

A Study on Innovative Experience Design for the Museum of the Mausoleum of the First Qin Emperor in the Era of Digital Humanities

Congwen Xu

*School of Architecture and Art, North China University of Technology, Beijing, China
343594918@qq.com*

Abstract. With the rapid development of artificial intelligence (AI) technologies, China has achieved significant progress in the digital preservation of cultural heritage. However, past integrations of AI with museum immersive experiences have been largely confined to contexts such as artifact restoration, conservation and display, and digital human-guided tours; they have lacked effective capture and understanding of visitors' needs. As a result, existing intelligent museum experience models struggle to satisfy visitors' demands for high-quality immersive visits. Based on the application of AI technologies in museum settings, this paper proposes new solutions for an intelligent experience at the Museum of the Mausoleum of the First Qin Emperor, aiming to facilitate the innovative dissemination of cultural heritage.

Keywords: Cultural heritage, Artificial intelligence, Experience design, Museum of the Mausoleum of the First Qin Emperor

1. Introduction

In recent years, interactive experience design in museums has increasingly converged with artificial intelligence technology, giving rise to a range of innovative digital presentation modes for cultural heritage. Examples include the National Museum's AI guide "Ai Wenwen," the AI photo-interaction function at the Poly MGM Museum, and the AI-restored digital persona of Lady Xin Zhui at the Hunan Museum. AI-enabled intelligent displays in Chinese museums have therefore shown a diversified trajectory of development. Yet, while these applications have improved visitor experience and diversified the digital presentation formats of cultural heritage, they have also generated problems such as homogenization and superficiality. Taking the Museum of the Mausoleum of the First Qin Emperor in Shaanxi as the object of study, this paper proposes a new form that combines AI + cultural heritage + immersive experience. Building on existing display methods and through case analysis and research, the study attempts to provide visitors with a more immersive tour experience, stimulate local cultural-tourism development, and advance the digital preservation of cultural heritage. At the same time, it seeks to promote the integration of AI technologies with cultural heritage and to offer new perspectives for research on intelligent exhibition and experience design for museums in the era of digital humanities.

2. A new direction for the living transmission of cultural heritage

2.1. The intervention of artificial intelligence technology

Artificial intelligence (AI) can realize the digital preservation of cultural heritage through technologies such as image recognition, style imitation, and 3D reconstruction, and has today evolved from a mere technical tool into an active participant in cultural dissemination and innovation. In museum contexts, AI can perform accurate restoration and modeling and provide personalized tour services for visitors; its applications in artifact restoration and digital-human guided tours are already fairly widespread. Relying on principles from reinforcement learning, fuzzy control, and expert systems, AI can adjust parameters according to an artifact's condition, accurately identify and restore an object's original appearance, and achieve precise restoration. For example, the National Museum's gold-and-silver cloud-pattern bronze rhinoceros zun has benefited from AI image-recognition and missing-data completion techniques represented by generative adversarial networks (GANs), which - together with encoder-decoder architectures - can model the context of missing portions and infer their content [1]. Combined with AI, digital guide personas are also capable of understanding visitors' questions and engaging in interactive Q&A. The Palace Museum's AI digital curator "Fu Daren" (Figure 1), for instance, can provide accurate answers to visitors' questions about Palace attractions and artifacts and can generate personalized visit routes and plans for guests [2].

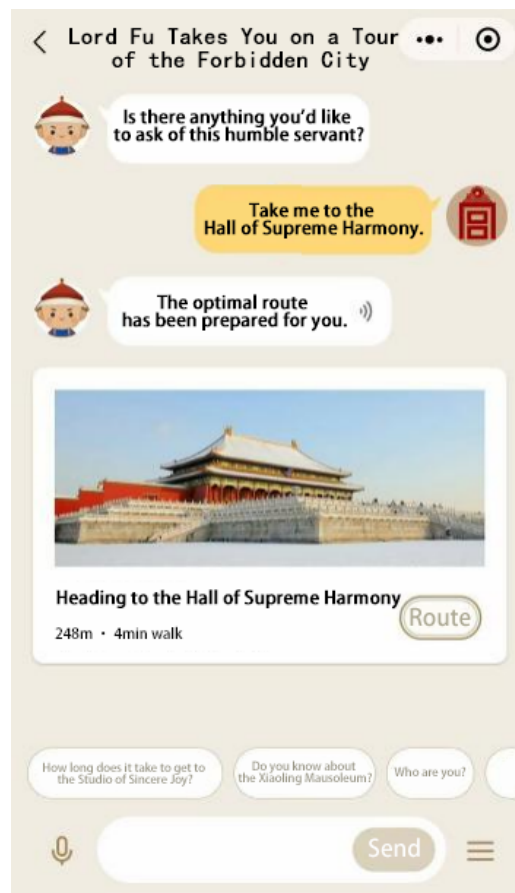


Figure 1. Screenshot of a Q&A with the AI digital curator "Fu Daren" (image source: "Play the Palace" mini-program 2.0)

