Research on the Application of Augmented Reality Technology in the Digital Preservation of Han Stone Portraits in the Huai River Basin

Dan Liu

School of Fine Arts and Design, Hefei Normal University, Hefei, Anhui, 230601, China

email: 28136576@qq.com

Abstract. With the continuous development of technology, Augmented Reality (AR) is gradually being applied in various fields, including the domain of cultural heritage. This article aims to explore the application of AR in the preservation of Han stone portraits in the Huai River Basin, showcasing how this emerging technology provides innovative solutions for the digital preservation and inheritance of Han stone portraits. By integrating practical case studies of Han portrait stone preservation in the Huai River Basin, this article delves into the application of AR technology in areas such as digital display, virtual restoration, and public education, providing valuable insights for research and practice in the field of Han stone portraits preservation and heritage.

Keywords: Digital preservation: Augmented Reality: Han stone portraits.

1 Introduction

We are living in an era of ever-evolving digital media, where digital technologies permeate all aspects of our socio-cultural lives. Augmented Reality (AR) is a technology that seamlessly blends digital information with real-world scenarios, allowing users to perceive and interact with virtual information superimposed upon their surroundings, The field of AR application began in the 1990s[1]. Unlike Virtual Reality (VR), which aims to fully immerse users in a virtual environment, AR enhances user perception and experience by merging virtual content with the real world. In recent years, driven by the advancement and integration of digital technologies, the field of ancient cultural heritage research and exhibition is undergoing a profound transformation. Han stone portraits, as an important cultural heritage of the Huai River Basin, serve as a significant marker of the development of ancient civilizations in the region and represent an outstanding example of ancient Chinese art. Possessing unique historical, artistic, and cultural value, Han stone portraits are renowned for their vivid carvings and distinctive artistic style, playing a crucial role in studying Han society, cultural inheritance, and artistic development. In traditional Han stone portraits exhibitions, visitors primarily acquire relevant information through text, images, and videos. This passive, one-way information presentation often fails to sustain viewers'

Y. Feng et al. (eds.), *Proceedings of the 4th International Conference on Internet, Education and Information Technology (IEIT 2024)*, Atlantis Highlights in Social Sciences, Education and Humanities 26,
https://doi.org/10.2991/978-94-6463-574-4_41

interest for extended periods, leading to a prevalent "cursory glance" approach. Consequently, visitors' overall experience and understanding of Han stone portraits remain subpar.

Furthermore, traditional exhibition methods tend to favor academic and fragmented presentations of Han stone portraits-related information. This approach can result in discrepancies between information transmission and audience comprehension. Therefore, the exhibition of Han stone portraits urgently requires the integration of digital technologies to enhance its preservation and dissemination capabilities, while also elevating the visitor experience.

This paper explores the innovative application of AR technology in the field of ancient artifact preservation, focusing on its utilization in digital exhibitions, virtual restoration, and public education. It emphasizes the significance of AR in the protection of Han stone portraits heritage in the Huai River Basin. By analyzing and discussing the application of AR technology in the preservation of Han stone portraits in the Huai River Basin, this paper aims to provide valuable insights for researchers and practitioners in the field of Han stone portraits protection.

2 The Current State of Digital Display of Cultural Heritage

In recent years, Virtual Reality (VR) and Augmented Reality (AR) technologies have gained increasing traction in the realm of digital cultural heritage preservation and exhibition. Their applications span a wide spectrum, encompassing virtual museums, education, tourism, and the safeguarding of intangible cultural heritage. AR can be used to overlay digital information, such as 3D reconstructions, historical narratives, or interactive elements, onto the real-world environment. This allows visitors to interact with and learn about cultural heritage in situ[2]. VR and AR transcend physical barriers, enabling individuals worldwide to access and explore cultural artifacts, sites, and experiences. For instance, VR facilitates virtual museum visits and exhibitions, granting access to artworks and artifacts regardless of geographical location. This enhanced accessibility promotes inclusivity, reaching a broader audience and making culture and heritage more readily accessible. Traditional exhibition methods for Han stone portraits face limitations such as geographical constraints and stone deterioration. The integration of VR and AR into cultural heritage digital exhibitions offers a solution, providing a boundless and interactive exhibition format. This opens up new possibilities for Han stone portraits displays, enhancing audience engagement and overall exhibition impact.

