Application progress of digital technology in the protection of Chinese traditional villages

Yajie Wu¹, Chunhua Huang¹,²*

¹ School of Architecture, University of South China, Hengyang, Hunan, 421001, China. ²Hunan Healthy City Construction Engineering Technology Research Center
*Corresponding author’s e-mail: 1977691619@qq.com

Abstract. As a new trend of cultural heritage protection, digital technology has brought opportunities and challenges to the detection, protection and development of traditional villages. First, this article introduces the specific application of digital technology in the three stages of data collection, information processing and display and dissemination, and constructs the corresponding integrated application diagram, then summarizes the implementation obstacles in the protection process. Finally, a prospect is made for the development of digital protection of traditional villages. The results show that digital technology can provide a strong data foundation and flexible processing methods for the storage, restoration, display and dissemination of traditional village protection, and promote the transformation of single technology to multiple integrated applications.

1. Introduction

Facing the rapidly dying village cultural heritage, the use of digital technology to achieve preservation and protection has gradually become an international consensus. Various fields have explored and tried the digitalization of cultural heritage, including digital modeling, virtual restoration, digital management, digital display, virtual reality, digital animation and digital composite imaging and other technical frameworks, key technologies and typical system applications. However, it is difficult to achieve the unity of data content and technical standards, effective natural heritage protection and intangible cultural heritage inheritance, and a lack of reasonable display and dissemination to the public after planning, there is no complete digital planning system and process for traditional villages.

Based on the existing digital protection technology of cultural heritage, this article reconstructs the digital integrated application system, and summarizes the implementation obstacles in the protection process of digital popularization, the establishment of regulations and standards, database integration and compatibility, and multiple display and communication. Finally, the development of digital protection of traditional villages in each stage is summarized and prospected.

2. Application of digital technology in the protection of traditional villages

Digital cultural heritage refers to the comprehensive use of remote sensing mapping and computer virtual reality technology to digitally store all movable and immovable properties of cultural heritage on a computer network to achieve true three-dimensional digital archives for protection, restoration, archaeological research and cultural exchange. The following summarizes the practice and exploration of predecessors on digital cultural heritage, applies the functions of digital technology such
as data storage, information processing, and display and dissemination to traditional villages, and tries to build a set of digital integrated application system.

2.1. Data collection technology
In the investigation of the protection of traditional villages, China has clearly required that “photographs of the overall view of the village, main streets and important traditional buildings be supplemented and improved”. Image acquisition has also become a more conventional and mature technical means in the long-term planning process\(^4\). In the process of village protection, the planning results are transformed into digital resources in a targeted manner, which helps to understand the village culture and show the characteristics of the village.

The acquisition of remote sensing images of the village can realize the collection of large-scale basic geographic information data of the village, the interpretation of the elements in the village landscape, and the acquisition of the dynamic change data of the village environment\(^4\). Oblique photography based on drone technology and digital camera modeling, mobile 3D laser mapping, point cloud vectorization assisted by lidar are highly efficient technologies that help restore the three-dimensional reality of the village\(^5\). F. Chiabrando et al. use airborne lidar to record high-resolution three-dimensional archaeological sites and landscapes, which can realize the segmentation, recognition and semi-automatic modeling of historical construction\(^6\), which helps to obtain traditional Related spatial information data such as the regional characteristics, spatial shape and key nodes of the village.

2.2. Information Processing Technology

2.2.1. Multi-party collaborative data platform construction
After completing the effective collection of village data, first carry out information extraction and integrated management of the data. Based on the management and classification of the village data type structure, the element database and the spatial database are combined to store and record the heritage building protection data. Then build a GIS analysis center that integrates real-time data access, dynamic process simulation, multi-dimensional space-time visualization and other functions to achieve resource sharing and collaborative analysis of the data platform\(^7\).

2.2.2. Construction of virtual reality scenes
Virtual reality technology is a comprehensive application of computer graphics technology, multimedia technology, sensor technology, human-computer interaction technology, network technology, stereo display technology and simulation technology\(^3\). After realizing the collaborative construction of database information, spatial information, and engineering information, multiple data can be visualized in a virtual model. Using virtual reality technology, it is possible to restore the complete village scene, allowing designers to control the panoramic pattern of the village environment at a macro level. Duan Linfeng uses virtual reality as a platform to reshape the historical building entity, surrounding environment and space details, which brings about a major change in the perception of historical building space and the experience of cultural connotation\(^8\).