2.2. Immersive and interactive museum experiences

2.2.1. Artificial intelligence and virtual digital humans

A virtual digital human may be defined as "a virtual persona constructed with digital technologies that possesses a human appearance, behavior, and even mental attributes." [3] As museum digital-display technologies iterate and upgrade, AI-integrated virtual digital humans have gradually become an important component of innovative exhibition formats in the museum field. For example, the Liuzhou Industrial Museum's digital-human docent (Figure 2) can retrieve database content in real time to respond to visitor questions. However, judging from the digital-human cases currently launched by various museums, their basic functions remain relatively simple - chiefly video presentations and database retrieval - so they are not yet able to support truly free-form interaction with audiences.

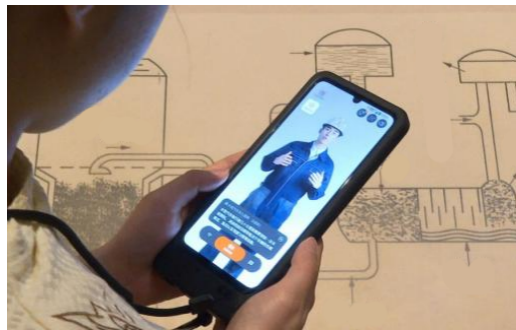


Figure 2. Digital-human docent at the Liuzhou Industrial Museum (image source: New Bulletin)

2.2.2. XR (Extended Reality) technology

XR (Extended Reality) refers to an environment that combines the real and the virtual and supports human-computer interaction through computer technologies and wearable devices; audiences can, by moving in the real world, exert control over and interact with virtual objects [4]. Through immersive XR experiences and interactive games, visitors can engage with historical culture in more direct and entertaining ways. For example, the Sui-Tang Luoyang City scenic area launched the VR full-sensory theater "Wind Rises in Luoyang" (Figure 3), which applies virtual reality, real-time motion capture over the internet, wireless streaming, and other technologies to construct a virtual three-dimensional space where audiences can experience Luoyang's rich cultural heritage first-hand [5].



Figure 3: "Wind Rises in Luoyang" VR full-sensory theater (Image source: Phoenix Net).

2.2.3. Blockchain technology and 3D digital assets

Blockchain's features - security and transparency, immutability, trustless operation, and traceability - offer new approaches to many problems around data sharing [6]. In the museum and cultural-heritage domain, blockchain can be used for the collecting and circulation of digital derivative cultural products. For example, the Baoji Bronzes Museum issued more than 10,000 3D digital cultural-creative items - such as the "Lü Buwei Eighth-Year Ge" and the "Carp Zun" - and simultaneously released "digital tickets" and the "Gongyu National Treasure Sword" digital commemorative ticket. By combining these releases with blockchain technology, the museum advances digital construction and enables a "shared-collection" experience that blends the virtual and the real.

3. Forms of intelligent experience design at the Museum of the Mausoleum of the First Qin Emperor

The Museum of the Mausoleum of the First Qin Emperor is composed of the Museum of the Terracotta Warriors and Horses and the Emperor Qinshihuang's Mausoleum Site Park (Lishan Garden). In 1987, it was inscribed on the UNESCO World Heritage List for its immense historical, scientific, and artistic value. With the advancement of digital technologies, the museum has launched a series of digital display methods - for example, the Terracotta Warriors VR Experience Center in 2019; the 2024 online exhibition The Underground Kingdom of the Eternal Emperor: Archaeological Discoveries of the Mausoleum of the First Qin Emperor, which applied 720° panoramic photography, VR, and 3D digital modeling technologies [7]; and the smart-guide mini-program Tracing the Mausoleum of the First Emperor.