VR and AR technologies play a crucial role in cultural heritage preservation. By creating high-fidelity 3D scans and digital replicas, immersive technologies capture the intricate details of artifacts, archaeological sites, and historical structures. These digital assets serve as archival records, preserving cultural heritage in the event of damage, loss, or decay. Immersive experiences can simulate and safeguard intangible cultural practices, languages, and traditions, aiding in their perpetuation. Both AR and VR offer significant benefits for cultural heritage education and preservation. They

can bring the past to life, deepen visitor engagement, and provide new ways to interact with and understand tangible and intangible cultural heritage[3].

VR and AR technologies deliver interactive and engaging experiences, fostering a deeper understanding and appreciation of cultural heritage. VR and AR immerse users in historical contexts, allowing virtual exploration of ancient sites and interaction with digital artifacts. This hands-on and multisensory approach enhances the learning experience, promoting a deeper connection and emotional engagement with cultural heritage.

3 The Application of Augmented Reality Technology in Virtual Restoration of Han stone portraits

Augmented Reality (AR) technology has emerged as a transformative force in the virtual restoration of Han stone portraits, seamlessly integrating computer graphics, computer vision, and virtual reality to facilitate more intuitive and efficient restoration and preservation methods. AR enhances the restoration process of cultural heritage through techniques such as 3D modeling, historical layer visualization, and virtual museums, introducing innovative approaches to cultural heritage conservation and enabling researchers and the public to engage with cultural heritage in novel ways.

3.1 Digital Documentation and Scanning

Digital documentation techniques, such as photogrammetry and laser scanning, are increasingly being used to record and preserve cultural heritage sites and artifacts[4].The digitization of AR Han stone portraits begins with the use of high-resolution scanning equipment to capture high-resolution images from various angles, providing texture and color information for the 3D models. The output of the scanning process typically produces point cloud data, representing the spatial coordinates of millions of points on the surface of the scanned object or site. The point cloud data is then combined with photorealistic texture mapping. This process involves overlaying high-resolution images onto the 3D model, ensuring that the virtual representation closely reflects the appearance of the real object. These detailed data form the foundation for creating authentic 3D models. Augmented reality technology can be used for 3D modeling of Han stone portraits, generating 3D models of Han stone portraits that can be used for virtual restoration, as well as the display and dissemination of Han stone portraits.

The 3D modeling of Han stone portraits enables the monitoring and detection of surface pattern degradation over time, allowing for restoration or the creation of replicas. Traditional methods such as photography and drawing are unable to capture the complete three-dimensional shape. However, laser scanning and photogrammetry used in 3D modeling can create highly accurate 3D point clouds and meshes. Digital modeling enables the creation of highly detailed 3D prints and replicas of Han stone portraits, accurately reproducing their original appearance. This approach facilitates their exhibition, prevents further damage during the original display process, and

allows for virtual preservation through 3D digital modeling and replicas. This, in turn, promotes documentation, restoration research, and widespread exhibition of Han stone portraits.

The 3D modeling and scanning technologies provide powerful tools and methods for the digital documentation of Han stone portraits, which are of significant importance for the protection, research, and inheritance of Han stone portraits cultural heritage. In the future, with continuous technological advancement, the application of three-dimensional technologies in the digital documentation of Han stone portraits within augmented reality environments will become more profound and extensive, making greater contributions to the promotion of excellent traditional Chinese culture.

3.2 Historical Layer Visualization

Digital documentation techniques, such as photogrammetry and laser scanning, are increasingly being used to record and preserve cultural heritage sites and artifacts[5]. AR technology has the transformative capability to overlay different types of historical information, such as text, images, and videos, in a layered and interactive manner, enabling users to explore the history of cultural sites in a more engaging and informative way. AR provides a revolutionary approach to visualizing historical layers, seamlessly blending virtual elements with the real world. By immersing audiences in historical scenes, AR enhances understanding of Han stone portraits and deepens the connection with the cultural heritage of Han stone portraits.

Visualization of historical layers can be achieved through the following methods: Firstly, visualization of historical archives: Existing literature and documentation related to Han stone portraits can be overlaid in the form of images or videos onto the actual Han stone portraits, providing interpretations and explanations of the information contained within the stones. Secondly, comparative overlay: In AR environments, historical maps can be superimposed onto real environments, allowing the recreation of the original appearance of Han portrait stone sites. This enables audiences to gain a more intuitive understanding of the past and present, appreciate the continuity and changes in the area where the site is located. Additionally, through animations and sound effects, historical events can be recreated on-site, such as scenes of battles depicted in Han stone portraits, enhancing realism and immersion.

