

# ***Research on Intelligent Experience and Living Inheritance of Cultural Heritage Against the Background of Artificial Intelligence***

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**Abstract:** Cultural heritage plays an important and irreplaceable role in the development of human society. It is a new trend that artificial intelligence technology is involved in the field of cultural heritage, which helps the dynamic development of cultural heritage. By analyzing the advantages of artificial intelligence technology in the protection and inheritance of cultural heritage, this paper discusses the new development direction of cultural heritage. By analyzing the cases of technological intervention in cultural heritage, this paper summarizes the different forms of expression brought by technological intervention for heritage development, shows the new achievements brought by technology for heritage development, and points out the possible new direction of future development.

**Keywords:** cultural heritage, artificial intelligence, intelligent experience, living inheritance

## **1. Introduction**

With the rapid development of the current era, artificial intelligence technology and mobile Internet technology continue to upgrade, develop, and deeply enter all aspects of life. The inheritance and development of cultural heritage is always an important field, but a second development hotspot is the important dabbling point of artificial intelligence technology in recent years. The study and analysis of the intervention of artificial intelligence technology in the protection and inheritance of cultural heritage will help to understand the current development status of cultural heritage, as well as more advanced development experiences, and point out the direction for cultural heritage that is looking for new opportunities for protection and development. At the same time, it can also point out the direction of discussion for the future development of cultural heritage. Firstly, through a brief analysis of the status quo of the development of cultural heritage, this paper points out that artificial intelligence technology is intervening in the process of the development of cultural heritage, relying on technological advantages to bring intelligent experience and living inheritance of cultural heritage; it also points out three forms of technological intervention in the development of cultural heritage through case analysis. In the case of the above summary analysis, this paper analyzes and deduces the future development of cultural heritage under the support of technology.

## **2. Current Status of Cultural Heritage Inheritance and Development**

“Cultural heritage” is a precious treasure in the development of human civilization. As a non-renewable cultural resource with regional characteristics, the protection and development of cultural heritage have been the subject of long-term research by all countries and related organizations. The protection and development of cultural heritage not only protects the achievements of human civilization but also brings huge economic benefits to the countries, regions, and local communities where it is located [1]. In this process, the government plays a leading role. By introducing national policies and increasing the inflow of funds to support and advocate the protection and development of cultural heritage, the government promotes the relevant dissemination of cultural heritage exhibitions between countries and regions to attract the attention of social groups. At the same time, relevant disciplines and research projects will be set up in universities to promote the development of theories and technologies, and the university will conduct joint research with museums and enterprises and hold relevant academic seminars to promote the protection and development of academic theories. With the help of various parties, digital technology, artificial intelligence, and other new means have also been promoted in the field of cultural heritage protection, injecting new vitality into the field. However, there are still some deficiencies in the survival of cultural heritage, such as environmental conditions, management and resources, weak awareness of inheritance and development, and forms of presentation.

## **3. The New Direction of Intelligent Experience and Living Inheritance of Cultural Heritage**

### **3.1. The Intervention of Artificial Intelligence Technology**

The development of artificial intelligence has ushered in a new wave of applications. Under the research and development of technology companies, different types of artificial intelligence ecology have been built according to different research objects based on commercial needs, and organic integration with the industrial chain has been realized [2]. On the basis of such developments, artificial intelligence technology has also begun to be applied in the field of cultural heritage and has affected the protection and inheritance processes of cultural heritage through different technological forms.

The first step of technological intervention is in the process of heritage protection, with two points of application. First, the intervention of technology is to lay the foundation for the diverse display and dissemination of heritage. Its main form is to accurately measure cultural heritage through various technologies to provide complete digital records and data, which belongs to high-precision heritage digitization. At the same time, the technology can carry out 3D reconstruction and repair on the basis of scanning measurements, laying the foundation for subsequent diverse presentations. The main technologies used are aerial stereoscopic mapping, UAV laser radar scanning, and 3D laser scanning reconstruction [3]. Secondly, the intervention of technology can make up for and enhance the shortage of human resources to protect the heritage. Data collection is not only based on static digitization and heritage restoration but can also realize dynamic data collection of cultural heritage and real-time monitoring of the status of heritage and heritage environments. Through dynamic analysis of intelligent real-time data, the hidden dangers of heritage can be reflected and adjusted in real time to make up for the imprecision of manual monitoring and action.

