

Exploring Augmented Reality Integration for Enhancing Heritage Museum Exhibits: A Focus on Innovative Display Design

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Abstract

As custodians of human civilization, heritage museums embody irreplaceable cultural treasures, inherently constrained by the imperative of preservation and the fixed attributes of their exhibits, which often limit their restoration efforts and aesthetic appeal. Nevertheless, the advent of augmented reality technology injects a newfound vitality into the realm of heritage museums. This paper seeks to harness the potential of augmented reality technology to propose innovative approaches to the exhibition design of heritage museums, aiming to elevate the visitor experience by offering diverse and enriched ways of accessing information. Through a user-centric lens, this research explores the myriad possibilities that augmented reality technology introduces to museum display design, particularly in reimagining spatial arrangements. By seamlessly integrating various forms (3D, 2D, audio, text) and content types (history, art), the paper envisions fostering interactive engagements between visitors and artifacts. The overarching goal is to augment the ornamental value of cultural relics, transcending traditional constraints and providing a versatile array of possibilities for the presentation of cultural heritage.

Keywords: Museum Exhibition, Augmented Reality, Design for Cultural Heritage, Display Design

Introduction

With a history spanning 5,000 years, China is home to a rich cultural heritage. According to statistics, the national cultural relics system houses an impressive collection of 1,660,377 pieces (or sets) of precious cultural relics (Boboc et al., 2022). These cultural relics, including artifacts, heritage sites, and historical information, represent the essence of Chinese civilization. They are not only national treasures but also shared assets of humanity. The

protection and transmission of these cultural relics has become a major global issue. Site museums, which are essential institutions for protecting and displaying these cultural heritage items, bear an irreplaceable responsibility. They not only showcase China's historical and cultural significance but also possess substantial artistic, cultural, and scientific educational values (Atallarick et al., 2021; Chatzigrigoriou et al., 2021; Trunfio et al., 2020).

However, current site museums face several significant challenges, such as low visitor engagement, monotonous exhibitions, and inadequate cultural knowledge absorption (Yoon, Elinich et al., 2012). The root cause lies in the limitations of the museums themselves and a lack of understanding among designers regarding the specific nature of heritage museums. This results in a disordered relationship between heritage protection and exhibition within the spatial environment, which hinders effective preservation of cultural relics and the overall development of the museum (Boboc et al., 2022; Bachiller et al., 2023). Thus, addressing these challenges and enhancing the functionality and appeal of site museums has become a critical task.

Augmented reality (AR), as an innovative multimedia technology (Challeno et al., 2019), offers new opportunities for site museums. AR seamlessly integrates virtual information with the real environment, greatly enhancing the exhibition experience by improving interaction and engagement. Specifically, AR can recreate the original appearance of damaged artifacts or supplement missing relics, increasing visitor immersion and depth of understanding, thereby enhancing the aesthetic value and educational function of the museum (Okanovic et al., 2022). Furthermore, AR technology allows cultural relics to be stored as metadata, enabling more dynamic and informative presentations (Elinich et al., 2012). These innovations provide museums with multidimensional display methods, enhancing their cultural dissemination effectiveness.

This study aims to explore how AR technology can effectively address the challenges faced by site museums, optimize the exhibition experience, and advance the dual goals of heritage preservation and museum development. By analyzing the application of AR in site museums, this paper will not only provide a new perspective for the academic community but also offer practical solutions for museum design and development. Ultimately, the research seeks to contribute new ideas to the global cultural heritage protection field and provide theoretical and practical guidance for the development of museums (Zou et al., 2021; Vlahakis et al., 2001; Tingshan et al., 2022; Vlahakis et al., 2001).

Ar in cultural heritage settings

Augmented Reality (AR) technology involves obtaining virtual images by tracking the image itself through a camera and overlaying them onto the real-time environment. This technology enhances the perception of the real world by incorporating visual, auditory, and interactive elements, offering characteristics such as visualization, realistic information, immersive experiences, and a natural interface (Challenor et al. 2019).

The integration of AR in cultural heritage (CH) settings has been facilitated by the widespread use of smartphones and tablets, opening avenues for innovative museum experiences. Many museums employ AR as a guide (Challenor et al. 2019), where scanning existing cultural relics generates video perspectives or dynamic images. For instance, the Museu Nacional d'Art de

Catalunya uses AR to "resurrect" dinosaurs, allowing visitors to interact intimately with them through mobile phones. The virtual dinosaurs can react to proximity(Chatzigrigoriou et al. 2021), growing larger and emitting sounds when approached. Some museums utilize storytelling to convey project details and cultural history(Zou et al.2021), establishing narrative structures that guide visitors through the significance of cultural relics.

In the British Museum's three-star digital discovery centre, an interactive adventure game called "A Gift to Athena" has been introduced (Boboc et al., 2022). Visitors can scan specific cultural relics using mobile devices, triggering the generation of diverse texts, images, and props associated with each relic. This information, collected through scanning, gradually unveils a storyline. Through interactive elements, visitors engage in a gaming experience while simultaneously learning about the cultural significance of the artifacts(Spadoni et al., 2022; Challenor et al., 2019).

