Research on Key Technologies of Digital Cultural Heritage Combining Virtual and Real

Huagang Li and Wei Sun(✉)

Changchun Institute of Technology Art and Design, Changchun, China
664799585@qq.com

Abstract. The combination of virtual and real digital technology is an important way to activate the cultural heritage. In view of the high cost of 3D modeling of large scenes and the difficulty of integrating with the geographical reality model, taking the digitization of historical and cultural blocks as an example, Proposes the construction method and infrastructure of multi-source data model, and studies the key technologies such as data standardization, data superposition, and service-based data fusion. This achievement has been successfully applied in the 3D digital Districts project of Xinmin historical district, providing a reference for the digitization of similar cultural heritage.

Keywords: Cultural Heritage · Historical and Cultural District · Multi-source data integration · Virtual Reality

1 Introduction

There are various ways to activate cultural heritage. In recent years, the digital activation of cultural heritage has made a breakthrough with the help of virtual reality, three-dimensional digitization and other technologies. Digital technology enables cultural heritage to be displayed in a visual and contextualized manner, and can be vividly reproduced in front of the audience and even interact in real time, significantly enhancing the charm and experience of cultural heritage, which has become the mainstream path of cultural heritage activation [1].

In recent years, 3D scanning, virtual reality, human-computer interaction and other technologies have been applied in the field of digital activation of cultural heritage. Stanford University of the United States cooperated with Cyberware to carry out the digital Michelangelo project, the Sulman mummy project of the University of Chicago, the virtual Pompeii ancient city and other projects; The European Union has carried out research on 3D-Murale, ECHO and other projects, covering European historical and cultural heritage. Japan has restored the ancient streets of Kyoto. China has built digital cultural tourism platforms such as "Digital Dunhuang" and "Digital Palace Museum" [2–4] and accumulated experience. However, at present, the proportion of digital activation of cultural heritage in China is not more than 10% [5]. The main problems include: (1) the diversity of digital resources of cultural heritage in large scenes and the difficulty of integration; (2) 3Dmax and Revit vector modeling methods are inefficient and costly;

M. F. b. Sedon et al. (Eds.): SSHA 2023, ASSEHR 752, pp. 1319–1324, 2023.
https://doi.org/10.2991/978-2-38476-062-6_170

(3) The virtual display of large-scale cultural heritage has a high demand for computing resources and network resources.

Historical and cultural blocks are an important part of urban cultural heritage. Based on the digital block project of Xinmin district in Changchun, a digital scheme based on multi-source data fusion and integration is proposed, and key technologies such as data standardization processing, data superposition, and service-based data fusion are studied, providing reference for digital activation of cultural heritage.

2 Overview of Xinmin Historical and Cultural District

Xinmin Street is the main axis of the construction planning of the Changchun Administration of Manchukuo (formerly known as "Shuntian Street"), and is the most concentrated area of the value of the Manchukuo warning cultural heritage in Changchun. In May 2012, Xinmin District was selected as the "famous historical and cultural district in China".

The Historical and Cultural District follows the checkerboard road network of the traditional capital of China, the District pattern of the western radial road plus the round square, and the cultural square and Xinmin square constitute the end view and visual convergence of the District. The official buildings on both sides of Xinmin District have distinctive characteristics and are known as Manchurian architectural style. The architectural colors are mainly brown, brown, and off-white, creating a thick and elegant color environment. The roofs are mostly tower style, and the patterns of dark red or dark green glazed tile roofs are used [6].

3 Multi-source Basic Data Model

The "1 + N" multi-layer design scheme is adopted for the digitization of cultural heritage, which uses geographic information to construct the base map, integrates the building model and narrative data model at the software level, and superimposes the expression as required. The following Table 1 shows the classification of data models (Table 1).

4 Digital Integration Architecture

The basic framework should meet the requirements of multi-source data superposition, fusion expression, virtual and real simulation, and human-computer interaction. As shown in Fig. 1.