In AR environments, the visualization of historical layers tailored to the information provided by Han stone portraits offers personalized explanations, helping users connect with historical contexts and generate new insights. By leveraging the cultural significance of the actual Han stone portraits sites, virtual and physical elements are seamlessly integrated, allowing audiences to gain a more direct and comprehensive understanding of the historical background and details of Han stone portraits.

3.3 Virtual Museums

The development space of traditional Han stone portraits museums is becoming increasingly limited, leading to the inability to fully realize their maximum value. How-

ever, virtual museums based on augmented reality technology allow users to appreciate museums at any time, place, and from multiple perspectives. Secondly, the traditional museum exhibition forms are too monotonous, making it difficult for viewers to interact with and resonate with the exhibits. The development of digital technology has made it more convenient for a large number of people who previously could not access information and experiences. Virtual museums are undoubtedly one of the best innovations of digital technology. They seamlessly integrate traditional museum experiences with the infinite possibilities of digital technology. They do not exist in binary opposition between physical or virtual spaces, but rather in dynamic intersections where the two seamlessly blend, providing visitors with richer, more interactive artistic, historical, and cultural experiences.

The virtual museum of Han stone portraits digitizes and stores the physical objects and documents, among other collection data, using technologies such as high-resolution scanning, photography, and 3D spatial modeling. Through the internet, it fully presents the functions of exhibition, collection, education, and research that a physical museum should have. The touring system of the virtual museum of Han stone portraits primarily adopts a gesture-controlled viewing mode. Gesture control refers to interacting with virtual objects or interfaces overlaid on the real world using physical movements or gestures. This interactive method allows users to manipulate and control digital content in the AR environment using natural movements of their bodies or hands. Users can perform gestures detected by the AR device's camera to trigger actions or manipulate virtual objects. For example, users can pinch their fingers together to grab and move virtual objects of Han stone portraits, zoom in, zoom out, and rotate them 360 degrees for observation. It can also track the user's body movements to enable interaction with virtual content. This involves tracking the direction of the user's head, body position, or limb movements to control the viewpoint, select virtual objects of Han stone portraits, or perform actions in the AR environment.

The AR virtual museum of Han stone portraits, provides users with an immersive and interactive way to engage with cultural heritage, historical artifacts, and educational content, enriching traditional methods of exhibition in Han stone portraits, museums and expanding the scope of cultural heritage experiences. The core of any museum experience, whether physical or AR-based, lies in its content. Creating high-quality AR content, captivating virtual tours, and interactive exhibits requires collaboration between museum professionals, technology experts, and storytellers to continuously explore the educational and entertaining value related to Han stone portraits.

4 The Application of Augmented Reality technology in the Public Education Dissemination of Han Stone Portraits

Augmented Reality brings revolutionary prospects to public education, particularly in the realms of history and cultural heritage. By seamlessly blending the real and virtual worlds, AR transforms passive learning into an active and engaging immersive experience.

4.1 Revolutionizing Engagement

Augmented Reality has revolutionized the way we interact with the world around us, enabling us to engage more deeply than ever before. By overlaying digital content onto the real world, AR enhances our understanding, facilitates collaboration, and establishes more meaningful and impactful connections with our surroundings.

AR can provide users with contextual information about the surrounding environment, enriching their understanding of the world around them. For example, AR can overlay historical documents, animated displays, or expert commentary videos related to Han stone portraits, offering a deeper insight into them. AR can transform passive observation into active exploration. Users can interact with virtual objects, manipulate 3D models of Han stone portraits, and view them from all angles, making the environment come to life and enhancing understanding for a more immersive experience. AR can customize information and experiences based on users' individual needs and interests. Users can choose to focus on specific themes of Han stone portraits, explore different perspectives, or engage with content aligned with their learning interests, creating personalized and engaging learning journeys. AR can evoke emotions and create a sense of wonder and awe. Users can experience historical events firsthand, interact with virtual characters, or explore stunning virtual worlds, establishing deeper connections with the content and gaining more meaningful experiences.

AR technology is transforming the way we interact with the cultural heritage of Han stone portraits, facilitating interactive exploration through the provision of contextual information and creating personalized learning journeys that cater to individual needs and interests. By evoking emotions and fostering meaningful experiences, AR can change the way we engage with history, making it easier to understand, more engaging, and more relevant to our lives. With the continuous development of AR technology and the growing richness of virtual content, we can expect to see innovative and impactful AR experiences that bring the past to life in an informative and inspiring manner.