On the basis of the data obtained in the process of technological intervention protection, technological intervention provides audiences with novel ways to contact and experience cultural heritage. From a single visit to the heritage entity to the understanding and experience of the cultural and historical background behind the heritage through technology, the intervention of technology

makes the experience more comprehensive and immersive, thus improving the influence of cultural heritage. In addition to upgrading the display experience, the intervention of technology has also improved the visitor service experience. For example, the previously complicated procedures of ticket checking and tour guide coordination are intelligitized, and real-time data and suggestions on exhibition flow routes are provided to the audience, thus bringing a more convenient experience. From this point of view, the intervention of technology also brings better management experience for the administrators of cultural heritage.

### **3.2. The Advantages of Technological Intervention**

Before the development and popularization of technology, the protection and development of cultural heritage largely relied on human data collection, heritage restoration, manual monitoring, and other behaviors. There are difficulties of different degrees and a lot of limitations, which make the efficiency of heritage protection low and the scope of cultural transmission limited. Although the development of cultural heritage faces new challenges as technology evolves, artificial intelligence and other technologies also bring new ways and opportunities to cultural heritage.

#### **3.2.1. Technological Intervention Brings Efficiency and Real-time Risk Avoidance**

The primary goal of the development of cultural heritage is to effectively protect it. Heritage is formed after a long period of existence and development, which means that its appearance is not complete and its understanding is not comprehensive. As a result, heritage data collection includes not only digital preservation but also a more detailed understanding of the heritage during the research process. But before technology intervened, it relied more heavily on human exploration and mapping. The existing problems are as follows: first, it requires a large amount of manpower and material resources, as well as a relatively long time; second, in the process of exploration, researchers may find themselves in more dangerous environments, and the internal structure of the heritage and the parts that have been missing due to natural conditions are inaccessible to researchers. But these problems can be solved well with the intervention of technology.

When technology intervenes, researchers can use drone mapping to collect data on heritage sites that are large or in adverse natural conditions. At this time, the data collection is more accurate and comprehensive. In this way, not only the data of the heritage itself can be extracted, but also the environmental data of the heritage can be preserved. And after data collection, researchers can use AI to identify the internal structure of the heritage, find parts that need to be repaired, and have AI guide the restoration of missing parts. The 3D modeling technology provides guiding data and virtual restoration to help researchers restore the appearance and understand the contents of the cultural heritage. The labor required to do this saves a lot of money compared to before.

Another focus of heritage protection is its survival. No matter what kind of cultural heritage there is, it is affected by the environment. The environment is divided into a natural environment and a man-made environment. In terms of the natural environment, severe weather such as insect and ant diseases, fire, thunderstorm, typhoon, and flood, as well as the change of environmental parameters such as carbon dioxide concentration and relative humidity, all threaten the existence of heritage. From the perspective of the man-made environment, the exhibition behavior of visitors, the flow of visitors, and the change of environmental parameters also pose a certain threat to the heritage [4]. All of these require a large number of human resources for monitoring. The huge and diverse workload and the precision required by the work flow result in the impropriety and incompleteness of protection monitoring.

The real-time monitoring brought by technology can effectively solve considerable problems. Artificial intelligence technology has entered the field of environmental protection. Relying on

technology in the field of environmental protection can monitor air pollution, forecast extreme weather [5], and perform other functions that can be derived and developed to achieve real-time termite monitoring, ancient building disease monitoring, fire and lightning testing, as well as carbon dioxide, temperature, relative humidity, and other environmental parameters for cultural heritage impact monitoring; At the same time, timely adjustments and threat warnings can be made; that is, artificial intelligence can adjust relevant machines to change environmental parameters after analysis. When uncontrollable threats are monitored and analyzed, alarms can be made in advance to facilitate the staff's taking countermeasures in advance. (Figures 1 and 2)

