

The Digital Protection and Dissemination Path of Cultural Heritage from the Perspective of Digital Humanities

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Abstract. Digital humanities, as an emerging field that integrates information technology and humanities, is reshaping the protection paradigm and communication logic of cultural heritage. This article focuses on two core issues: the technological path of digital protection and the transformation of communication paradigms. It systematically sorts out the technological evolution from digital collection and archiving to immersive experience and then to artificial intelligence-driven, and analyzes the paradigm shift of cultural heritage communication from one-way display to interactive narrative and value co-creation. Research has found that digital technology has promoted the transition of cultural heritage protection from "static preservation" to "dynamic regeneration", while the dissemination mode has undergone an evolution from "media migration" to "narrative reconstruction" and then to "ecological co-construction". This discovery expands the theoretical boundaries of the issue of "authenticity" in the field of digital humanities, providing an analytical framework for constructing a new paradigm of heritage protection that balances technological empowerment and cultural integrity.

Keywords: Digital humanities, Cultural heritage, Digital protection.

1. Introduction

Driven by the dual waves of intelligence and digitization, the protection and dissemination of cultural heritage are undergoing a profound transformation. Digital humanities, as an emerging field that integrates information technology with traditional humanities, provides a new perspective and method for the recording, preservation, research, and dissemination of cultural heritage. With the help of technologies such as digital collection, virtual simulation, digital display, and artificial intelligence, the recording and presentation of cultural heritage can achieve higher levels of accuracy and comprehensiveness [1-3].

However, the current digital presentation of some cultural heritage still tends towards surface level migration of "formal digitization", which involves the electronic translation and one-way presentation of cultural resources in a straightforward manner, leading to a dilemma of "excessive technological empowerment but insufficient narrative activation" in communication. How to find a balance between technological empowerment and cultural depth has become the core proposition of cultural heritage protection in the digital age [4]. This article focuses on two main themes: the technological path of digital protection and the transformation of communication paradigms. It systematically reviews the research progress and practical exploration of cultural heritage protection and communication from the perspective of digital humanities.

2. The technological path of digital protection

2.1. Digital Collection and Archiving: From Physical Remains to Data Assets

Digital collection is the first link in the digitalisation of cultural heritage. At present, technologies such as 3D laser scanning, photogrammetry, hyperspectral imaging and multispectral imaging are frequently used in the data acquisition for cultural heritage. The above technologies can achieve millimeter-level recording of the physical shape of heritage and also acquire microscopic information that cannot be observed with the naked eye, such as the original appearance of murals covered in smoke and dust, or micrometer-level texture structures on the surface of cultural relics [5].

Data management is shifting to digital storage for cultural heritage data at this time. The dual-track parallel development of native digital archives and digital archive resources has built a multi-dimensional archive construction system that covers collection, protection, inheritance, display and dissemination. By adding fine-grained annotations and building knowledge graphs, the individual digital resources can be organised into a system of connected knowledge networks. For example, in the "Digital Dunhuang" project of the Dunhuang Academy, knowledge graphs have been used to intelligently link music and dance pictures in murals with music score documents and cave inscriptions to achieve mutual embedding and interconnection of cultural symbols across different categories. In the late 1980s, the concept of "Digital Dunhuang" was put forward, and since then, Dunhuang Academy has created a full-featured set of digital key technologies and workflows for immovable cultural relics. To date, we have completed the digital acquisition of murals in 300 caves, image stitching and processing for 200 caves, 3D reconstruction of the seven main sites, 3D reconstruction of 45 coloured sculptures, and digital scanning of 50,000 historical archive negatives; a total of more than 500TB of digital assets have been accumulated. The digitalisation team is advancing steadily at a rate of 10-15 caves per year, and it is expected that in the next 10 years, all the existing caves in the Mogao Grottoes will be fully digitised and collected.

Standardisation of data and cross-repository interoperability are the current problems. The construction of an information silo for different institutions and projects is to establish a unified data standard and sharing protocol. In recent years, the practice of the "Digital Oracle Bone Co Creation Center" has provided a typical case by integrating scattered global oracle bone collection data, promoting the internationalization of oracle bone protection standards and the global sharing of resources [6].