The combination of AR and cultural heritage not only expands museum exhibition methods but also transforms the role of designers from mere attraction and entertainment to providing context-related information, thereby enhancing the overall visitor experience(Boboc et al., 2022; Bachiller et al., 2023).

An Overview of the Site Museum

A Brief Introduction to the Site

According to the "Convention Concerning the Protection of the World Cultural and Natural Heritage," the classification of "cultural heritage" and "natural heritage" is outlined in Article 1. The Convention defines "cultural heritage" as monuments, including architectural works, monumental sculptures and paintings, elements or structures of archaeological significance(Spadoni et al.2022;Challenor et al.2019), inscriptions, cave dwellings(Zou et al. 2021), and combinations of features that possess outstanding universal value in terms of history, art, or science. It also includes groups of buildings, whether separate or connected, that, due to their architecture, homogeneity, or location in the landscape, are deemed to have outstanding universal value from the perspectives of history, art, or science. Additionally, sites, encompassing works of human origin or combined works of nature and humanity, as well as areas containing archaeological sites, are considered cultural heritage when they demonstrate outstanding universal value in terms of historical, aesthetic(Challenor et al.2019), ethnological, or anthropological significance.

On the other hand, "natural heritage" under the Convention comprises natural features encompassing physical and biological formations or groups of such formations, which exhibit outstanding universal value from an aesthetic or scientific standpoint(Trunfi et al.2020). This category also includes geological and physiographical formations, along with precisely delineated areas constituting habitats for threatened species of animals and plants, demonstrating outstanding universal value in the context of science or conservation. Furthermore, natural sites or precisely delineated natural areas are considered natural heritage when they exhibit outstanding universal value from the perspectives of science, conservation, or natural beauty (Challenor et al., 2019).

The existence of a site museum is premised on the presence of heritage, which constitutes the core content of such museums (Trunfi et al., 2020). The term "site" embodies distinct

characteristics, including human participation, immobility, universal value, and historical and regional significance. It is important to note that the focus of this paper pertains specifically to site museums falling within the category of "cultural heritage," and the research scope excludes consideration of "natural heritage."

In essence, the site museum, as discussed in this paper, centers around cultural heritage, encompassing monuments, groups of buildings, and sites with outstanding universal value from historical, artistic, or scientific perspectives (Trunfio et al., 2020; Challenor et al., 2019; Spadoni et al., 2022). The exclusion of natural heritage from the research scope emphasizes a deliberate focus on the human-created and historically significant aspects embedded in cultural heritage sites.

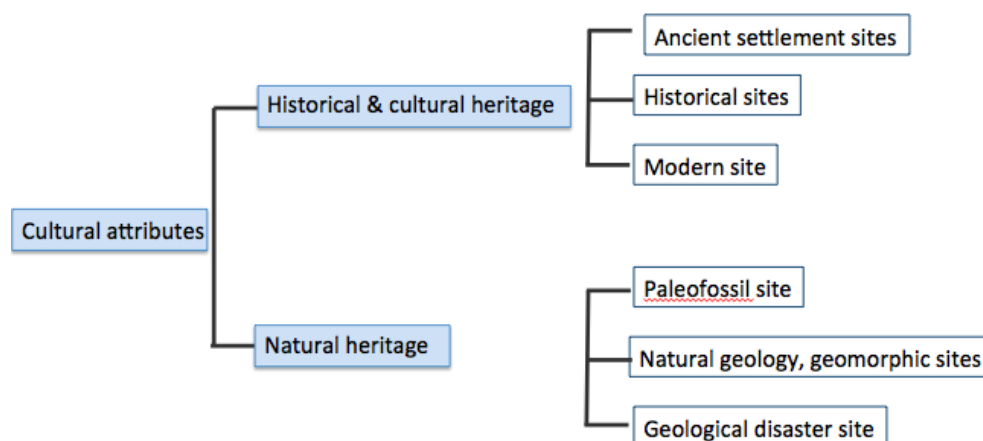


Figure 1 : The difference between "cultural heritage" and "natural heritage"

Classification and Functional Streamlining of Site Museums

The functional composition of the site museum parallels that of other museum types. However, the immobility inherent in site museums dictates that the site serves both as a display area and a collection area (Zou et al. 2021), seamlessly integrating the exhibition of cultural relics with their preservation. Consequently, graphic design assumes a decisive role in the site museum. Given that the site itself undergoes ongoing excavation and development, its location at the intersection of external and internal areas emphasizes the exhibition status of the site. Additionally, owing to technical or other constraints, many sites remain incompletely developed. Consequently, site museums often establish independent archaeological research centers, with some being affiliated with existing museums (Trunfio et al., 2020; Challenor et al., 2019; Spadoni et al., 2022).