2.2.3. Restoration and practice of cultural heritage
The virtual restoration and process simulation of cultural heritage is aimed at certain high-value, high-endangered cultural heritage. Integrated technologies such as three-dimensional modeling, graphics processing, and artificial intelligence can be used to realize heritage information collection, protection and restoration, and process simulation. The damaged buildings and structures of the village are scanned by three-dimensional laser to obtain point cloud data, and all element information is retained to realize the storage and transmission of digital repair data, and then carry out targeted scientific repair and utilization. A. Del Mastio et al. have established an integrated software for image processing of cultural heritage, which can simulate actual restoration through virtual restoration tools, and can also process real works of art through digital image processing\(^9\).
2.3. Demonstrate communication technology

2.3.1. Research on Convergent Narrative of Digital Media
With the rise of digital media technology and interactive design theory, new narrative and communication methods using digital information technologies such as the Internet, cloud computing, and virtual reality have been incorporated into today’s museum system[10], making the dissemination of cultural heritage more easily accepted by the public. In order to show the regional and vernacular characteristics of traditional villages, the village scene environment and residential buildings can be displayed and spread through three-dimensional virtual technology. And the folk customs and other intangible cultures are presented using the fusion narrative method of digital media, so that the public has an immersive, interactive, and imaginative[8], and realizes the diversification of the cultural heritage protection and communication methods of the village. Jiang Shen et al.’s visual narrative of the digital reproduction of Dunhuang culture explored the development potential and application trends of interactivity in the display and dissemination of cultural heritage, and realized the deep integration of Dunhuang culture and digital technology[11].

2.3.2. Activated protection and communication with public participation
Through the establishment of a digital virtual reality model, injecting humanistic feelings and folk customs, it is helpful to conduct contextual analysis of the village and show the historical evolution trend of the development of the village. This high-experience digital media presents the cultural context, traditional skills and folk customs of the village, and at the same time changes the past situation of “emphasizing technology and neglecting culture”, and helps to realize the living inheritance of the intangible cultural heritage in the development of the village. Saptarshi et al. proposed to explore new media such as game design and animation as a contemporary art paradigm, and explore the method of user-driven design exploration to protect and spread the cultural heritage value of Indian traditional art forms in the new generation[12].

2.4. Technology integration and comprehensive application
Digital technology has been studied in depth in all aspects of cultural heritage protection, but the development of a single technology is prone to resource fragmentation and information islands, and it is difficult to realize the integration and sharing of multiple heritage resources. Therefore, traditional villages need to establish a comprehensive management platform under a unified standard to link the three major parts of data collection, information processing, and display and dissemination to ensure multidisciplinary collaboration and information resource sharing. The working principle is shown in the figure (see Figure 1). First collect the basic survey data of the village’s photos and videos, historical humanities, and public opinion questionnaires. At the same time, integrate the overall and local spatial element data of the village. Then unified input to the database platform for data information processing and visualization model construction, and finally effective display and dissemination of cultural heritage information in multiple ways.
3. Obstacles to the implementation of digital technology in the protection of traditional villages

3.1. Insufficient understanding of digitalization and insufficient technical level
In recent years, although China has made great progress in the digital protection of cultural heritage, its main targets are still large-scale projects such as palaces, temples and urban relics. Compared with the formal structure and clear construction of official buildings, digital technology is often more difficult to apply and practice in traditional villages because of its wide distribution, large number and complex types. As a result, people's understanding of digitalization of traditional villages is still insufficient, and there is a lack of experience in actual protection and development.

In addition, due to the numerous disciplines involved in the protection of traditional villages, and the difficulty of unifying data collection and processing, technical personnel are often required to have high digital literacy. It is also required that they can comprehensively master a variety of traditional village digital technology methods and complete high-tech information processing tasks.

3.2. Lagging of Regulatory standards and lack of top-level design
At present, China has not issued a special legal document regulating the protection and development of traditional villages, and the legal system for the protection of traditional villages is not yet complete[13]. In addition, there are also no detailed specifications and regulations for the digital protection of traditional villages in terms of technical regulations, digital quality, and digital accuracy. Therefore, the standards and procedures for the construction of digital information databases need to be gradually established and improved during the protection process[14]. Besides, due to the unclear responsibilities and powers of various functional departments and the lack of necessary division of work and cooperation
in actual implementation, the traditional village database construction standards, data quality, and data accuracy cannot be unified, which affects the depth and convenience of digital resource sharing.

3.3. Lack of compatibility and integration of database resources

At present, computer information technology, geographic information science technology and network communication technology for the protection of cultural heritage are rarely used in village protection and development research. Although some research institutions and university teams have made some attempts on the digital technology of traditional villages, the construction of traditional village databases is still in the exploratory stage, and most of the content of the construction is limited to simple data collection. Therefore, how to efficiently obtain the digital information of the village, integrate the existing digital technology, and realize the compatibility of multiple data is very important.

In addition, due to the unclear division of powers and responsibilities of various departments in the traditional village protection process, various data standards are not unified, and the effective sharing of resources cannot be realized. How to effectively apply data collection, information processing, and display and dissemination technologies to a unified platform to achieve a comprehensive application of multi-technology integration is a problem that needs to be solved urgently.

3.4. Digital resources value preservation rather than dissemination

Existing researches mostly focus on the digital construction and preservation of traditional villages, and there is less research on the dissemination, utilization and sharing of traditional village resources. Although a large amount of village protection data has been obtained and saved, these data are difficult to apply to the maintenance, restoration and dynamic monitoring of traditional villages, and they have not played a role in cultural communication, cultural creativity and virtual tourism, which affected the sustainability of the digital protection of traditional villages[14].

The protection of traditional villages focuses on the technical realization of integrated services of digital resources, but there is no in-depth study on how to develop integrated services for the public in cultural heritage resources under the network environment[15]. Moreover, due to the diversity and complexity of the village types, it is still very difficult to use the intangible cultural elements of the village, and to build a standard digital display and dissemination system.