3.1. Online tours

Many temporary and permanent exhibitions at the Museum of the Mausoleum of the First Qin Emperor can be visited online in immersive formats via its official website. These visiting experiences adopted 720-degree panoramic photography, virtual reality and 3D modeling technology, which reproduced the whole exhibition space. For example, the temporary exhibition "The Hub of Civilization: Treasures of Ancient Syrian Cultural Relics" shows Syria's rich cultural and historical heritage of civilization, such as Assyrian, New Babylon, Macedonian, Roman and Arabic cultures. Syria is often described as a "kaleidoscope of civilization", where different traditions are passed on to each other, leaving a profound historical imprint. Another temporary exhibition, "Asking Shu: Special Exhibition of Shu Culture in Eastern Zhou Dynasty", discusses the regional characteristics and development of Shu culture in three parts, and shows the glory and mystery of ancient Shu culture through bronzes, pottery, lacquerware and wooden slips. The special exhibition "The Underground Kingdom of an Emperor through the ages: Archaeological Discovery of Qin Shihuang's Mausoleum" (Figure 4) is the first basic exhibition focusing on the archaeological achievements of Qin Shihuang's Mausoleum, showing the representative cultural relics unearthed in the past 50 years. It reflects the richness of Qin culture in politics, economy, military affairs, art, social production, leisure and spiritual life. Online exhibitions break through the time and space constraints, allowing visitors to watch cultural relics and even the whole scenic spot anytime and anywhere, thus greatly promoting the digital display of cultural heritage.



Figure 4. 2024 online exhibition The Underground Kingdom of the Eternal Emperor: Archaeological Discoveries of the Mausoleum of the First Qin Emperor (image source: Museum of the Mausoleum of the First Qin Emperor official website)

3.2. Smart guide services

With the arrival of the digital age, multimedia interpretations in text, video, and audio have become increasingly popular with museum audiences, making the construction of intelligent guide systems a clear trend [8]. The smart-guide mini-program Tracing the Mausoleum of the First Emperor, jointly developed by Tencent and the museum, uses Tencent Maps for precise navigation and panoramic matrix technology to assemble a 50-billion-pixel panoramic interior image from museum data. It provides visitors with an overview of the entire site, hand-drawn maps (Figure 5), in-hall navigation, audio explanations, recommended routes, facility searches, and VR panoramic tours. Visitors can plan their own routes with the hand-drawn map or follow intelligently recommended classic routes to save time. By tapping the position of an artifact in the program, visitors can listen to audio explanations. The program also supports 720° panoramic tours, where rotating one's phone changes the perspective.



Figure 5. Hand-drawn map

3.3. VR cinema

As a new form of museum exhibition, virtual reality technology runs through many stages of cultural heritage protection—from high-precision scanning modeling to immersive experience, interactive display and non-contact research. It opens up a new way for the protection of cultural heritage and promotes cultural exchange and integration [9]. Terracotta Warriors and Horses VR Cinema launched the film *Qin: Terracotta Warriors and Horses*, which was jointly produced by Qin Shihuang Mausoleum Museum and Xi'an Keshi Kejue Network Technology Co., Ltd. The theater uses panoramic CG technology, 8K ultra-high-definition images, VR head-mounted display equipment and multi-degree-of-freedom motion platform to create a 720-degree immersive experience. The equipment can generate vibration, gravity and tactile feedback in real time. After wearing the equipment, visitors can experience 360-degree collision, rotation, weightlessness and overweight, and explore the reconstruction scene of the underground palace of Qin Shihuang Mausoleum. Through the perspective of Terracotta Warriors and Horses, the audience will follow Qin Shihuang to unify the six countries in the world, establish the Qin Empire, and fully appreciate the advanced productive forces of the Qin Dynasty.

3.4. XR theater

Different from the official exhibition mode of museums, many enterprises commercialize the Terracotta Warriors and Horses as cross-regional and cross-cultural "cultural symbols", and integrate cultural heritage into daily life through immersive scenes and interactive design. For example, the 2025 immersive XR meta-universe project "Exploring the Sleeping Mausoleum" (Figure 6) developed by Shaanxi Zhixing Wukong Digital Technology Co., Ltd. covers an area of more than 2,500 square meters in four exhibition halls. The project provides visitors with multi-sensory experiences such as wind, heat, gesture interaction and flight through XR large space technology, bringing them into the underground world rebuilt more than 2,000 years ago. Tourists incarnate as archaeologists, under the guidance of virtual guide "Professor Shi", shuttle between traps and institutions, and finally enter the mausoleum passage. In the underground palace, they can see the twenty-eight moon palaces above, the mercury river below, and even ring the bell that senses with the movement.



