, this 3D model should be combined with other methodologies to help user get more detailed information (history and culture). Those methodologies will be discussed in the next chapter.

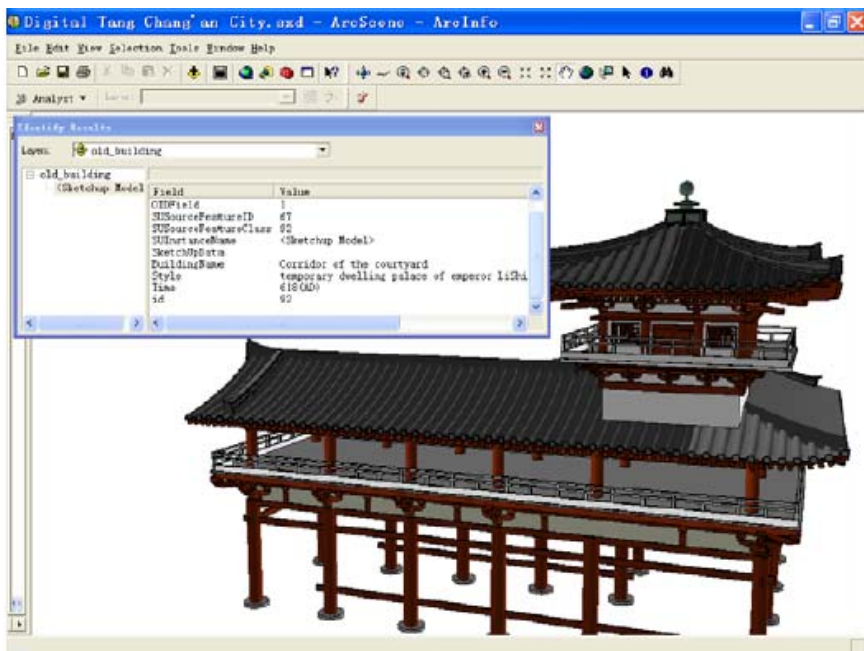


Figure 4. The 3D GIS model in Digital Tang Chang'an City

2.2.4 Web Technology

With the rapid global expansion of broadband communications, the potential for web-based Digital Tang Chang'an City has been greatly increased. The operations on current Web sites mainly involve text: users search information by keywords and software robots retrieve information. This search-and-retrieve metaphor works well, especially if the needed information is distributed worldwide. If the Internet is to be used for geo-referencing, however, the geographic interface will become more important. Furthermore, the geographic database of this digitized model contains 3D information so that this kind of material needs to be displayed by using 3D web-based GIS technology.

To develop web-based 3D-GIS, UrbanViewer for Web™ from CAD Center Corporation which is specifically designed to distribute a 3D model on the web can allow user of DSL-level broadband to view the digitized model and to interact actively using widely available browsers like Microsoft Internet Explorer. In addition, GeoLink is also a web-GIS software which can connect geo-data to web-based information. It uses a new data model called augmented WEB space which is composed of conventional hyper links and geographical links.

3. Methodologies for the historical and cultural information

By the domination in Tang Dynasty during the period from AD 618 to 907, both Chinese society and culture reached to a new high level. Especially Chang'an City, once was the capital whether in political or cultural, was the biggest cosmopolitan city in the world and its population approximately reached 2 million. The folkways cultural resources were exceedingly rich. In the meantime, the national administrative and religious agencies and imperial examination system had been rebuilt. It thus directly led the academics and arts move towards the booming era. It is still generally acknowledged that Tang Dynasty is the greatest period of Chinese poetical work.

Section 2 mainly illustrated the technical framework on how to represent the material form of Digital Tang Chang'an City, however, judging a digital ancient city system whether is complete depends on the existence in immaterial pattern (folk customs, culture and religions etc) should also be considered (discussed in the first chapter). Present-day GIS researches about humanities can be regarded as the references to deal with the relations among geo-information and history (NHGIS by University of Minnesota), literature & arts (ECAI, Electronic Cultural Atlas Initiative by University of Berkeley), religion (Diamond et al) and philosophy (Holenstein, Elmar). The literature below will discuss how to bridge the gap among space, history and culture involved in the Tang Chang'an City.

3.1 For historical information

Specifically, the historical information for common users should be categorized to when (time period), location (where), what (king, the name of an event and its description). Thus, the historical information database can be seemed as the spatial-temporal frame of the Digital Tang Chang'an City which clarifies the relations between time and historical events and still can be in the use of the geo-referenced data. Figure 5 shows the view of the database design by Microsoft SQL server 2005.