Site museums typically fulfill five primary functions: (1) public service area, (2) display area, (3) collection area, (4) academic research area, and (5) administrative office area, as illustrated in Figure 2. These functional areas may intersect with one another. The architectural design dataset for museum functional streamlining indicates that museum usage generally involves visitors, professional visitors, researchers, technicians, curators, staff, and service personnel. Three main applicable groups are defined: general visitors, professional visitors, and internal personnel, as depicted in Figure 2. The streamline itself is simpler than that of non-relic museums due to the relatively uniform display content of relic museums.

When designing the traffic flow of site museums, careful consideration should be given to the relationship between the site and the museum. Analyzing and understanding the size, type, and characteristics of the site's planning, as well as the geographical context surrounding the site, is essential for graphic design, internal and external streamline design, and functional block planning, as illustrated in Figure 3.

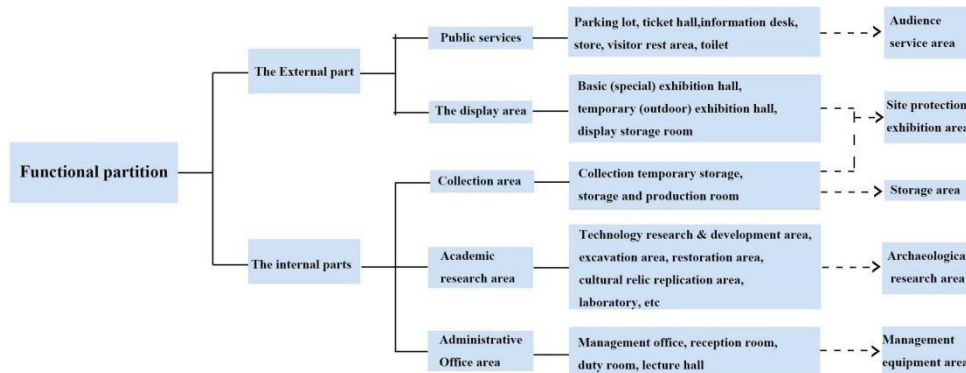


Figure 2 : Functional Division of site Museum

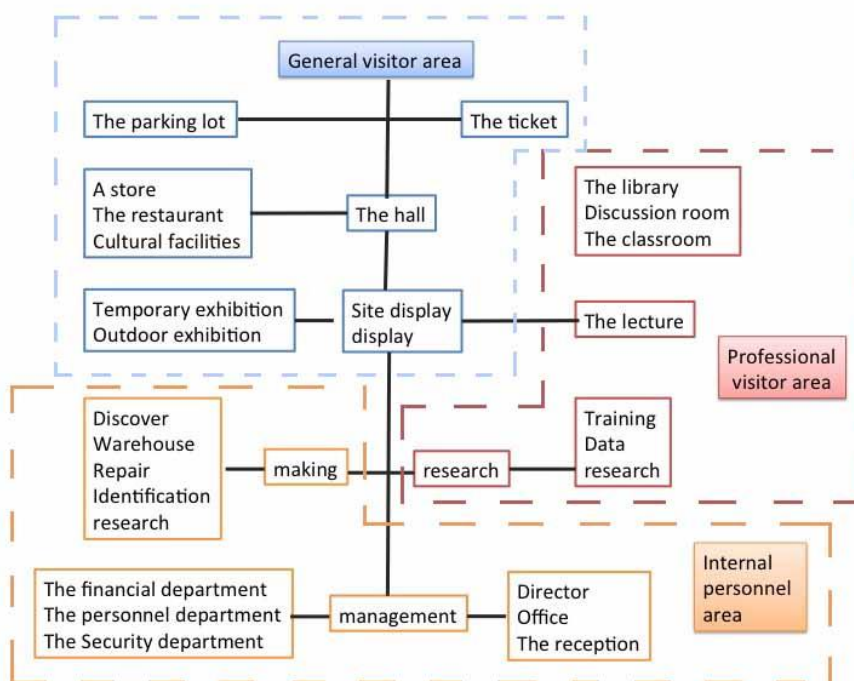


Figure3 : The functional streamline of site Museum

Augmented Reality and Museum Display Design Principles

Firstly, interactive exhibitions should prioritize interaction, immersive experiences, and the restoration of the site's original appearance. Augmented reality (AR) stands out from other display methods by enabling exhibits to interact with visitors, and the virtual display effects to engage visitors dynamically (Zou et al.2021). This interaction entails visitors obtaining information vividly through AR technology, with unrestricted access, and interactive content being updatable in real time. Various forms of interactive exhibitions include touch screens, virtual e-books, and touch all-in-one machines (Spadoni et al.2022; Challenor et al.2019).