The support layer includes the software and hardware environment of the platform, including database system, server, network platform, etc.

The data layer includes building 3D mapping data, scene data, DEM, DOM, vector data, audio and video and other multimedia data.

The integration layer is based on the virtual reality development platform and integrates GIS, sensor, body and sensory interaction modules to achieve data integration and business interoperability.

Table 1. Multi-source basic data model

Model Type	Model Construction Method	Data Sources
Geographic base map	The geographical base map is constructed by DEM elevation data and DOM image data.	Google Earth
Building modeling	Use 3DMax and other tools to build the building vector model. Use Revit to build building BIM model.	1. Field mapping. 2. Historical documents. 3. Color collection.
Scene model	1. Sketchup is used for rapid modeling of District and water systems. 2. Vegetation is modeled with tools such as SpeedTree.	1.Make reference to satellite image data 2.Import the material library.
Cultural tourism service data model	1. Structured data can be modeled by PowerDesigner. 2.Collect unstructured data such as text, audio and video.	Designed according to the application requirements of cultural tourism integration.

The business layer is the operation core module supporting the upper application, including the service engine for virtual display and interaction, data processing tools, modeling tools, development engines, control terminals, etc.

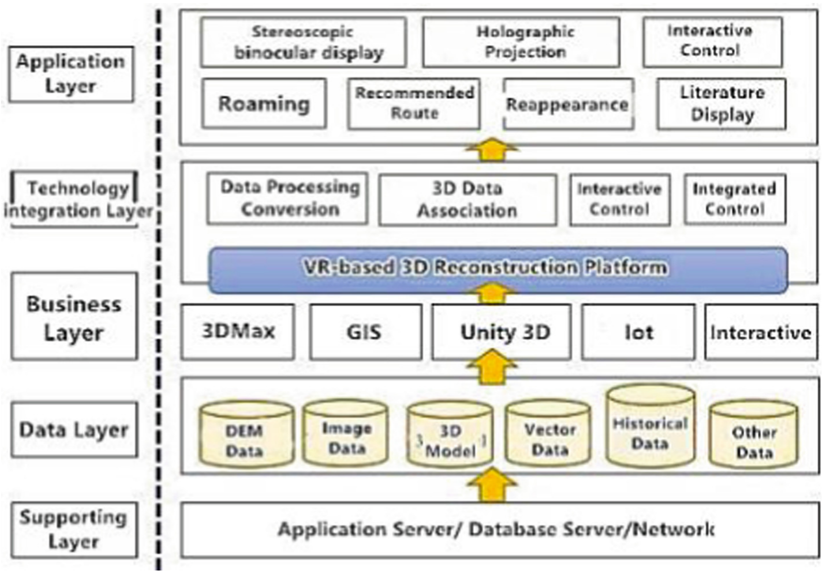

Fig. 1. Basic Framework

The application layer includes application software modules such as cultural heritage roaming display, tour guidance, situational narration, intelligent interaction, tourism management, etc.

5 Key Technologies

5.1 Basic Data Encoding

Design 11-digit digital encoding system. The first representative model is classified into three types: geographic model, vector model and text travel model. The 2nd and 3rd digits represent data classifications, including landmarks, buildings, plants, streets, and landscapes. Bits 4, 5 and 6 represent model codes; The 7th and 8th digits represent the classification of travel data, including text data, picture data and image data. The 9th, 10th and 11th bits of data are sequential codes, from 001 to 999. The principle of coding is to maintain the uniqueness and consistency of each data.

5.2 Multi-source Data Superposition

Multi-source data superposition needs to unify all data coordinate systems and scales. Google Earth uses WGS84 coordinate system, and China has enabled CGCS2000. Geographic data can be converted from WGS84 to CGCS2000 using the coordinate conversion function provided by ArcGIS. Vector models such as buildings are generally built based on the View Space view coordinate system. ArcGIS can be used to obtain the coordinate values of the location feature points of buildings, define the location data table (id, a.b.c, x.y.z, h), develop a coordinate conversion program, and convert the View Space coordinates into CGCS2000 coordinates.