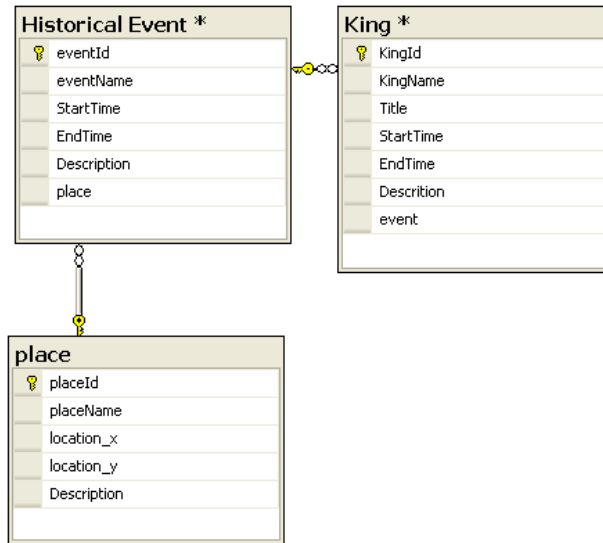


Figure 5. Historical information database design

As mentioned before, the historical information in the digitized model not only describes the historical event but is a spatial-temporal frame of the digitized model. It is very imperative for Geo-data modeling researchers to deal with the spatial-temporal data effectively and efficiently so that can present an intuitional and easy-understanding perception to the user. In this study, historical information can be displayed in a 3-dimensional cube which can greatly meet this demand in interpreting spatial patterns and relationships in complex data in the geographical context. Figure 6 shows that this model combines space and history in a natural way: the geographical data is displayed in the X-Y plane at the bottom of the cube; time is shown on the Z axis; the Y axis of the top rectangle can help the user to clear the background of each historical event and get more detailed temporal concept related to the history; the small-sized cube located in different 3D position of cube represents the historical event. From this 3D cube model, the axes and rectangles can form a plane to describe different things based on the same condition. For instance, the X-Y plane at the bottom of the cube and time axes can form a “time plane” or “geographic plane” to illustrate the events happened in same time or location. Therefore, the historical information can be comprehensively visualized and can be precisely located by time, location and king axes in this 3D cube model.

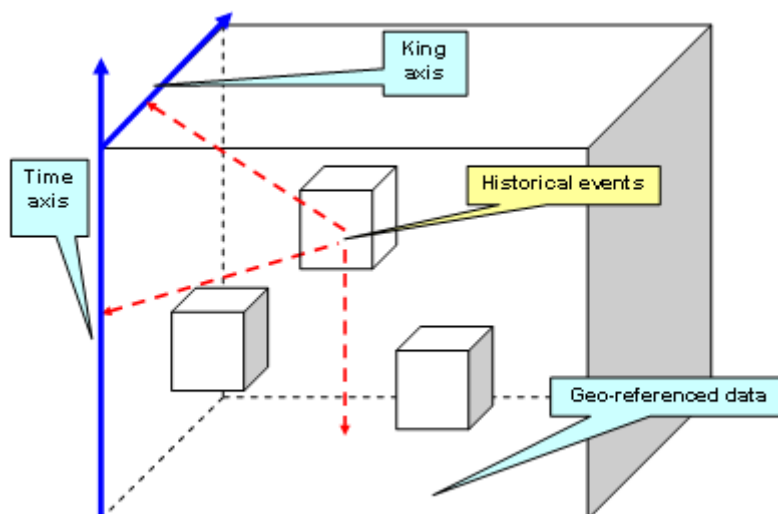


Figure 6. 3D cube for historical information representation

3.2 For cultural information

Tang Dynasty was a time when culture flourished, and many paintings, drawings and documents from that era survived. But there are no photographs or diagrams at that time providing us with objective measures. Nowadays, the effective manifestations of the combination between geographic information and cultural information mostly are the applications of cultural maps. The relevant research in Chinese Taiwan can be considered as a representative sample. Figure 7 illustrates the system structure of the spatial-temporal framework of Chinese Civilization by Academia Sinica, Chinese Taiwan. Based on this framework, it is fundamentally to collect and integrate the relevant academic resources mainly involve cultural relics, documentations, statistical data and image data. Afterwards, the work is constructing the geographic frame. The paper-based static historical maps should be as historical geographic coordinate information for the basic geo-referencing accordance, meanwhile, the topographic map, remote sensing image and DOM of present-day City are also needed as the subsidiary geo-reference. The final step is to handle the attribute data and geo-data and integrate them organically by analyzing and distributing the dataset to the Internet by the web server to interact with web users. Figure 8 shows the cultural map (Taiwan History and Culture in Time and Space) based on the framework, this cultural map system collected all kinds of electronic documents and related the object of the digital map to the image or literature sources.