Interactive content encompasses details such as the name, historical background, and relevant data of displayed cultural relics. Additionally, AR can establish archaeological sites, assist in creating electronic exhibition spaces, and simulate cultural relic restoration. Interaction methods include automatic pop-ups, scanning, app assistance, or visitors' operations through virtual interfaces. The integration of these interactive technologies enhances the museum experience, transforming passive acceptance into active participation. Secondly, designers should emphasize the combination of static and dynamic displays to enhance visual impact. Traditional museum exhibition methods often revolve around static displays centered on exhibits (Yoon et al. 2017; Jung et al. 2021). However, merely considering how to display cultural relics in a limited space environment overlooks the purpose of visitors' visits and their post-visit feelings, falling short for a successful exhibition space. Static displays can lead to a replication of traditional elements and cultural symbols, inducing boredom and fatigue among visitors over time (Zou et al., 2021; Vlahakis et al., 2001; Tingshan et al., 2022; Vlahakis et al. 2001).

In contrast, augmented reality can present information interactively and dynamically, guiding people to cultural relic exhibition halls, sparking interest, or creating specific atmospheres tied to cultural relic backgrounds (Trunfio et al. 2020). The fusion of museum design and augmented reality technology adeptly addresses the aspect of "audience harvest," dynamically displaying the humanistic spirit behind the cultural relics. This approach allows visitors of different ages to find resonant elements. In terms of details, this technology enables visitors to study materials, crafts, and interpret cultural relics within context (Atallarick et al., 2021; Chatzigrigoriou et al., 2021; Trunfio et al., 2020).

Augmented Reality and Design Method of Site Museum

Augmented Reality and Cultural Relics Protection

The protection of cultural relics involves two primary aspects: protection and restoration. Cultural relics, being non-renewable cultural resources, are susceptible to destruction. Many culturally significant artifacts, particularly those severely damaged or buried underground, may lack high ornamental value (Damala et al. 2007). In some cases, sites are intentionally left unexcavated or unreconstructed for conservation purposes. Augmented reality technology proves instrumental in combining with cultural heritage, offering a non-invasive means to restore relics and establish a comprehensive database for precise and interactive display to visitors (Tscheu et al. 2016).

The integration of augmented reality and cultural relic protection manifests in two principal ways:

(1) Restoration

Augmented reality aids in restoring damaged cultural relics or sites to their original appearance through multimedia technology (Newcombe, R.A et al. 2011). This method is particularly effective for large cultural relics, such as archaeological sites, providing a strong sense of substitution that traditional display methods cannot achieve (Teichrieb et al., 2007; Albers et al. 2023; Trunfio et al., 2020).

In instances where the restoration of highly precious or costly artifacts is challenging through traditional means, augmented reality technology becomes invaluable (Trunfio et al., 2020). For instance, Professor Zhou Mingquan in Beijing, overseeing the project "Research and

Application of Digitization and Conservation of Cultural Heritage," utilized virtual reality and augmented reality, along with image processing techniques, to virtually restore part of the terracotta warriors and horse relics (Figure 4).

Augmented reality and cultural relic protection not only preserve the integrity of artifacts but also offer visitors a high-precision(Ho, A.G et al.2012), interactive display experience. Utilizing mobile devices, users can observe cultural relics in 360 degrees and gain a comprehensive understanding of the historical background through videos and pictures(Ho et al., 2012; Khan, et al., 2014; Trunfio et al., 2020; Khan M et al., 2014).



Figure 4 : Terracotta Army

(2) Reproduction

Augmented reality proves invaluable for objects that are not physically present or are situated in foreign countries. Traditional display methods often rely on photos, videos, and models to showcase such objects, but augmented reality enables a complete virtual reproduction(Teichrieb et al.2007).

For instance, a Boston startup has been dedicated to enhancing visitor engagement in museums(Zhou, F et al.2008). CEO Brendan Ciecko and his partner utilized AR Kit to recreate stolen collections from Boston's renowned Isabella Stewart Gardner Museum. On the 28th anniversary of the museum theft, they "returned" the stolen paintings through AR, establishing an AR website application to creatively address the heist.

This use of augmented reality not only provides a virtual reproduction of objects that may be challenging to exhibit physically but also engages visitors in a unique and immersive manner(Teichrieb et al.2007; Albers et al.2023; Trunfio et al., 2020). The example from the Isabella Stewart Gardner Museum highlights how AR can be employed creatively to showcase and contextualize cultural artifacts in a way that goes beyond traditional display methods.

Augmented Reality and Immoveable Cultural Relics

Immoveable cultural relics, predominantly found in heritage museums, often include ancient buildings and extensive ruins. Augmented reality (AR) technology proves instrumental in complementing existing relics by restoring and reproducing the original appearance of buildings (Tscheu, F et al. 2016). This application becomes particularly valuable for structures with damaged or inconsistent sculptures and murals. Notably, sites that pose challenges for physical reconstruction, such as underwater or mountainous locations with complex terrain, can be effectively restored using AR technology (Teichrieb et al., 2007; Albers et al., 2023; Trunfio M et al., 2020).

