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Literature Review of Digital Protection of Material Cultural Heritage

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Abstract

From the perspective of the protection and inheritance of digital technology in material cultural heritage, this paper analyses the distribution characteristics of the application of digital technology in material cultural heritage in China, combines the protection results of digital material cultural heritage in different stages with the innovation of digital technology, and then integrates it with the inheritance of digital technology in material cultural heritage. However, at present, the digital inheritance of cultural heritage in many places has not reached reasonable technical expectations. Moreover, its cultural sites also face the dilemma of damage caused by various factors and not being repaired in time, as well as a lack of protection consciousness. On this basis, this paper aims to systematically grasp the application status of digitization in the protection of cultural heritage in China, study the shortcomings in the process of digital promotion in China, and propose corresponding improvement measures.

Keywords

material cultural heritage, digital technology, cultural heritage protection, cultural heritage inheritance

1. Introduction

1.1 Background on the Study

Since the sampling theorem was proposed by Shannon in the 1940s, which laid the foundation for digital technology, digitization has been applied in different fields at different stages of development. During the period of reform and opening up in the 1970s, the creation of the Worldwide Web opened the prelude to China's digital revolution. Digitization has gradually advanced, from the early application of traditional film recording to the application of map scanning, the printing and dyeing industry, the architectural design industry and so on. Later, three-dimensional laser scanning technology and CCD imaging technology gradually matured. Because they can truly record the original three-dimensional information and texture information of archaeological excavation sites, they have been applied in site archaeology and have emerged in the protection of China's material and cultural heritage.

With many major revolutions in digitization over the millennium, new information science techniques have been used in the digitization of cultural relics, the restoration and restoration of cultural relics, digital archaeology and other aspects, and a number of scientific research projects have been completed, such as the collection of three-dimensional digital true color information of cultural relics, the information protection of

digital cultural relics, the virtual restoration of digital cultural relics, the restoration of skull-based features and identity authentication, etc. This work has made a significant contribution to the long-term preservation of the original state and historical value of cultural heritage and has become a part of the cultural heritage protection strategy that cannot be ignored, providing future generations with opportunities to learn and understand historical culture and inherit cultural heritage.

In the inheritance of cultural heritage, digitization also plays a role as a medium. In addition to the knowledge media of traditional books, cultural heritage resources can be stored and displayed through digital technology, overcoming the limitations of time and space, using the internet for global communication, and presenting them to the public in a more vivid and intuitive form. Moreover, digital technology also provides new opportunities for the innovative development of cultural heritage, integrates with the cultural and creative industries, enters the public's life in a more humorous way, and diversifies the inheritance of cultural heritage.

However, in recent years, owing to economic factors, human factors and time factors, the digital inheritance of cultural heritage in many places has not reached reasonable technical expectations. Moreover, its cultural sites also experience damage caused by various factors and have not been repaired in time, as does the dilemma of weak protection awareness. On this basis, this paper aims to systematically grasp the application status of digitization in the protection and inheritance of cultural heritage in China, study the shortcomings in the process of digital promotion in China, and propose corresponding improvement measures.

1.2 The Significance of the Study

On the basis of the protection and inheritance of cultural heritage, this paper explores the application of digital technology to cultural heritage. The use of digital technology can not only maintain, repair and protect cultural heritage to ensure its uniqueness and integrity and prevent it from being damaged, stolen, stolen and other illegal acts, as well as the demise or loss caused by overexploitation or unreasonable use but also pass the knowledge, skills and values of cultural heritage to a new generation, cultivate a new generation of cultural pride and national identity awareness, and achieve the fundamental purpose of promoting traditional culture.

The significance of this topic can be divided into academic significance and practical significance:

Academic significance: This paper uses an interdisciplinary and innovative way to protect and promote material cultural heritage. Unlike traditional research and display methods, it provides a new research method for the application of digital technology in the protection and inheritance of material cultural heritage. At present, research on digitalization in cultural heritage is focused mostly on the influence of digital technology on the spread of intangible cultural heritage and the wide application of digital technology at archaeological sites. From the perspective of the protection and inheritance of digital technology in material cultural heritage, this paper analyses the distribution characteristics of the application of digital technology in material cultural heritage in China, which can enrich the research on the protection of material cultural heritage in China and then integrate it with the inheritance of digital technology in material cultural heritage.