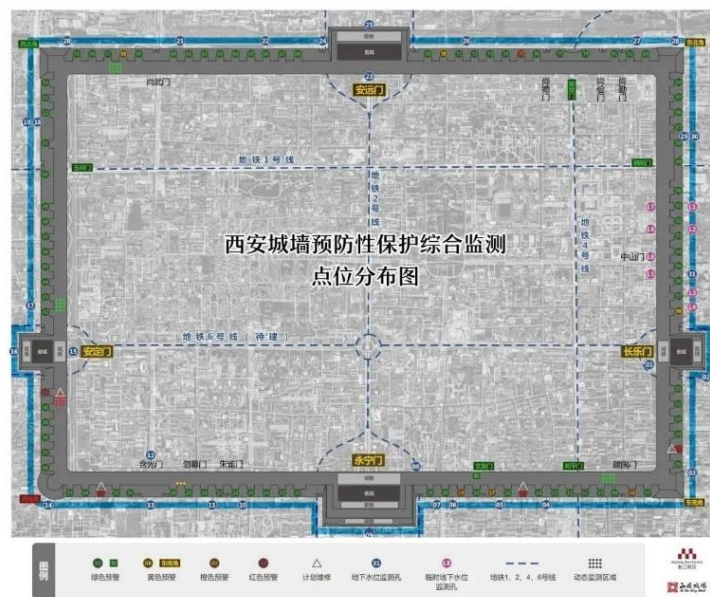


Figure 1: Distribution map of comprehensive monitoring points for preventive protection of the Xi'an City Wall (photo source: official website of the Xi'an City Wall Administrative Committee).



Figure 2: Monitoring display of the Xi'an City Wall Information Center (photo source: the official website of the Xi'an City Wall Administrative Committee).

### 3.2.2. Technological Interventions Provide a Piloted, Complete, and Multimodal Experience

The intervention of technology makes up for the incomprehensibility and singularity of people's experiences of cultural heritage. Currently, most of the common forms of heritage display are mainly a single heritage display, pictures, text, and other forms, or more videos. Although online pavilions have also been popularized with the development of Internet technology, more of them only break through the time and space restriction that the audience cannot reach the scene through three-dimensional technology, and there is not much of an update in the form.

The intervention of artificial intelligence technology can achieve two main goals. As for the visiting process of the audience, through the integration and processing of 2D and 3D data, the audience can systematically understand the main content and historical background of the cultural heritage through virtual presentation before visiting the heritage, so as to reduce the strangeness of the visit. At the same time, in the process of human-machine interaction, technology can make timely and effective suggestions and route plans for the visitors' visiting process through identification and judgment, bringing convenience and comfort to the exhibition.

As for the display of cultural heritage, technology can display those cultural heritages that cannot participate in the display, have not completed the restoration, or cannot complete the restoration due to technical reasons at the present stage through virtual restoration and multi-dimensional display, so as to ensure the integrity of heritage display. At the same time, the intervention of technology can also create the historical environment of the heritage, or the full picture of the heritage from multiple angles, so that the audience can see the full range of high-definition scenes of the heritage with their own eyes, bringing them an immersive experience. On this basis, technological intervention can also bring about a high level of human-machine interaction. Through the linkage and analysis of devices and big data, accurate positioning of people can be provided to provide a variety of intelligent experiences, which also change the boring form of pure objects, two-dimensional pictures and videos, and text and voice [6]. (Figures 3 and 4)



Figure 3: Hanguang Gate site (photo source: the official website of the Xi'an City Wall Administrative Committee).



Figure 4: AR experience of Daming Palace Site Museum (photo credit: Industrial Qujiang Wechat official account).

#### **4. The Expression Form of Intelligent Cultural Heritage Experience Against the Backdrop of Artificial Intelligence**

##### **4.1. Heritage Digitization and Restoration: Jiankou Great Wall**

Since the development of artificial intelligence, it has been continuously penetrating our lives and solving the difficult problems of life with new means. When artificial intelligence intervenes in the field of cultural heritage, it is not only creating a new history but also passing on one. Technology is conducive to the protection and repair of cultural heritage. Technological intervention can digitally restore the before and after states of cultural heritage and identify the parts in need of repair through an artificial intelligence algorithm for guidance, so as to facilitate the follow-up and further research. In the process of restoring and protecting the Jiankou Great Wall, Intel is using technology to help protect the Great Wall.