5.3 Service-Based Data Fusion Components

In order to reduce the computation and network resources required for roaming and browsing, the corresponding model can be called to render the representation according to the functional requirements in the application. A service-based data fusion component has been developed, including application service (AS) and control service (CS). AS meets the digital display of cultural heritage. CS controls the work of multiple services through business rules, and the rule information of specific businesses will be saved in XML documents. When executing services, the data fusion engine calls CS, and CS calls AS to complete scenario simulation and interactive experience as required.

6 Application Cases

The development process of the digital project of Xinmin District is as follows:

(1) Establish important objects of the block through surveying and mapping, and use DJ6 optical theodolite to measure the size of the building. Digital camera is used for digital photo shooting in building appearance application. Use TOPCON BM-7 color brightness meter and China Standard Color Card (GB/T18922–2008) to collect building colors. To meet the requirements of "C" light source (color temperature is 6774k).

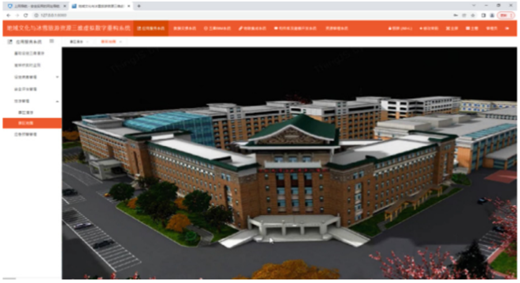

Fig. 2. Three-dimensional roaming system of Xinmin historical District

(2) The real geographical base map of the block uses Google Earth satellite map to collect and process information, and draws two-dimensional vector base map according to the standard data structure and unified coordinate system.
(3) Use 3DMAX to complete the building 3D model of the block. It is necessary to accurately express the roof, wall structure, supporting column components, windows, etc. Apply texture mapping technology to enrich the visual effect of architectural details.
(4) Based on the base map and digital model, develop service-based application modules for historical blocks in roaming display, scene restoration, historical narration, tourism experience, cultural communication, etc., and build digital blocks through data fusion components. As shown in Fig. 2.

7 Conclusion

The digital reconstruction of cultural heritage is an innovation in the protection and inheritance of cultural heritage. This paper uses digital media technology to create a virtual situation of historical and cultural blocks, so that tourists can feel the charm of cultural heritage. The next step will also be to carry out interactive design research, so that visitors can interact with cultural heritage in the virtual space, and better realize the value inheritance of cultural heritage.

Acknowledgement. This research was financially supported by "The Jilin Science and Technology research Plan (No. 20200403183SF、20220203062SF)" and "Project of Jilin Provincial Department of Education (No.JJKH20191273SK)".

References

1. Lin Song. Implantation, integration and unification: value selection in the activation of cul-tural heritage [J]. Journal of HUST (Social Science Edition) ,2017,31(02):135-140.
2. Geng G H, etc. 2022. Research progress on key technologies of cultural heritage activation. Journal of Image and Graphics, 27(06): 1988-2007 [DOI:10. 11834 / jig. 220198]

3. Arpa S, Süsstrunk S and Hersch R D. 2015. High reliefs from 3D scenes. Computer Graphics Forum, 34 (2): 253-263 [DOI: 10.1111/ cgf. 12557]
4. Hua Z,etc. 2002. Research on virtual color restoration and gradual changing simulation of dunhuang frasco. Journal ofImage and Graphics, 7 (2): 181-186
5. SUN Wei,Research on Key Technologies of Three-dimensional Digital Reconstruction of Cultural Heritage in Historical and Cultural Block.CTMCD 2021,2021.7
6. Changchun Xinmin Historical and Cultural District Protection Planning Text and Map (2013–2020) [z]. Changchun Urban and Rural Planning and Design Institute,2014.5. 1–4