2.2. Immersive Technology and Augmented Reality: Reforming the Experience

Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR) and other extended reality technologies have changed the form of display for cultural heritage from "viewing" to "experiencing", making people feel as if they are actually in the past or at a particular site.

At present, applications of augmented reality technology for cultural heritage have moved from simple documentation to new forms of presentation. In the early days, precise scanning and digital reconstruction were carried out to create a digital twin of cultural heritage, and its accuracy and completeness were then investigated. At this time, the formal perspective is enhanced and the space covered is expanded by "anchoring", but its recorded state has a lag and solidification compared with reality. With the development of technology, digital twins are increasingly combined with high-end technologies such as the metaverse and artificial intelligence to realise the "activation and regeneration" of cultural heritage. The construction of a smart cultural and tourism digital twin platform for Longmen Grottoes integrates situations and immersive interactive experiences to allow visitors to enjoy the artistic charm of the grottoes remotely.

The third path for the 3D printing replication of Yungang Grottoes is also feasible. The world's first movable 3D-printed 1:1 replica cave - the 12th cave ("Music Cave") replica cave of Yungang Grottoes has been displayed in Shanghai, Paris, France and other places. Yungang Research Institute has worked with Zhejiang University and other institutions to overcome a series of technical difficulties, achieved 3D printing and proportional reproduction, and created a new model for large-scale complex and immovable cultural relic exhibitions. Previously, the Western Buddha of Cave 3 was "settled down" in Qingdao, and the standing Buddha of Cave 18 was "settled down" at Beijing Jianzhu University. Wherever the replicated caves are shown, the number of local tourists visiting Yungang Grottoes will also rise accordingly [2] [4].

2.3. Integration of Artificial Intelligence into Applications

The integration of artificial intelligence technology marks a new stage in the digital protection of cultural heritage, moving from "digital preservation" to "intelligent understanding". The multimodal large model, with its outstanding advantages in perception, understanding, and generation, provides

a new path for knowledge discovery, intelligent restoration, and innovative narrative of cultural heritage.

The "Digital Scripture Cave" database platform is a model of AI driven knowledge discovery. In May 2025, Dunhuang Academy released the "Digital Tripitaka Cave" database platform, allowing the lost overseas Tripitaka Cave cultural relics to be "reunited" in digital form. At present, the platform has released 9946 volumes (pieces) of digital resources of Tibetan scripture cave cultural relics, with more than 62000 images and completed content recognition of over 7.8 million words.

Faced with illegible text on scriptures, Dunhuang Academy utilizes artificial intelligence technology to assist in data processing and intelligent retrieval; Blurred characters and sloppy handwriting are reviewed and corrected by researchers. The platform also has a column called "Identification and Interpretation of Documents Excavated from the Cave of Buddhist Scriptures", inviting experts and enthusiasts of ancient texts from around the world to participate in interpretation. Currently, some texts have been recognized and deciphered through this method. The platform also has functions such as character comparison reading, character pronunciation and correction, and full-text comparison reading. As of now, the database has been accessed by over 250000 people from 33 countries and regions [7] [8].

2.4. Comparison and Collaboration of Technical Paths

Each of the three technological paths has its own strengths, with digital collection and archiving focusing on information fidelity recording and long-term preservation; Immersive technology focuses on the reconstruction of experiences and the enhancement of perception, while artificial intelligence is dedicated to the deep exploration and intelligent application of knowledge. The three are not a linear substitution relationship, but form a collaborative chain of "collection presentation understanding". In practice, major projects such as Digital Dunhuang and Digital Forbidden City have demonstrated the integration and application of three technological paths.

3. The paradigm shift of communication pathways

3.1. Media Fusion and Reconstruction of Communication Ecology

In the digital age, the media ecology for the dissemination of cultural heritage has undergone fundamental changes. The traditional one-way communication model of "display cabinets+ commentary" is being replaced by a composite communication network composed of multiple channels such as social media, short video platforms, online exhibitions, and interactive applications. The popularity of mobile devices such as smartphones has transformed individuals from recipients of information to producers and disseminators of information - by sharing photos, videos, and experiencing stories, the general public unconsciously constructs a perception channel for the authenticity of cultural heritage [9] [10].