Figure 6. XR metaverse project Exploring the Sleeping Mausoleum (image source: Baidu Baike)

In 2025, Qin Shihuang's epic VR Full Sensory Theater took Qin culture as the theme, and integrated panoramic sound, micro-landscape, motion capture and AI restoration technology to create an immersive cinema space. Through multiple historical narratives, the theater reproduces scenes such as Xianyang City and the underground palace of Qin Shihuang's Mausoleum. The audience wearing VR equipment can "cross" back to the Qin workshop and repair the damaged

terracotta warriors and horses by themselves. The six-act repertoire includes Dune Change, Return of the King, Mausoleum Workshop, Fiery Goose, and Battle of Xianyang. The audience can not only appreciate the architecture and landscape of the Qin Dynasty, but also hold the controller and fight with swords, shuttling through the characteristic scenes such as single slab bridge, cableway and suspension bridge. Trembling floors, swaying seats and dense fog together create a strong immersion experience.

The XR cinema project "Wonderful Night of Terracotta Warriors" launched in 2024 is based on the cultural relics of the Mausoleum of the First Qin Emperor, integrates XR and AIGC technologies, and uses UE5 development engine to create AAA-level scenes and visual effects, perfectly recreating the archaeological sites of Pit 1 and Pit 2. Through motion capture technology, the three treasures of the museum-general figurines, kneeling figurines and cavalry figurines-are digitally resurrected. The audience incarnated as a "Little Qin" doll, and ventured with the reborn Terracotta Warriors and Horses in the interactive film to explore the story behind the cultural relics. Wearing head-mounted equipment and sitting in synchronized seats, the audience will gallop side by side with the Terracotta Warriors, cross the original tunnels, climb the forests and mountains, cross the Great Wall and the ocean, and learn the history of the Terracotta Warriors while exploring. The seat can bounce, rotate 360 degrees and simulate environmental changes, so that the audience can immerse themselves in it.

4. Exploration of innovative forms of intelligent experience

4.1. Cross-media intelligent interactive digital human system

This study proposes a digital navigation system (Figure 7), which provides visitors with multiple IP roles with different characteristics to choose from. The system can also analyze visitors' problems, communication methods and knowledge background to infer their preferences and personality characteristics, so as to customize explanations for visitors of different age groups and education levels. In order to improve the user experience, the system integrates facial recognition and memory storage functions. Digital tour can remember each visitor's facial information and related preferences, and actively recall these information in subsequent interactions to enhance the sense of interaction. In addition, this series of digital tour IP can be accessed simultaneously on the official website of the Qin Shihuang Mausoleum Site Museum, forming an online and offline integration mode. When browsing the museum website, visitors can create accounts and select keywords such as "sunshine", "pleasure" or "gentleness", and generate personalized digital navigation images by using generative AI. Digital guided tours can answer questions about online exhibitions and cultural relics. The system stores conversations in real time and associates them with guest accounts, so the next time you log in, the digital tour guide may say, "Do you remember the question you asked me last time?" This increases interactivity and encourages repeated visits. Visitors can rent hand-held digital tour guide equipment in the museum, and they can activate the exclusive tour service by facial recognition or account login.

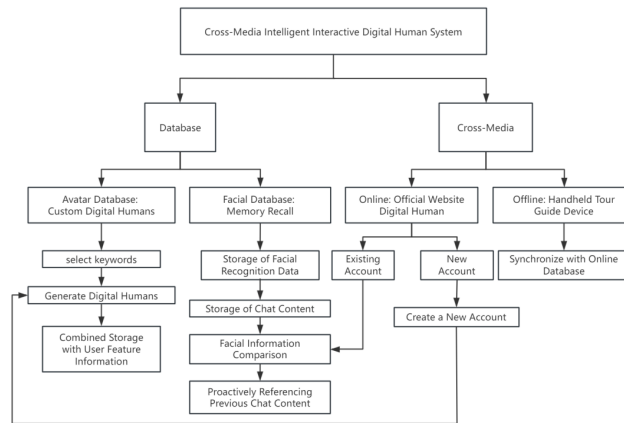


Figure 7. Overview of the cross-media intelligent interactive digital human system