Practical significance: This paper first analyses the application of digitization in the protection of cultural heritage, analyses the application of digital technology in the protection of material cultural heritage at different ages, and compares the protection of cultural heritage before and after the important node period of digital technology reform. Furthermore, under the condition of good protection of material cultural heritage, this paper analyses the dissemination of Chinese culture rich in material cultural heritage by digital technology, compares the inheritance of the same type of material culture in the same period and analyses the reasons for the differences. Digital technology can not only compensate for deficiencies in the investigation of material culture in terms of methods but also help the public inherit material culture more conveniently and enhance people’s awareness of cultural inheritance.

2. Research Review

As an important means of material cultural heritage protection and inheritance, digital technology is widely used in material cultural research activities and cultural propaganda. Digital technology can not only

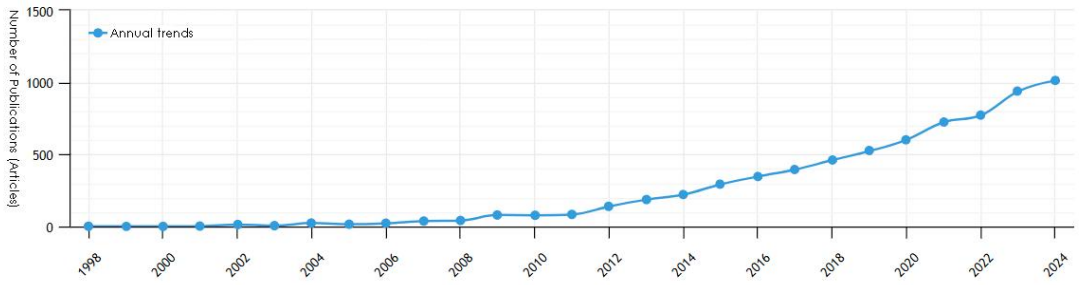
help experts record data on the spot but also help the public understand more vividly the first-hand information in the tangible cultural heritage that is difficult to obtain in daily life. Scholars have achieved fruitful results in the study of material cultural heritage by using digital technology, which provides research data for the study of digitization in the protection and inheritance of material cultural heritage.

2.1 Status quo of Digital Protection of Material Cultural Heritage

2.1.1 Domestic Research Status

Compared with the world, the development of digital protection of cultural heritage in China started late, and the whole can be divided into three time stages. First, in the 1990s, digital technology was gradually used to record and preserve detailed information on cultural heritage, including data on the form, structure, and materials of cultural heritage. These data not only help researchers better understand the history and current status of cultural heritage but also provide a scientific basis for the development of conservation programs. In the early 21st century, in the digital protection of cultural heritage in China, digital technology began to be widely used in archaeology. With the development of various policies and technological innovations, digitization has increasingly occupied an important position in the protection of cultural heritage. After 2010, as shown in Figure1, the literature on the application of digital technology in the protection of cultural heritage began to surge. On this basis, it is inferred that digital technology has matured and been widely used. The detailed classification and statistics of China's material cultural heritage are also clearer throughout the whole process through the formulation and revision of the law on the protection of cultural relics, the census and identification of cultural heritage and long-term academic exploration. According to the classification of the Convention for the Protection of the World Cultural and Natural Heritage, this paper divides the material cultural heritage into three categories, namely, cultural relics, buildings and sites, and sorts them out in order.

Figure 1: Bibliometric visualization analysis



The first stage, from the late 1990s to the early 21st century, represents the practical exploration stage of China's digital technology in the protection of material and cultural heritage. Digital technology is mostly used in the recording and archiving of cultural relics and ancient books in libraries. The National Library of China has explored many new methods for document protection. Using digital technology to preserve cultural heritage, the first is to use digital technology to transform rare literature into hundreds of thousands. The use of digital technology to explore cultural heritage, for the library collection of literature, is essentially based on the texts of some of the literature (Zhang, 2009), most of which are ancient books. Currently, digital technology is less commonly used in the investigation and research of buildings, with a focus on the photogrammetry and digital archiving of ancient buildings. For example, in 1998, the GIS method was combined with modern photogrammetry technology to study the digital archiving management of ancient cultural relics and ancient buildings in the Three Gorges Reservoir area (Zhu et al., 1998). In the field of archeological research of relics, remote sensing image technology was used. In 1996, Qian (1996) published a "'Aerial B-ultrasound' - Remote Sensing Images for Archaeology", which records in detail the discovery of the capital of the Pre-Zhou Dynasty 3000 years ago by using a global satellite positioning system and remote sensing imaging technology in China. This is also the first discovery of cities in the historical period of the Pre-Zhou Dynasty and the Western Zhou Dynasty in China's archaeological history.