4.2 Adaptive Learning Experiences

AR can adapt to individual users' preferences and learning styles, providing personalized educational experiences. This adaptability ensures that the content is engaging and relevant to different audiences.

In an AR environment, a typically adaptive learning experience is facilitated through a dynamic content delivery mechanism. When users explore Han stone portraits through an AR application, the system adjusts the content presentation in real-time to match their pace and level of understanding. Simultaneously, the adaptive viewing experience in AR provides a customized browsing path. Based on users' prior knowledge and interests, the AR system can guide users by emphasizing specific aspects of Han stone portraits, such as images, stories, or site displays, offering personalized visiting and learning experiences. Through progress tracking and assessment features within the AR application, user interactions and responses are monitored. The system evaluates users' proficiency and comprehension levels based on the

tracked data, thereby adjusting the difficulty or complexity of the content. In the Han stone portraits AR application, information about user interactions, preferences, and behavioral patterns can be collected to create user profiles. These profiles are then utilized to adjust the presentation of digital information related to Han stone portraits based on individual user preferences. For example, older user groups may prefer voice interaction over gesture-based interfaces for browsing. Therefore, the AR interface automatically switches to voice mode and guides users through information using voice prompts.

AR allows multiple users to interact with the same virtual content simultaneously, creating a shared virtual workspace where they can collaborate on tasks and projects[6]. The adaptive learning experience in AR environments focuses on user experience and personalized content customization, catering to the preferences of different user groups. As an evolving technology, AR still faces several challenges in creating seamless and immersive experiences. Additionally, in the process of adaptive learning experiences, AR applications collect user data, which can raise concerns about privacy and data security. Despite these challenges, augmented reality still holds the potential to transform the way we communicate with the cultural heritage of Han stone portraits, making it more personalized, engaging, and meeting the needs of different user groups.

5 Conclusion

Digital technology provides a new opportunity for the creative transformation and innovative development of Han stone portraits. The application of augmented reality technology in the digital display of Han stone portraits not only breaks through geographical limitations, allowing more people to appreciate this precious cultural heritage, but also provides a richer, more intuitive, and interactive exhibition experience, promoting the inheritance of cultural relics and the popularization of culture. Adopting these technological advancements in the protection and exhibition of Han stone portraits can not only expand the influence of Han stone portraits but also provide more meaningful connections between the past and the present. With future advancements in display technology, graphics rendering, and haptic feedback, the sense of presence and sensory engagement will be enhanced. Users will be able to interact with elements of Han stone portraits cultural heritage visually, audibly, and through touch. The boundary between the virtual and physical worlds will be further blurred.

Acknowledgments

This article is one of the interim achievements of the research project entitled "Inheritance and Development of Han stone portraits in the Huaihe River Basin Based on Augmented Reality Technology" (SK2021A0509) from the 2021 Annual Research Projects on Humanities and Social Sciences in Anhui Universities.

References

1. Rauschnabel, P. A., Felix, R., Hinsch, C., Shahab, H., & Alt, F. (2022). What is XR? Towards a framework for augmented and virtual reality. Computers in human behavior, 133, 107289.
2. Boboc, R. G., Băutu, E., Gîrbacia, F., Popovici, N., & Popovici, D. M. (2022). Augmented reality in cultural heritage: an overview of the last decade of applications. Applied Sciences, 12(19), 9859.
3. Noh, Z., Sunar, M. S., & Pan, Z. (2009). A review on augmented reality for virtual heritage system. In Learning by Playing. Game-based Education System Design and Development: 4th International Conference on E-Learning and Games, Edutainment 2009, Banff, Canada, August 9-11, 2009. Proceedings 4 (pp. 50-61). Springer Berlin Heidelberg.
4. Jo, Y. H., & Hong, S. (2019). Three-dimensional digital documentation of cultural heritage site based on the convergence of terrestrial laser scanning and unmanned aerial vehicle photogrammetry. ISPRS International Journal of Geo-Information, 8(2), 53.
5. Tetep, T., Jamilah, J., Ismail, A., Mulyana, E., & Widyanti, T. (2019). History visualization using augmented reality. In Journal of Physics: Conference Series.Vol. 1402, No. 7, p. 077032
6. Martín-Gutiérrez, J., Fabiani, P., Benesova, W., Meneses, M. D., & Mora, C. E. (2015). Augmented reality to promote collaborative and autonomous learning in higher education. Computers in human behavior, 51, 752-761.