4.2. Digital terracotta warriors

Recently, the Gansu Bamboo Slips Museum integrated its AI guide robots "Xiao Jian" and "Xiao Du" with the DeepSeek large model, enabling natural and fluent voice dialogues to answer personalized questions from visitors. In contrast, the current digital exhibitions on the Emperor Qinshihuang's Mausoleum Site Museum's website only allow users to drag and view high-resolution 3D models of artifacts and read accompanying texts. These static display modes lack interactivity, and it is difficult to continuously attract tourists' interest. Therefore, this study proposes to upgrade the existing 3D model of Terracotta Warriors to an interactive digital human exhibition driven by artificial intelligence. By equipping high-resolution models with intelligent interactive systems, Terracotta Warriors will be able to "speak" and tell their own history. When visitors browse the website, they can not only watch the restored original form, but also participate in real-time conversation. With the help of motion capture technology, Terracotta Warriors can even show specific movements. For example, when tourists ask, "When were you discovered?" At that time, the terracotta warriors and horses carrying AI will tell their archaeological background and historical stories.

4.3. Automatic guide glasses

At present, AR glasses used in museums mainly provide basic explanations of cultural relics. After wearing it, visitors can trigger visual effects by scanning the exhibits, voice commands or manually entering the number of the exhibits. This technology has been applied in Luoyang Museum (Figure 8) and the Sui and Tang Dynasties Grand Canal Cultural Museum. However, these devices have some limitations, such as the lack of positioning system, complicated cultural relics identification process, and limited display content to video playback, which can neither provide personalized recommendation nor intelligent navigation function.

In order to solve these shortcomings, this study proposes to integrate positioning system, eye tracking and facial expression recognition functions into the guide glasses. The positioning system can accurately capture the movement trajectory and the length of stay of visitors in the exhibition hall, so as to identify their interests and push relevant content. Eye tracking technology can capture the direction of sight in real time and display related words on the lens in real time. The facial expression recognition function is based on the efficient original perceptual facial expression recognition model P2FER [10], which can infer the emotional state and needs of visitors.

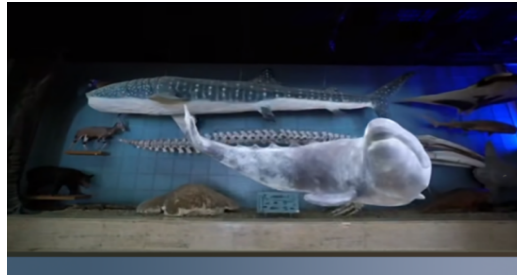


Figure 8. View through AR guide glasses at Luoyang Museum (source: Baidu Baike)

For example, when a tourist wearing automatic guide glasses stares at a kneeling archer in pit 2, eye tracking technology will identify the focus and trigger the handheld guide device to play audio guide. If the positioning system detects that the stay time exceeds five minutes, the digital guide may ask, "Do you want to know more about kneeling archers?" If the facial recognition system detects a confused expression, the device can prompt the digital tour guide to ask, "Is there anything unclear about my explanation just now?" By observing the state of tourists from multiple angles and linking with hand-held guide equipment, automatic guide glasses can provide real-time personalized service.

4.4. Immersive theater

The immersive theater (Figure 9) combines digital images, comedy performances, dance and music to construct a three-dimensional space that can simultaneously mobilize vision, hearing, smell and touch, thus significantly enhancing the interactive experience between the audience and cultural relics [11].

At present, the VR cinema of Qin Shihuang Mausoleum Museum only plays fixed movies, lacking real-time interaction with tourists' behavior. In order to solve this problem, this study designed a multi-sensory immersive cinema. According to Bahremand's Smell Engine: Artificial Smell Synthesis System in Virtual Environment [12], VR helmet is equipped with a smell simulation device, which will release different smells synchronously with the visual environment. For example, when tourists enter the Terracotta Warriors pit, the device will emit the smell of soil; In Lishan Garden, there will be fresh wood fragrance.

In narrative design, immersive theater provides two experience modes: scene restoration and gamification narrative. In the scene restoration mode, visitors explore the restored virtual museum environment through wearable devices, covering tomb layout, terracotta warriors and horses workshop, Lishan Garden and so on. Real-time rendering technology creates a realistic atmosphere, while gesture recognition and motion sensing devices allow visitors to break through fixed routes and explore freely. For example, touching the virtual pottery kiln will trigger the holographic projection of the "firing process of terracotta warriors and horses", so that visitors can not only observe, but also interact with virtual craftsmen to ask questions. The system also supports the dynamic time switching of "morning, middle, evening and dusk", allowing visitors to experience scenes under different lighting conditions. In the gamification narrative mode, generative artificial intelligence creates a unique story for each visitor, who can choose to explore alone or play in teams. Tourists' choices will affect multiple narrative endings. They can find hidden endings and gain cultural knowledge along the way. The system also introduces a reward mechanism: successful players can get cultural products with museum themes as prizes.