In the second stage, from the beginning of the 21st century to 2010, modern technologies such as modern surveying and mapping, remote sensing, geographic information systems, databases and networks began to

be comprehensively applied in the protection and research of cultural heritage at this stage, and the technology entered maturity. Research on the digital protection of cultural relics has focused on the acquisition of three-dimensional mesh models and three-dimensional texture mapping of cultural relics. The 3D laser scanner InSpeck 3D-DF is used to collect the geometric data of the cultural relics, and then the 3D modelling tool is used to process the geometric data of the cultural relics to construct the grid model of the specific cultural relics (Zhang et al., 2007). Luo and Wu (2005) began to study the digital restoration and restoration of ceramic relics and the digital reproduction and development of lost ceramic relics. In 2008, the Educational Information Technology Engineering Research Center of Central China Normal University used multimedia technologies such as three-dimensional modelling, three-dimensional large terrain, and virtual studios to realize the digital display of the Three Gorges cultural relics (Hu et al., 2008). In 2009, the Bavarian Cultural Relics Bureau of Germany cooperated with the Research Office of the Qin Shihuang Terracotta Warriors Museum in China to collect data and process them with digital camera technology and establish three-dimensional scenes. VR platform virtual reality technology can realize the modernization of the display and protection of cultural relics and archaeological sites, which is helpful for the virtual display of the construction of the Qin Shihuang cemetery (Huo et al., 2009).

At this time, to protect ancient buildings, three-dimensional laser image scanning technology is widely used in the mapping and protection of ancient buildings. The Palace Museum took the lead in carrying out the reform of electronic information and comprehensively adopted electronic technology to strengthen the scientific management, protection and utilization of cultural relics and ancient buildings (Tan, 2003). In 2004, the Beijing Palace Museum conducted a study of restoration surveying and mapping. Compared with the previous data, the detailed feature points of the surveying and mapping work are collected by the total station and PC, and the data are displayed and checked on the spot. The detailed collection of components is carried out by a handheld rangefinder and digital CCD camera. Through surveying and mapping data, a complete three-dimensional solid model library of buildings and components was established via CAD (Yu et al., 2004). Following Forbidden City, Shang and Kong (2006) also carried out research activities involving close-range photogrammetry and three-dimensional laser scanning of Sizu Temple and Wuzu Temple in Hubei Province in 2006. Data collection, model establishment, computer display, and proportional restoration through rapid prototyping. In 2006, ground three-dimensional laser scanning technology ushered in technological innovation. Leica developed high-definition survey (HDS) technology. Compared with the past, this technology is more suitable for the measurement of cultural relics and ancient buildings. Until 2007, the digital measurement of the Forbidden City, the formulation of the protection plan of the Foguang Temple, the archaeological site record of the No. 2 pit of the Terracotta Warriors, the investigation of the resources of the Great Wall, the digital archive of the protection of the Leshan Buddha and so on were successful (Li, 2007). In 2010, Tongji University began to build a parametric component library platform for ancient Chinese buildings in cooperation with enterprises. As a carrier tool for the precious data of ancient buildings, this platform began to be widely used in education and other industries to facilitate the subsequent study of ancient architecture (Yuan & Zhao, 2010).

Compared with the protection of ancient buildings, few studies have focused on the protection of sites at this time. Most of them determine the location of sites on the basis of aerial remote sensing technology and then establish a field archaeological survey database. In 2004, China initially built a 'digital archaeology' database framework for the planning and management of cultural heritage protection to establish a professional grid information system (Chen & Huang, 2005). Grid information system technology has been applied to Hongshan cultural sites (Meng, 2004), Helan Mountain Rock Painting (Tang, 2004), and Koguryo King City (Li, 2004). In addition, the application of three-dimensional display technology in this period is more mature. For example, Duan et al. (2005) built a virtual Yinxu museum via the VRML network language. In 2008, with the further innovation of digital technology, the interactive mechanism of virtual reality modelling language combined with the Java language could complete the virtual restoration of interactive three-dimensional scenes (Cao et al., 2008), laying a foundation for the digital protection of material culture in the next stage.

