Mixed Reality The application strategy exploration of technology in the preventive protection of architectural heritage

Yuxin Yang
School of Architecture and Civil Engineering, West Anhui College

Abstract. Digital, information and other computer technologies are more and more applied to the protection of architectural heritage, Mixed Reality technology with its "spatial consistency of real scene and virtual scene" characteristics, shows a broad application prospect in the preventive protection of architectural heritage. This paper first clarifies the definition of preventive protection of architectural heritage, then sorts out the development path of preventive protection, and finds that new technologies and methods are constantly added to the work of preventive protection. Secondly, the possibility of Mixed Reality technology intervention in preventive protection is discussed, and finally the application strategy of Mixed Reality technology in preventive protection is constructed.

Keywords: preventive protection; architectural heritage; Mixed Reality technology; digital technology; visual collaboration.

1. Definition of preventive protection

The basic definition of preventive protection can be developed around two key words, namely "preventive" and "planned". The concept of preventive protection has appeared frequently in the international policy and EU-funded research projects since the mid-1990s, gradually forming its own methodology. Explore the two development paths around these two key words:

The first one is the theoretical exploration path. From "preventive (Italian Preventiva)" to "planning (Italian Programmata)" to "planning (English) Planned"

The second is the practice path of "Preventive", which is constantly developed and updated in practice.

In 2009, a report at the Cuomo Conference in Italy used "planned preventive protection (Planned Preventive Conservation, PPC)". In 2016, the International Conference on Structural Analysis of Historical Building Structures (SAHC), held in Leuven, Belgium, also took PPC as one of the sub-topics, and more accurately defined the protection framework under the preventive thinking. Since then, the "planned preventive protection (PPC)" has fully covered the core of preventive thinking.

2. Development of the theoretical system of preventive protection

2.1 Lay the foundation of modern theory (before 1960s)

European scholars of preventive protection in architecture trace the origin of the ideas in this field: Ruskin's masterpiece The Seven Lamps of Architecture (1849) proposed: proper care of historic sites, They will not need to be repaired; William Morris (1834-1896) pointed out in the book The Manifesto of the Society for the Protection of Ancient Buildings: stave off decay by daily care; to put Protection in the place of Restoration; Camillo Boto: Not only based on knowledge of past art and history, But also based on an understanding of the most advanced technology and scientific practice; Gustavo Giovannoni: "scientific restoration" and emphasizes the importance of routine maintenance; afterwards, Chesare Brandi proposed "preventive restoration" in his "Theory of Restoration". In 1964, the Venice Charter was formulated, which clarified the concept of "authenticity" of architectural heritage and clarified that "continuous maintenance is the key to the protection of cultural relics and historic sites", providing a theoretical basis and guiding guidelines.
2.2 The beginning of modern practice exploration——Monitoring and planned protection of cultural relics and historic sites (1970s)

Dutch architect Waltclemer founded the Monumentenwacht (MOWA) organization, which emphasizes the importance of regular and systematic inspection in heritage protection, specializing in regular inspection, maintenance and necessary minor repairs. This is the first attempt in Europe to use architectural heritage maintenance as a professional work and to be undertaken by specialized agencies and professionals.

Weng district cultural heritage planning protection pilot project, from the regional level analysis of cultural heritage of all kinds of risks (geological, earthquake, meteorological disasters, air pollution, population reduction, etc.), assess the cultural heritage status damage of various factors, forward-looking planning system maintenance plan, monitoring scheme and other countermeasures. This is one of the first attempts to discuss the conservation of architectural heritage and its environment and area as a whole. At the same time, the 1977 Machu Picchu Charter proposed that not only historical buildings need to be protected, but also well-designed modern buildings should be included in the protection and development of the block. To protect the buildings, we need to protect the city style and the city culture first.

2.3 Redefinition of protection and inclusion of new technical methods (after 1980-Present)

With the theory of air pollution, environmental degradation, limited earth resources and the destruction caused by various sudden disasters, the academic circle began to reflect on the redefinition of preventive protection of architectural heritage and discuss the different methods of preventive protection of architectural heritage.

In 1982, then the director of the ICCROM British architect Bernard felden (Bernard M.Feilden) published book "historical building protection", points out that according to the physical conditions of historical buildings, damage reason and expected future environment, determine the different scale, different degree of intervention, the protection project is divided into seven different degrees of intervention, namely "prevent damage, preservation, structure reinforcement, repair, (function) update, reconstruction and reconstruction", clear "prevent damage" including environmental control and preventive maintenance based on regular inspection. In the 1970-1980s, when the earthquakes occurred around the world, the architectural heritage protection community began to think about how to deal with natural disasters such as earthquakes.