The current trend of digital dissemination of Chinese cultural heritage is shifting from "form transfer" to "deep embedding". Early practices mainly focused on the electronic translation and one-way presentation of cultural resources, while current explorations emphasize the deep integration of cultural elements with digital technology, contemporary values, and diverse application scenarios.

3.2. Interactive Digital Narrative

Interactive digital narratives are now used to spread the culture of Chinese classical music. The previous mode of linear storytelling had a passive audience, but now interactive storytelling can have audiences choose, take part in, and even create. The new form of storytelling for cultural heritage has shifted from "telling people a story" to "having people build the story themselves through interaction".

Interactively narrated stories take many forms in practice: First, the ancient architecture app teaches traditional woodworking knowledge by virtually disassembling parts in a three-dimensional way during virtual construction; second, a mobile game integrates ink-painting styles and intangible cultural heritage skills into urban management games, and players need to learn the cultural meaning

of Suzhou gardens when designing them. Secondly, the "Chang'an Twelve Hours" immersive cultural district focuses on Tang-style urban life and has created many different "original Tang" forms that integrate snacks, cultural creativity, performing arts and games to extend cultural dissemination from knowledge acquisition to tangible experience. Thirdly, on short-video platforms, users' secondary creations, such as "intangible cultural heritage cross-dressing" and "ancient and new creations", form an organic chain of dissemination and allow cultural heritage to take on numerous forms in the digital soil.

Interembedded narratives are comprehensive systems of many cultural elements that have been deeply combined by integrating cultural cores, digital technology, contemporary values and application scenarios.

3.3. Value Co-creation and Experiential Shift in Communication

Digitalisation of the spread of cultural heritage is aimed at value co-creation and an experiential shift. At this time, the purpose of spreading is no longer merely to transmit information but to create and share meaning.

In terms of the spread effect, digital platforms have significantly increased the scale of distribution for cultural heritage. The world-class traffic of the "Digital Dunhuang" resource library has surpassed 22 million, and more than 200 cultural and museum institutions in 17 countries have been included in the data of the "Silk Road Cultural Big Data Platform". Based on the above data, digital communication has broken the constraint of physical space, and cultural heritage has moved from being a "limited presence" to an "infinite online".

At the same time, the public's contact with cultural heritage through digital platforms has also changed. Through social media, online communities and live-streaming platforms, interest groups have formed around certain cultural themes such as Chinese-style music, Hanfu and traditional handicrafts, established stable online communities, and expanded these into joint offline activities. For example, in an online community for the restoration of old clothes, members work together to study related literature and design drawings, and then use both online and offline communication to produce and exhibit these restored old clothes. Thus, cultural inheritance has moved from being solely the result of institutional output to a joint construction involving the public, and has been transformed from passive acceptance to active participation.

At the same time, through immersive technology, an "embodied" experience can be created to foster all-encompassing cultural cognition of the senses and emotions, rather than only gaining abstract knowledge. Historical scenes in virtual reality and simulated experiences of ancient people participating in etiquette help to improve the inheritance of cultural memory and the sense of identity.

4. Conclusion

The digital protection and dissemination of cultural heritage from the perspective of digital humanities is essentially the re encoding and reactivation of cultural genes in the digital age. From the perspective of technological path, digital protection has undergone an evolution from "digital filing" to "immersive presentation" and then to "intelligent understanding", forming a multi-level and collaborative technological system; From the perspective of communication paradigm, the dissemination of cultural heritage has achieved a transformation from "media migration" to "narrative reconstruction" and then to "ecological co construction", and the communication logic has shifted from one-way transmission to interactive co creation.

However, errors in information translation and excessive commercial packaging may distort the original appearance of the heritage; The digital divide may exacerbate the imbalance in the utilization of cultural resources; The tendency of "technology first" may dissolve the deep value of culture. Only by maintaining the necessary tension between technological empowerment and cultural depth, and seeking a dynamic balance between instrumental rationality and value rationality, can cultural heritage truly achieve innovative development in the digital age.

Future research should further focus on the theoretical construction of digital humanities methods. Only when technology truly serves the inheritance and innovation of culture, can the value of digital humanities be fully realized.

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