Jiankou Great Wall in Beijing is a Ming Dynasty section with a history of more than 450 years. It has been badly damaged by natural and man-made influences for a long time and is in urgent need of repair. Jiankou is about 19.3 kilometers long and is considered one of the more dangerous sections of the Great Wall. Most of them are located on steep peaks and cliffs with lush vegetation around them. Such environmental characteristics also lead to the slow maintenance of the Jiankou Great Wall (see Figure 5). The process is time-consuming and labor-intensive, and the steep terrain makes it hard to get accurate data. Intel's goal is to work with Wuhan University and the China Foundation for Cultural Relics Conservation to use AI and deep learning to protect Jiankou.



Figure 5: Jiankou Great Wall before restoration (photo source: the official website of the China Foundation for Cultural Relics Conservation).

Intel is providing drone technology, high-performance computer platforms, and artificial intelligence algorithms and technologies. In terms of UAV, the company uses the Intel Falcon 8+ UAV (see Figure 6). This is a drone that can efficiently and accurately capture close-range mapping in harsh conditions. Its main task is to carry out monitoring and aerial photography of the wall to obtain high-resolution images. In order to carry out the follow-up work, tens of thousands of pictures will be needed, and the addition and use of this UAV can reduce the original workload of one month to about three days. The resulting image data is quickly analyzed on a workstation with an Intel Xeon expandable processor to detect cracks and missing tiles that need to be repaired. What AI does is analyze, process, and virtually reconstruct the collected multi-form data so as to provide guidance and data prediction for the subsequent work [7].



Figure 6: Intel Falcon 8+ Drone (photo source: “Hello AI” documentary).

Specifically, artificial intelligence technology is applied in two aspects. The first is the identification and positioning of the parts of the Great Wall that need to be repaired. Artificial intelligence collects samples of 3D models of the Great Wall, which it establishes after data collection and completes with normal 3D models of the Great Wall. After obtaining sample data, it conducts a large number of training and analysis sessions to form recognition abilities. The second is a digital, virtual restoration of the Great Wall. Based on this recognition capability, AI will be able to identify the damaged parts and types of the Great Wall and carry out digital and virtual repairs. Artificial intelligence generates the 3D repair effect and calculates the required materials, time, manpower, and cost as reference suggestions (see Figure 7). By making use of advanced technology to obtain more

accurate data, we can create faster and more efficient solutions to problems that can't be solved in the conservation of cultural heritage sites like Jiankou Great Wall.



Figure 7: Jiankou Great Wall intelligence defect monitoring (photo source: “Hello AI” documentary).

#### 4.2. The Intelligence of Data: “Digitized and Intelligent Jiangxi Museum”

When cultural heritage is displayed in front of people, there are some problems that last a long time: massive cultural resources, a large number of audiences, and complex management problems. The work of regulatory bodies is also centered around these. The current development content and direction in the case of continuous technological development is how to use the power of science and technology to optimize these problems. At this level, the participation of AI technology is mostly combined with big data and other technologies. Excavating the knowledge system behind it and establishing the knowledge map through correlation, etc., can broaden the way for the development of cultural heritage and lay the foundation for living inheritance [8]. The first thing is to use big data and artificial intelligence technology to promote the construction of cultural heritage wisdom data, and then to promote the digital and formal transformation of cultural heritage expression forms and related knowledge. The Jiangxi Provincial Museum gave a good answer based on this point.

Under the vigorous development of promoting the policy of “smart museums,” Jiangxi Provincial Museum has launched the comprehensive management service system of “digital and intelligent Jiangxi Museum.” With the support of big data, cloud computing, the Internet of Things, artificial intelligence, and other technologies, Jiangxi Museum has carried out the overall digital transformation and intelligent upgrading of the whole museum business and built the intelligent collaborative management and service of the whole museum. Jiangxi Provincial Museum itself has a large number of cultural resources, in addition to the protection of cultural relics, but also considers the problem of long-term cultural inheritance. With the support of science and technology, the Jiangxi Museum has begun to digitize cultural resources and intellectualize digital resources.