The 1987 Washington Charter document innovatively identified the important role of residents in the protection of historic districts. It believed that the users of historic districts were local residents, who played an important role in the daily maintenance of historic districts. The document formulated a series of relevant protection principles. The local residents are encouraged to become the main body of the implementation of the protection policies, and the people are encouraged to
actively participate in the practice. In 1994, Nara Authenticity Document pointed out that in the process of building protection, different cultures should be fully respected, and the protection should be implemented for different regions, different nationalities, different countries and so on, which can not be generalized. Preventive protection of architectural heritage has been raised to new heights.

At the same time, with the continuous progress of computer information technology and modern measurement technology and entering the field of architectural heritage, the risk analysis, assessment and prevention at the regional level as well as the analysis and diagnosis of damage at the ontology structure / material level can be carried out. For instance:

- Analysis, evaluate and monitor the environmental risk factors faced by architectural heritage from the regional level based on GIS technology;
- Developed a continuous monitoring WETCORR system for temperature and humidity on the surface of wood structure and internal microenvironment;
- Research on the continuous monitoring and damage diagnosis of the building heritage body and the development of the corresponding software systems and technical tools;
- Technical support in the fields of materials science and structural mechanics, measurement and monitoring technology.

## 3. Mixed Reality

### 3.1 Definition of the Mixed Reality

Mixed Reality (MR) was proposed by Milgram et al. in article "A taxonomy of mixed reality visual displays" in 1994, which introduced the concept of "real — virtual continuum". The emergence of hybrid reality technology came into research and application after the release of Microsoft's hybrid reality device Hololens in 2015. MR is a combination of technologies, which not only provides a new input mode, but also provides a new virtual image display method to build a new innovative way and development direction. By highly integrating virtual images in the real world, the technology ensures the spatial consistency of real scenes and virtual scenes, so as to enhance the authenticity of user experience.

![Figure 1: Definition of the Mixed Reality](source: Self-drawn)

### 3.2 The characteristics of the Mixed Reality

1. Interaction of real-time feedback
   MR technology through its sensing device and sensing technology, to achieve efficient behavior interaction, and real-time acquisition of visual picture, audio and vibration feedback information. Compared with the VR interaction mode that is completely separated from the real environment, the interaction characteristics of MR are more in line with human cognitive and behavioral logic.

2. Full understanding of human behavior and the environment
MR technology identifies and judges the real position of users in the real space through environmental input, and converts its movement in the objective world into the movement in the virtual world, so it has a full cognition of human behavior.

(3) The immersion sense of virtual and real fusion
That is, the real environment and the virtual objects are displayed in the same visual space, and the virtual scene and the real scene are perfectly integrated, so that users can realize that the virtual image is a part of the objective world.

3.3 The necessity and feasibility analysis of preventive protection for introducing MR

3.3.1 Necessity analysis
(1) Protection, interpretation and display needs of architectural heritage sites
Traditional protection methods often hide the historical and cultural information such as cultural relics, ancient books and other images behind the entity of architectural sites in museums, making them away from the space of the original, which also leads to the separation of the overall concept.

MR technology can according to the data such as literature, present damaged or no architectural details, through a combination of visual, hearing, touch, multi-sensory perception interactive display, simulate the surrounding historical environment and human activity scene, in a cover of human material and non-material level, to obtain, understand and use the sages for culture contribution of truth and wisdom.

(2) The needs of sustainable economic development in the heritage areas
In the rapid development of contemporary social environment, the use of augmented reality, artificial intelligence, virtual reality, database and multimedia, high precision, high realistic modern information technology, the reasonable development and utilization of heritage area resources, it contains the historical and cultural resources combined with commercial operation, is to promote heritage regional culture and economic sustainable development of an effective way.

Combining architectural-related features and historical and cultural content, providing visitors with the experience of "body perception perception and interaction in the space", so that they can acquire unique aesthetic experience and cultural cognition in the space.

(3) The needs of the historical and cultural inheritance and dissemination contained in the architectural heritage
Domestic cultural relic protection and technology companies tend to focus on reflecting the advantages of technology when doing digital exploration, and still lack relevant development and display in the historical and cultural content of architecture.
MR technology can travel through the limitation of time, comb the complex architectural data according to a certain main context, overlay the virtual architectural form on the real scene, and change according to the change of the building in time.