Due to the substantial scale of large sites, complete reproduction within a site museum may be unfeasible. Many large sites are challenging to protect and excavate fully, making it impossible to unveil their entire panorama. State regulations (Teichrieb et al., 2007; Albers et al., 2023), under the State Administration of Cultural Heritage, prioritize protection over development for large sites. Avoiding unnecessary excavation and addressing academic questions through small-scale digs are emphasized (Spadoni et al. 2022). This limitation creates an opportunity for augmented reality. In comparison to traditional models, AR technology can more directly showcase the overall appearance and grandeur of large sites, such as the Beijing-Hangzhou Grand Canal in China. Augmented reality enables an immersive tour that, in reality, would be logistically challenging and financially unrealistic.

For instance, ARCHEOGUIDE, supported by EUIS and involving various European organizations, presents a solution for restoring historic buildings (Ho et al., 2012; Teichrieb, et al., 2007). Utilizing computer servers, wireless networks, and personal data assistant clients, ARCHEOGUIDE allows the restoration of structures like the Temple of Hera through AR technology. Whether presented in historical reality or 3D virtual reality, the goal is to capture the allure of cultural relics and sites, allowing the scene to serve as an exhibition backdrop.

Augmented reality and intangible cultural heritage

Intangible cultural heritage, encompassing the richness of human traditions like language, drama, music, dance, religion, myths, habits, customs, festivals, and handicrafts, represents an invaluable part of our shared heritage. Preserving and promoting these intangible elements present unique challenges as they require thoughtful and innovative approaches. Augmented reality (AR) technology emerges as a transformative force in this context.

In the realm of intangible cultural heritage preservation, the use of media, and particularly augmented reality (Albers et al., 2023; Vlahakis et al. 2001), offers a revolutionary solution. AR technology provides the means to create comprehensive meta-databases capable of storing and representing the intricate nuances of non-material cultures. By integrating various media formats, augmented reality allows for the faithful reproduction of diverse intangible cultural elements (Teichrieb et al., 2007; Zhou et al., 2008; Albers et al., 2023). Visitors can now experience the vibrancy and authenticity of these traditions through electronic devices, fostering a deeper connection and understanding.

One of the notable advantages of augmented reality in this context is its ability to transcend geographical and temporal limitations. Many intangible cultural heritage practices face restrictions due to their geographical and temporal contexts (Newcombe et al. 2011). AR

technology liberates these cultural expressions, enabling them to be presented and experienced beyond the confines of their original settings (Spadoni et al., 2022; Challenor et al., 2019). Whether it's a traditional dance, a religious ritual, or a linguistic tradition, augmented reality allows for modern expressions that can be accessed anytime and anywhere. Augmented reality achieves this by seamlessly combining existing physical sites with virtual reconstructions (Ho et al., 2012; Teichrieb et al., 2007). This fusion creates a dynamic platform where visitors can explore and interact with intangible cultural heritage in ways previously unimaginable. The technology not only breaks down barriers to access but also contributes to the ongoing safeguarding and promotion of these cultural treasures (Damala et al., 2007; Khan, et al., 2014; Newcombe et al., 2011; Zhou et al., 2008). As we navigate the intersection of technology and culture, augmented reality stands as a bridge between the tangible and intangible, fostering a renewed appreciation for the diversity and richness of our shared human heritage.

Design Case Analysis: Terracotta Army Museum

Terracotta Army Museum

The Terracotta Army Museum is situated in Xi'an, Shanxi Province, and stands as a colossal pit in the burial site of Qin Shihuang Ying Zheng, the first feudal emperor of China. The cemetery spans an extensive area of 2.18 million square meters. The museum, constructed on the original site, is centered around the iconic terracotta army, making it the largest ancient military museum in China.

The Terracotta Army Museum follows the covering mode museum design. Illustrated in Figure 5, this model involves building on-site, covering either the entire or a portion of the archaeological site (Zhou, F et al. 2008). This approach integrates the site seamlessly into the architectural space, providing a protective effect. The museum encompasses three terracotta army pits (Yang Lu, Huang Jianhua, et al., 2019). Pit No. 1, the largest rectangular pit, serves as the main force featuring combat vehicles and infantry. Covering a total area of 14,260 square meters, it houses approximately 6,000 life-sized terracotta warriors. Adjacent to Pit No. 1, Pit No. 2, covering 6,000 square meters, is considered the essence of the terracotta army, comprising four well-organized units in a mixed formation of chariots, cavalry, and crossbowmen. Pit No. 3, located northwest of Pit No. 2, serves as the command system of the army, occupying an area of 524 square meters (Figure 6).