In the third stage, from 2010 to the present, the digital technology of this stage has matured and begun to popularize, with Dunhuang's material and cultural heritage research being the most prominent. In terms of cultural relic protection, the International Dunhuang Project (IDP) has carried out the restoration, cataloging and protection of ancient documents and cultural relics unearthed in Dunhuang and Xinjiang and has used

the internet to recombine these works of art with high-quality digital images so that scholars and the public can obtain increasingly relevant information on the internet (Wei, 2014). In 2015, Wu Jian, director and researcher of the Digital Center of Dunhuang Academy, cooperated with the Digital Center of Dunhuang Academy, the National Engineering Research Center for the Protection of Ancient Murals and Earthen Sites, the Key Scientific Research Base of the State Administration of Cultural Heritage for the Protection of Ancient Murals, and the Key Laboratory for the Protection of Ancient Murals and Earthen Sites in Gansu Province, used technical means to carry out the digitization of grottoes and temples. For the purpose of art, Dunhuang grottoes with high value were presented to the audience (Wu, 2015). Liang et al. (2016) proposed a colour control colour card method for Dunhuang painted artworks to solve the problem of inaccurate colour collection and reproduction in the digital protection of Dunhuang painted artworks. According to the "Overview of the Digital Restoration Project of the Lost Overseas Dunhuang Cultural Relics" published by the Luo et al. (2022) in Luo Huaqing Dunhuang Research Institute, the Dunhuang Research Institute promoted the digital restoration of Dunhuang relics and other cultural relics scattered overseas through high-tech means such as digitization and informatization and realized the digital sharing of Dunhuang cultural and artistic resources on a global scale. In addition to Dunhuang, the digital protection of cultural relics has also been carried out throughout the country. For example, in 2012, the Shandong Museum used and developed a cultural relic database of digital museums (Wang, 2012). In 2016, Jiangxi Province carried out the construction of the thematic database of archaeological relics of "Haihunhou" (Liu, 2016). In 2020, the Xinjiang Institute of Archaeology carried out digital information collection on textile cultural relics unearthed from the Niya Cemetery in Xinjiang (Shang et al., 2020) and so on.

Since the protection technology of previous ancient buildings has improved, digital technology has begun to develop in the direction of artistic expression in the restoration animation of ancient buildings and the display effect of the digital exhibition hall of ancient buildings. At this stage, the digital protection technology of cultural sites is more diverse on the basis of previous technology, and the research direction is more detailed. For example, in 2020, digital panoramic borehole camera technology was applied in the protection project of Dazu Qianshou Guanyin cultural relics (Shi & Zhai, 2020). In the literature published in 2022, how to use X-CT and digital image correlation methods to improve the deterioration caused by repeated drying and wetting of the site was detailed in the literature published in 2022 (Zhuang et al., 2022).

2.1.2 Foreign Research Present Situation

The development of digital protection work in foreign countries has been ahead of that in China for many years. The beginning of the "World Memory" project launched by UNESCO in 1992 heralded the official development of the digital protection of global cultural heritage. The project selects typical cultural heritage for digital and information protection at a global scale. Encouraged by the United Nations Educational, Scientific and Cultural Organization, various countries, such as the United States's Declaration of Independence and the United States Constitution and its amendments in 1992, the first print edition of Spain's Don Quixote in 2001, South Korea's Direct Heart and Body Festival in 2004, Russia's Peter the Great Decree Collection in 2005, and the original manuscript of Britain's Magna Carta in 2007, actively declared. With the development of digital technology, digital protection projects in various countries have gradually achieved promising results. For example, France has successively carried out the "Palace of Versailles Digital Project," "Louvre Digital Project," and "Notre Dame de Paris Digital Restoration Project," which has shortened the distance between people and history and art so that people can enjoy valuable cultural relics at home. IBM's Digital Library Project 'Digital Protection Project ' in the United States digitizes all previously retained books, music, images, manuscripts, etc., to facilitate public access. Germany's digital protection project has achieved the best results. The German Museum and Archives Agency has carried out the digital protection project of cultural heritage from the five dimensions of digital recording, digital restoration, virtual exhibition, digital integration and digital development, which provides reference and inspiration for other countries.

3. Conclusion

In summary, the development of digital heritage protection in China has changed with changes in digital technology. As the first step of digital heritage protection, digital acquisition transforms cultural heritage into a digital format through high-speed scanning, high-precision cameras and other technical means to facilitate

subsequent storage, display and dissemination. Digital display and communication technology present cultural heritage to the audience in a more vivid and vivid way, enhancing the experience and perception of the audience. This type of inheritance mode is more novel than before. However, when the technology has matured, the results of digital protection in various places are mixed, and the reasons behind this are thought-provoking.

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Conflicts of Interest

The authors declare no conflict of interest.

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