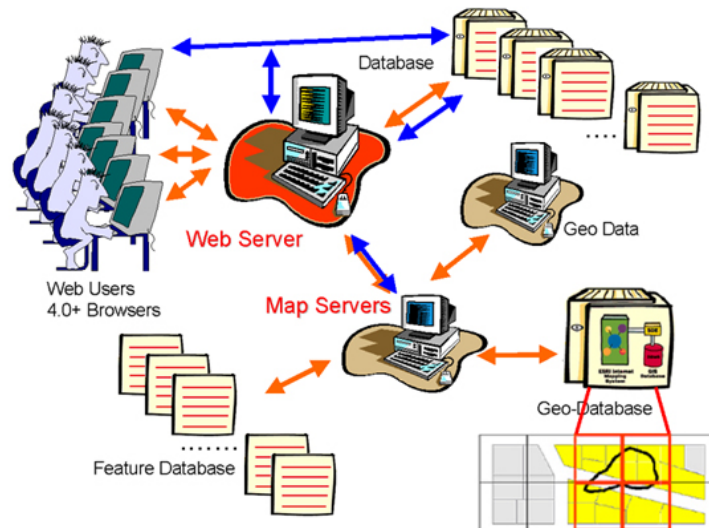


Figure 7. The system structure of the spatial-temporal framework of Chinese Civilization

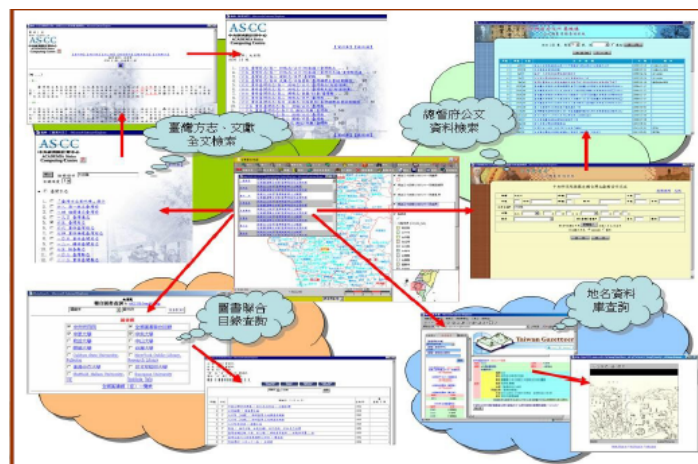


Figure 8. Taiwan History and Culture in Time and Space

Besides the literature documentations and images which describe the cultural information, multimedia video and audio content is also an effective way to give the user an intuitional view of the culture, especially when reflecting the folk customs. For example, cockfighting is prevailing in Tang Dynasty and it definitely cannot be completely understood by literature. The video from the TV plays associated with the digitized model could be a great help. In addition, the multimedia accompanied with narration can introduce many historical or cultural figures in an easy-understanding way.

4. Conclusions

Digital city is the digitized model which can collect and organize the digital information from the corresponding city and provide a public information space for people to interact with. Based on this notion, the study provided a technical framework of Digital Tang Chang'An City by discussing the technologies for data modeling based on three-layer system architecture and the methodologies for representing humanities such as history and culture. From the framework, it can be seen that GIS, Visualization and Internet are the core techniques of this digitized model. Of these, the transportation of 2D or 3D geo-visualized data via the web page is mostly important because of its effectiveness and interactivity.

With the support of advanced technologies, the viewpoint "the death of distance" brought the concerns from every academic research to the concept of space, especially the field of humanities. Through this research, it should be aware of that although the object with physical substance like spatial information is fundamentally and absolutely necessary, the importance of humanities which are regarded as the corporal property of each city cannot be ignored. This kind of information with immaterial patterns makes the digital city complete and full of "vigorous". Presently, the researches about the digital humanities are not in a deep-going way, it needs the geo-researchers to do more future work in this area.

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