First of all, the Jiangxi Provincial Museum adopts scanning, modeling, digital rubbing, and other digital technologies to preserve the physical characteristics of cultural relics without damage with high precision and high fidelity, so as to achieve digital protection and data collection of cultural relics. The digitized workload of Jiangxi Museum resources ranges from more than 20,000 pages of paper archives to more than 400 pieces of three-dimensional modeling and other figures. After cultural digitization, the Jiangxi Museum begins to intellectualize digital cultural resources using artificial intelligence, big data, and other technologies.



The images saved in the data acquisition process are quickly classified by artificial intelligence technology, and the real details of the images are used in the process to improve the actual clarity of the magnified images, which is convenient for the subsequent communication work. At the same time, artificial intelligence technology is used to cooperate and train with big data and an applied knowledge graph, and with the support of mobile Internet technology, the digital humanities research and service platform of Jiangxi ancient celebrities is constructed (see Figure 8). Besides, the thematic knowledge and service platform of Jiangxi ancient celebrities inside and outside the connecting library is also established, which is of great value for mining and activating Jiangxi Museum cultural resources. At the same time, the intelligent data can collect, analyze, and identify the audience's activity data in the museum under the joint action of artificial intelligence technology and mobile Internet technology. The mobile Internet platform provides more targeted services to the audience, such as pushing exhibitions, activity information, and cultural relic viewing recommendations according to the audience's preferences (see Figure 9). Nowadays, most cultural heritages are being digitally preserved, and the cultural development after digitalization points to the wisdom of data, though the possibilities brought by that wisdom still need to be explored and discovered continuously.



Figure 8: Jiangxi Ancient Celebrity Digital Humanities Research and Service Platform (photo source: the official website of Jiangxi Provincial Museum).



Figure 9: Real-time monitoring display of the Jiangxi Provincial Museum (photo source: the Jiangxi Provincial Department of Culture and Tourism).

### 4.3. In-depth and Active Content Experience: Digital Twin of the Longmen Grottoes Intelligent Cultural Tour

In addition to playing an effective role in the protection of cultural heritage, the intervention of artificial intelligence technology plays an important role in the dissemination, presentation, and experience of cultural heritage. With the maturity and popularity of VR and other virtual reality technologies, artificial intelligence technology can combine with cultural heritage to innovate in form and content. Artificial intelligence technology simulates cultural heritage and its growing environment in depth, carries out speech recognition and image scanning of cultural heritage, and combines virtual reality with intelligent modeling technology. On the basis of retaining the details, the conceptual scenes, such as the human environment and architectural style, are reproduced intelligently and optimally, so as to build a simulation environment for vivid display and dissemination in a more vivid way. Longmen Grottoes is a scenic spot on the line of exploration and practice in this regard.

Longmen Grottoes, located in Luoyang, Henan Province, were built during the reign of Emperor Xiaowen of the Northern Wei Dynasty, more than 1,500 years ago. Longmen Grottoes scenic spot is large and complex because of its characteristics of material form, area, and surrounding environment. In order to better serve tourists and spread culture, the management staff set up the digital twin platform of smart culture and tourism with the support of various technologies to activate the cultural resources of Longmen Grottoes.

Longmen Grottoes Scenic Spot uses a rendering engine, an interactive engine, real-time light and shadow, digital restoration, and other technologies to carry out medium-precision restoration of 31.7 square kilometers of terrain, geomorphology, traffic network, cultural relics, mountains, fields, forests, and rivers, ecological vegetation around the scenic spot, and carry out three-dimensional modeling of surrounding villages. Laser point cloud technology is used to carry out medium-precision scanning and object-based modeling of the grottoes to restore their appearance and texture. The contents with high value, such as the Vairocana Buddha in Fengxian Temple, were restored with a precision of 1 mm in structure and 1 mm in texture so as to preserve and protect information and make imitation products [9] (as shown in Figure 10). It realizes 360-degree all-around high-precision and high-fidelity restoration and presentation. In the form of “science and technology + culture,” visitors can enjoy the full range of 3D high-definition scenes of the caves with their naked eyes and feel the cave shape, exquisite statues, and subtle marks caused by thousands of years of weather up close, creating an episode-like and immersive interactive experience.