Figure 5 : The covering mode museum

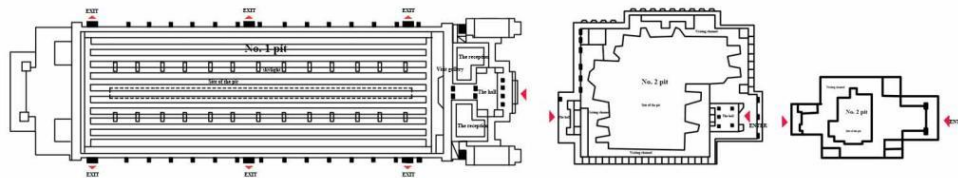


Figure 6 : Plan figure of pit NO.1 pit NO.2 and pit NO.3

Augmented Reality and Cultural Relics Conservation – "Terracotta Army Restoration Hospital"

Due to various factors such as time, air, environment, and temperature affecting the terracotta warriors and horses, issues like aging paint layers, hollowing, warping, and peeling of colored paintings emerge upon their excavation (Spadoni et al. 2022; Challenor et al. 2019). These problems contribute to the gradual fading of the vibrant colors originally adorning the terracotta warriors and horses, as depicted in Figure 10. Faced with these challenges, the "Terracotta Army Restoration Hospital" employs augmented reality (AR) technology to restore culturally significant artifacts that have suffered severe damage.

By focusing on cultural relics that have experienced serious deterioration and are no longer visually accessible, the restoration process utilizes augmented reality (Damala, A et al. 2007). Visitors can participate in this experience by scanning QR codes and accessing the program on their mobile phones or tablets. They can select specific terracotta warriors and weapons of interest, then click "CONFIRM" to view the artifacts restored in three dimensions through AR technology (Challenor et al., 2019; Spadoni et al. 2022).

Augmented reality enhances the visitor's engagement by allowing them to manipulate the size of the cultural relics through relevant gestures (Tingshan et al. 2022). Moreover, detailed text information about the relics is provided, and visitors have the option to listen to explanations, as illustrated in Figure 7. This innovative approach not only addresses the challenges of physical conservation but also offers an immersive and educational experience, bringing the restored artifacts to life through the integration of cutting-edge technology and cultural heritage.



Figure 7 : "Terracotta army restoration hospital"

When the terracotta warriors and horses were excavated, they were all fragments and not complete terracotta figures. Numerous cracks and fractures were present within the terracotta warriors and horses, necessitating a thorough scientific examination and analysis, followed by professional team efforts to meticulously splice them together. Due to the intricate nature of this process, its complexity makes it challenging to demonstrate. However, leveraging Augmented Reality (AR) technology, visitors can now engage in the fascinating process of splicing their own terracotta warriors using their mobile phones.

During this interactive experience, visitors gain insights into the scientific analysis and assembly of terracotta warriors. By selecting tools and referring to visual aids, visitors actively participate in the step-by-step process, progressing from handling unearthed fragments to successfully assembling a complete terracotta warrior. This immersive encounter not only enhances visitors' understanding of the intricate production of these historical artifacts but also provides a hands-on and educational opportunity, as illustrated in Figure 8.

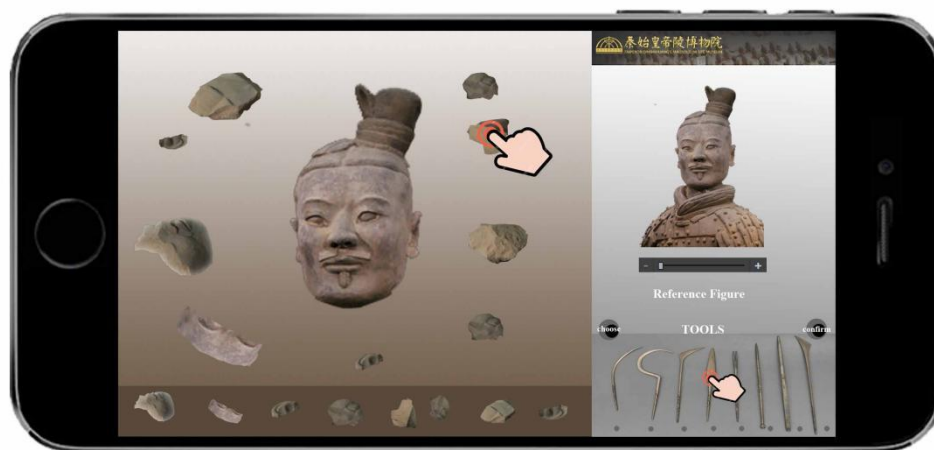


Figure 8 : “Terracotta army restoration hospital”

In the current display space, the terracotta warriors appear colorless, fostering the misconception that these ancient figures might be "grey-headed." However, the reality is quite the opposite—the terracotta warriors themselves are inherently vibrant and colorful. Mining technology limitations during the excavation in the 1970s contributed to the oxidation of natural pigments (minerals) used by craftsmen over 2000 years ago, resulting in the grey appearance of the terracotta warriors we see today. Despite this, historical research indicates that the original terracotta warriors were adorned with a rich array of colors, including green, red, jujube purple, blue, and more (Jianhua, et al., 2019).