3.3.2 Feasibility analysis
(1) The increasing attention to the computer treatment
Digital, information and more computer technologies are increasingly applied to the protection of architectural heritage.
(2) Support given by modern digital technology
3D data acquisition technology, building database, 3D digital modeling technology, 3D animation and motion Capture technology.

4. Mixed Reality technology in preventive protection
4.1 Analyze the shortcomings of the current architectural heritage protection
(1) The performance of the core value connotation of architectural heritage is not strong enough, and the integration, interpretation and display of architectural information resources are lacking, mainly with static display and single display.

From the protection of the architectural heritage can be found, its exquisite architectural structure, material, history, culture and artistic characteristics, but in the actual scene of the information and physical building is separated, the relevant information mostly adopts the text, pictures, model or image data record way to save and display.

In the form of pictures and models, the sizes, colors and materials of the components are described, which can not completely summarize the building information, and the display content is one-sided, and the lack of relevant explanation, which is not conducive to the actual cognition of users.

And through the way of image records and display, although can be more intuitive performance of the development of construction, historical background, the content of the time line, but for all kinds of data analysis of construction lack of accurate expression, for the description of the building details still lack, it also led to the actual situation in the inconvenience.

Users lack interactivity in the actual visit of the architectural heritage, and lack of three-dimensional information perception of the architectural space.

At present, the content for user interaction with buildings is limited to the design of interactive screens, due to the actual situation.

The lack of relevant research tools makes it relatively difficult for users to understand the structural details and historical context of the building, and gradually lose interest in the operation process without autonomy.

(2) In the heritage space, the historical and cultural content and expression modes are still very thin, the expression methods are relatively traditional, and lack the intervention of modern scientific and technological means.

One of the historical and cultural content and art form of distinctive features is manifested as non-material, the current interpretation of the content mainly by video, pictures, related text description way, its integrated into the effect of the actual situation is limited, and the lack of integrity and interactivity, it is difficult to achieve effective to the display and interpretation of the corresponding cultural connotation.

4.2 Deal with the current situation and the use prospect of Mixed Reality technology
(1) Knowledge of architectural heritage-related knowledge
It includes the historical background, region, characteristics, feng shui view and culture of the building, and analyzes the social, economic and political environment at that time.
(2) Retrieval, editing and use of architectural heritage information
Architectural heritage contains tens of thousands of components information, and the combination between components is also extremely complex. In the research work on architectural heritage, it is necessary to view and extract the digital parameters and data of various building structures in real time. It includes discrete geometric information such as the size of the building components, the surface, texture and material of the wooden structure, as well as attribute information such as pictures, text, video and audio.

(3) Experience the traditional design process and the use of craftsmen as tools
Users use digital craftsmen as tools to disassemble and restore the building components, and simulate the production of the components, so as to understand the basic principles, processes, techniques of architectural heritage construction, as well as the use of materials and tools.

(4) Architectural space experience
Users need to feel the craftsmanship level of the architectural heritage and the artistic style of the space.

(5) Building restoration work
Architectural heritage has gone through different periods of architectural activities, and has a process of evolution and repair. The construction and reconstruction of architectural heritage in various historical periods need further display and analysis; At the same time, the detection data is displayed in the building space in real time, which is helpful for researchers to detect, manage and record, so as to grasp the state of the hall effectively. This helps in its daily maintenance, repair and reinforcement of the building management and repair work, and provides the necessary reference information for subsequent research, research and protection.

(6) Cultural perception and experience
Users need to experience the historical legends and stories related to the architectural heritage, and can have a strong sense of participation and immersion.

(7) Visualization and collaboration
At the building site and between off-site researchers, it is necessary to describe each other's problems and ideas through camera recording and 3 D visualization to facilitate efficient communication and work.

4.3 Build the working path of Mixed Reality technology in preventive protection
Combined with the shortage of building heritage protection and Mixed Reality technology in the prospect of preventive protection, build its implementation in the preventive protection path, mainly divided into five large units: building heritage information collection, building information classification, information digital processing, MR building information model building, MR information system design and late combined with hardware equipment, as shown in the figure below:
Figure 3 Mixed Reality The working path of the technology in the preventive protection
Source: Self-drawn

5. Summary

From the development path of preventive protection, the analysis of new technology to join the possibility of preventive protection work, Mixed Reality technology can be digital information and the specific objects in the building space to form the relationship between mutual mapping, thus the virtual object accurately placed in the real scene, presented to the user the real-time real fusion picture effect.

Reference