Figure 10: Virtual restoration of Longmen Grottoes (photo source: official website of Longmen Grottoes).

In addition to bringing a better viewing experience, Longmen Grottoes Scenic Spot and Beijing Xiangshu Technology Co., Ltd. use digital twin technology to create a digital twin platform of Longmen Grottoes (see Figure 11). By monitoring infrared, sensor, and other data, combined with big data analysis and an AI algorithm, we can calculate and predict all kinds of data related to tourists in scenic spots, use "one picture" to improve the management level of scenic spots, bring more convenient services and a better viewing experience for tourists, and achieve the purpose of better cultural dissemination. This is a critical aid in the intelligent operation and management of Longmen Grottoes.



Figure 11: The digital twin platform of Longmen Grottoes (photo source: Henan Provincial Department of Culture and Tourism).

## 5. The Future Trend of Cultural Heritage Living Inheritance

At present, vigorously protecting and inheriting cultural heritage is a hot trend in the cultural industries of various countries. However, due to the differences in various capacities, such as economic and technological levels, as well as the situations and problems encountered by cultural heritage, the protection and inheritance of cultural heritage are also different among countries. In addition to the economic situation, technology and experience with heritage protection have become important factors influencing heritage protection. With technology, I can improve work efficiency but also solve problems. With experience, I can quickly analyze problems and find solutions. And the best way to solve these two problems is to rely on technology. The resource platform is constructed by integrating local resources, associating and integrating remote resources, recording, classifying, and labeling heritage resources, saving and sharing data and cases, and cooperating across regions and countries [10].

To build a regional and national cultural heritage wisdom data resource platform, the preservation function of resources is the first step. The platform can record the types, locations, cultural periods, materials, and conditions of heritage resources, as well as records of the process of heritage protection and repair. The second is the sharing of resources. It records the characteristics of the heritage itself and its surrounding environment, shares the heritage protection process and development process, points out the problems or hidden dangers in the process, provides solutions for final use, and shares the experience of heritage protection and inheritance. Finally, it is to connect resources. Numerous and complex relationships can be established in these vast and complex resources using the characteristic record and classification management of resources based on cultural content or the degree of similarity between the situations.

Today, the Getty Conservation Institute and the World Architecture Conservation Fund have taken a step forward. Their jointly developed open source software platform for cultural heritage data management, known as Arches, is now freely available to organizations around the world for installation, configuration, and expansion according to their individual needs without restriction. The platform is also ideal for other non-cultural heritage uses, such as asset management. Cultural heritage institutions around the world use Arches to log in, survey, and help manage all types of heritage resources, including immovable and intangible cultural heritage. As of now, Arches is more of an adaptable heritage management system, but it is evolving into a comprehensive system capable of visualization, comparison, and sharing. Among these, the security of heritage resources is an important issue in development.

The construction of the platform is the foundation for the sharing of heritage resources, and what is more important for the future development is the connection after sharing. Can we connect other cultural resources from that time period, such as financial trade data and health and disease records, with the cultural heritage itself, in addition to looking for complex relationships in the vast heritage resources? Mass storage and recognition training of data with AI and other technologies are utilized to make breakthroughs in the connection body to achieve the identification and extraction of cultural genes, hypothesis verification, knowledge reasoning, and so on to help further the development of cultural heritage, which may be the direction and purpose of living inheritance of cultural heritage in the future.

## 6. Conclusion

The inheritance and development of cultural heritage have long been and will remain the common concern of the world in the future. The intervention of artificial intelligence technology has injected new vitality into the development of cultural heritage and is also a new way of combining culture and science. Existing development cases have demonstrated the advantages brought by artificial intelligence technology, and the promotion and use of technology have become trends. In the future, we should not only pay attention to the use of technology in heritage development but also seek a balance between technology and culture. Under good development, technological intervention in cultural heritage may not only bring intelligent experience and living inheritance but also develop unknown new forms of heritage culture.

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