The challenge lies in conveying these vivid colors to visitors without physically altering the cultural relics. Traditional methods like painting the terracotta warriors directly are impractical. Augmented Reality (AR) technology, however, offers an effective solution. By implementing AR technology, we can showcase the true colors of the terracotta warriors to visitors. A QR code is incorporated into the existing display setup, allowing visitors to scan and observe the vibrant hues of the terra-cotta warriors, as depicted in Figure 13. This approach aims to establish an electronic auxiliary display space through AR technology, enhancing the visitor's experience and providing a more accurate depiction of the terracotta warriors' characteristics (White et al., 2003).

Augmented Reality and Immoveable Cultural Relics – Pit No. 1

When exploring Pit No. 1, visitors currently follow a designated corridor to view the terracotta army. While the initial experience is undoubtedly impactful, the subsequent visit can become tiresome and monotonous. Furthermore, the vast expanse of the site prevents visitors from comprehensively appreciating the entirety of Pit No. 1, as illustrated in Figure 9. In an effort to enhance the existing display format, the author proposes the integration of an Augmented

Reality (AR) experience center at the conclusion of Pit No. 1.

By employing AR technology to revitalize Pit No. 1, visitors, armed with electronic devices, can transcend the limitations of the physical space. This augmentation not only reinvigorates the immersive experience, allowing visitors to relive the awe-inspiring scene, but it also provides a more profound understanding of the grandeur and significance of the terracotta warriors. The envisioned AR experience center, depicted in Figure 10, seeks to elevate the visitation experience and offer a more comprehensive appreciation of the cultural relics within Pit No. 1.

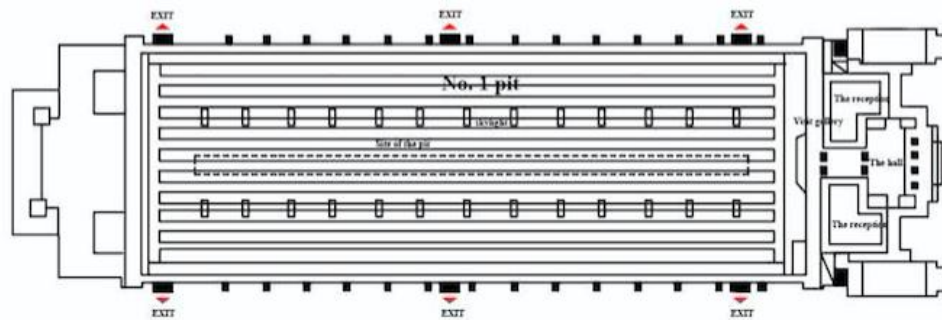


Figure 9 : Terracotta army pit NO.1

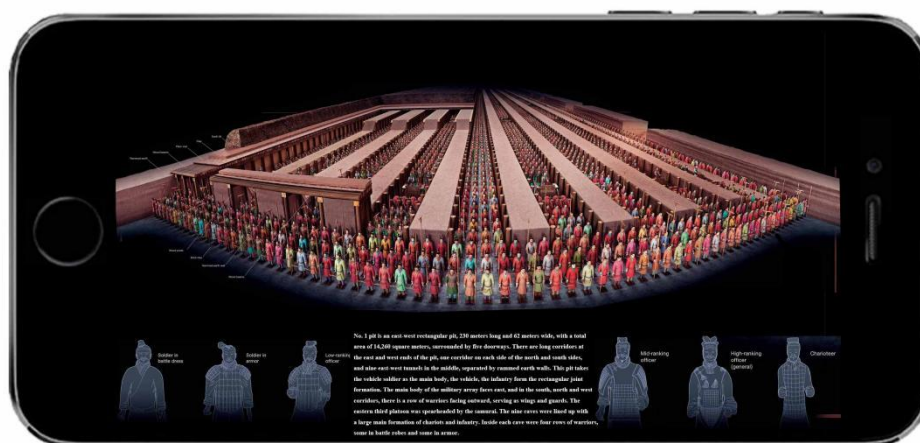


Figure 10 : Terracotta army pit NO.1

The restoration process involves the following key steps: (1) Research, which entails understanding the site through available information. (2) Field research, focusing on the site itself to ensure its authenticity, serving as the foundation for restoration efforts. (3) Form determination, requiring consistency between the site and museum style throughout the restoration process. (4) Risk elimination, involving the assessment of equipment placement to prevent damage to the site and minimize interference from the environment on electronic equipment, among other considerations (Lehn et al., 2005).

Digital modeling, necessitating accurate digital representation of the restoration content. (6) Equipment construction, ensuring construction occurs without compromising the site's environment and providing optimal viewing angles for visitors. (7) Check test, involving the calibration of equipment to guarantee effective results. (8) Feedback, actively seeking input

from visitors and making adjustments based on received feedback. (9) Maintain and update, involving the expansion and enhancement of hardware equipment, along with regular updates to align with the latest technological advancements. The comprehensive restoration process, as illustrated in Figure 16, aims to seamlessly blend modern technology with historical preservation efforts.