4. Conclusion and future work

The digital protection of traditional villages is not only an effective practice of cultural heritage protection, but also a response to the current trend of big data and intelligent development. Based on the specific application of digital technology in the protection of cultural heritage, this article proposes to build an integrated application system for the digital protection of traditional villages on the basis of predecessors, and puts forward the prospect of digital technology in the protection of traditional villages from three aspects:

- In terms of data collection, the data is required to be true and complete, and a unified collection standard is established. Due to the wide variety of traditional villages, various types of data and information are prone to differences in the preservation process, relevant laws and regulations should be improved, and data protection and development should be realized under a unified framework.
- In terms of information processing, it is necessary to cultivate compound research talents with strong professional skills, but also to focus on interdisciplinary and data integration, and build a digital integrated application platform under a unified standard.
- In terms of display and dissemination, the situation of "emphasizing technology and neglecting culture" should be changed, paying attention to the inheritance of the village's intangible cultural heritage and strengthen the protection of the regionality.

Acknowledgments

This article was supported by Study on the Weakening of Spatial Structure of Traditional Villages in Hot Summer and Cold Winter Areas (190XQD047), Study on the Problems and Countermeasures of
Hunan's Aging Society—Demonstration of Ageing Building Design Based on Action-oriented Concepts (XSP19ZDI003), Eco-type region-Urban Planning and Management Hengyang Key Laboratory (2018KJ1J13), Study on the mechanism of two-way four-dimensional full-period coupled heat and moisture transfer in the wall of the phase-change energy storage multi-layer multi-heat bridge (51876087), Migration and diffusion of airborne pollutants under temperature stratification conditions (U1867221), and Hunan Healthy City Construction Engineering Technology Research Center (2019TP2072).

References
[1] Jia Xiuqing, Wang Jue. (2012) The application of digital methods in the field of inheritance and innovation of my country’s cultural heritage [J]. Modern Communication (Journal of Communication University of China), 34(02): 112-115.
[2] Li Deren. (2008) The application of virtual reality technology in the protection of cultural heritage[J]. Journal of Yunnan Normal University (Philosophy and Social Sciences Edition), (04):1-7.
[3] Li, Deren, Zhu, Yixuan, Du, Zhiqiang. (2006) Virtual Tang-Style Timber-Frame Building Complex[J].
[4] Zhang Hongji, Luo Yong, Liu Hui, Wang Yonghua, Chen Qingsong, Tan Xiaoqin. (2017) Research status and prospects of digital protection technology for traditional villages in my country [J]. Resource Development and Market, 33(08): 912-915.
[5] Yang Ting, Zou Shan. (2016) Research on the application of digital survey technology in the protection and reconstruction of historical locations—Based on the practice in the Pearl River Delta [J]. Architecture Journal, (12): 22-27.
[6] F. Chiabrando, G. Sammartano, A. Spanò. (2016) Historical buildings models and their handling via 3d survey: from points clouds to user-oriented hbim [J]. ISPRS - International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, XLI-B5.
[7] Niu Haifeng, He Yi. (2015) The construction and planning application of the ancient village geographic information system-Taking Ningbo Hanling historical and cultural village as an example [C]. China Urban Planning Society, Guiyang Municipal People's Government. New Normal: Inheritance and Reform—2015 China Urban Planning Annual Conference Proceedings (04 New Urban Planning Technology Application). China Urban Planning Society, Guiyang Municipal People's Government: China Urban Planning Society, 579-591.
[8] Duan Linfeng. (2016) Application of virtual reality technology in the protection of ancient villages [D]. Jiangxi Normal University.
[9] Mastio A D, Cappellini V, Caldelli R, et al. (2007) Virtual Restoration and Protection of Cultural Heritage Images[C]// Digital Signal Processing, 2007 15th International Conference on. IEEE.
[10] Yan Feng. (2018) Digital application of cultural heritage [J]. Art Observation, (07): 19-22.
[11] Jiang Shen, Lu Xiaobo. (2013) Interactivity and Application of Display Communication in the Digitization of Cultural Heritage——Taking the Contemporary Communication of Dunhuang Culture as an Example [J]. Modern Communication (Journal of Communication University of China), 35(08):19-23.
[12] Kolay, Saptarshi. (2016) Cultural Heritage Preservation of Traditional Indian Art through Virtual New-media[J]. Procedia - Social and Behavioral Sciences, 225:309-320.
[13] Liu Zhizhi, Yang Yun, Sheng Yong. (2019) Legal protection of traditional villages: status quo, problems and countermeasures [J]. Legal System and Society, (19): 164-166.
[14] Liu Peilin, Li Bohua. (2018) The origins, misunderstandings and countermeasures of digital protection of traditional villages[J]. Journal of Capital Normal University (Social Science Edition), (05): 140-146.
[15] Tan Biyong, Xu Yongjun, Zhang Ying. (2011) Technology:Culture:System: A Review of Intangible Cultural Heritage Digitization Research[J]. Zhejiang Archives, (06): 30-33.