Augmented Reality and Intangible Cultural Heritage

The making of terracotta warriors

The intricate process of crafting terracotta warriors involves numerous steps, creating a complex and fascinating procedure. Unfortunately, experiencing the entire process in real life is impractical. Augmented Reality (AR) technology, however, provides a solution by enabling users to immerse themselves in the comprehensive journey through electronic devices. This facilitates knowledge dissemination about the craftsmanship behind the creation of terracotta warriors, serving educational purposes.

Designers can leverage AR to extend exhibition locations into specific virtual realms, establishing the entire process of making terracotta warriors through multimedia data. Visitors not only have the opportunity to observe the complete process via electronic devices but also engage in a virtual experience of crafting the terracotta warriors themselves. This interactive process involves selecting the soil, forming each body part, and assembling the head, ears, and limbs to achieve the final terracotta warrior shape. The next step involves placing the terracotta warriors into the kiln and subjecting them to temperatures of about 1000 degrees. Once out of the kiln, the five sensory organs are meticulously painted, as illustrated in Figure 11. This innovative use of AR enhances the visitor's understanding of the ancient artistry involved in creating these iconic cultural artifacts.

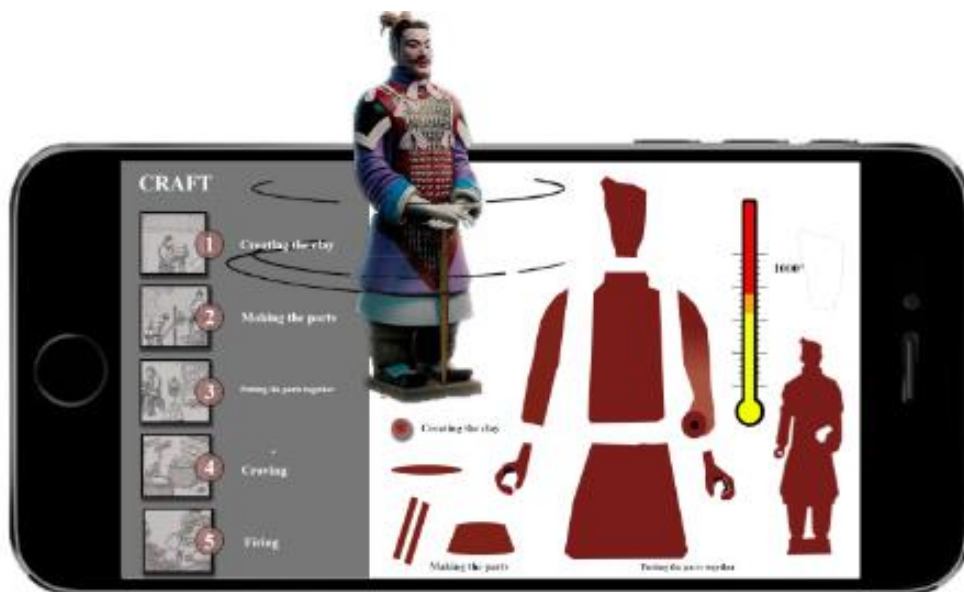


Figure 11 : The making of terracotta warriors

Bronze Chariots and Horses in Pit No. 1

Over 2000 years ago, the Qin people employed cutting-edge technologies in the creation of Bronze chariots and horses, showcasing advancements such as rust technology, wire drawing processes, welding, mosaic techniques, injection molding, casting and forging methods,

hollow casting, loose-leaf jointing, connection technologies like female and male buttons, thread and pin connections, and button link connections, among others (Junxiao, Yuanru, 2005). The Bronze chariot and horse represent the earliest, largest, and best-preserved type of carriage from that era. However, the current display limitations, enclosed behind glass, prevent visitors from physically interacting with these masterpieces and fully appreciating their extraordinary craftsmanship.

Enter augmented reality technology, which allows for a detailed analysis of the Bronze chariots and horses in a segmented manner, as depicted in Figure 12. By scanning a specific QR code with their mobile phones, visitors can explore the intricate structure of each part of the bronze carriage and horses. For those with a deeper interest, professional visitors can access Computer-Aided Design (CAD) drawings of the Bronze chariots and horses. Three-dimensional models visually represent each part of the cart, complemented by detailed textual information, providing an engaging and educational experience for visitors to deepen their understanding of these remarkable artifacts.



Figure 12 : Bronze chariots and horses

Conclusion

This design case primarily focuses on the application of AR technology in site museums, with the main objective being the protection and restoration of cultural relics and sites through the utilization of AR technology. It becomes evident that augmented reality technology can be effectively integrated into site museums to address existing challenges. By utilizing mobile phones or tablet computers as the medium, AR technology enriches the display methods of site museums, achieving the visualization of 3D digital models of cultural relics within the museum. This transformation facilitates the conversion of passive visits into active engagement, offering virtual restoration and display of cultural relics without causing any harm, making it particularly suitable for site museums. As the project progresses, ongoing user feedback will be sought to continually enhance and refine the product.

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