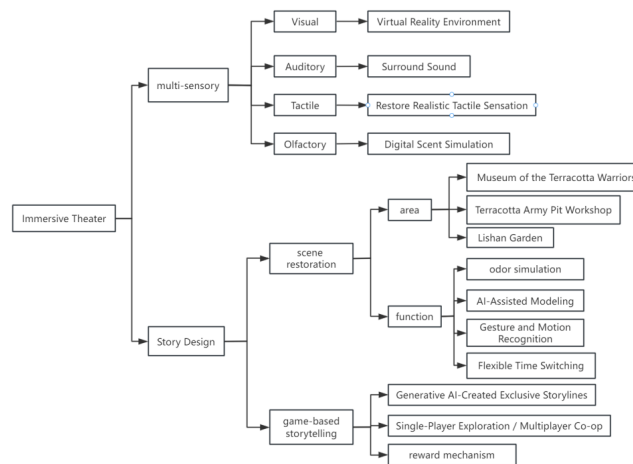


Figure 9. Immersive theater model

5. Conclusion

By proposing innovative methods, such as cross-media intelligent interactive digital human system, digital terracotta warriors and horses, automatic guide glasses and immersive theater model, this study provides a new perspective for the digital display of cultural relics in the Qin Shihuang Mausoleum Museum. On the basis of traditional museum exhibitions, these designs integrate artificial intelligence and other digital technologies to enhance interactivity and entertainment, and change museum visits from static cultural relics appreciation to multi-sensory interactive experience, while maintaining the integrity of cultural heritage communication.

At present, the application of artificial intelligence in the field of digital protection of cultural heritage is still relatively limited in China, and the interactivity of cultural relics exhibitions is also insufficient. The interactive digital navigation system and digital terracotta warriors and horses proposed in this paper provide an important reference for solving this problem and play an important role in promoting the innovative experience design of live transmission, a cultural heritage in the digital humanistic era. By promoting the deep integration of digital technology and museum experience, these innovative measures have injected new vitality into the development of digital preservation and dissemination in Chinese heritage. This kind of integration is not limited to superficial tour and exhibition, but also takes into account tourists' behavior patterns, cognitive characteristics and emotional needs, providing real-time interactive feedback and auxiliary services. It is expected that through continuous innovation iteration, the museum's live transmission and innovative experience mode will promote the digital preservation and dissemination of Chinese heritage to develop in the direction of higher quality and deeper humanistic participation.

References

- [1] Dai, T. (2025). Discussion on technologies for improving the accuracy of cultural relic restoration driven by artificial intelligence. *Collection*, (04), 70–72.
- [2] Zhang, Y. (2025, June 9). When museums encounter AI. *China Culture Daily*, p. 5.
- [3] Wang, W., Zhao, D., Hei, Z., et al. (2025). The process and mechanism of cultivating the commercial ecosystem of virtual digital humans: A longitudinal case study of Luo Tianyi. *Foreign Economics & Management*, 1–21. Advance online publication. <https://doi.org/10.16538/j.cnki.fem.20250704.302>
- [4] Yan, S., Liu, Z., Dai, W., et al. (2024). A review of XR-based immersive media interaction and collaborative perception. *Packaging Engineering*, 45(20), 32–42. <https://doi.org/10.19554/j.cnki.1001-3563.2024.20.003>

- [5] Liao, F., & Chen, G. (2025). Practical paths of empowering digital culture and tourism integration with intelligent technologies. *Communication and Copyright*, (14), 72–75. <https://doi.org/10.16852/j.cnki.45-1390/g2.2025.14.001>
- [6] Yang, W., Liu, W., & Sun, Z. (2021). Research on the construction of a government data-sharing model based on blockchain and ROMA. *Information Studies: Theory & Application*, 44(05), 115–121. <https://doi.org/10.16353/j.cnki.1000-7490.2021.05.017>
- [7] Zhao, Y., Zhao, X., & Gong, Z. (2022). Museum digitalization from the perspective of cross-media narration: A case study of the Emperor Qinshihuang's Mausoleum Site Museum. *New Media Research*, 8(03), 40–43, 47. <https://doi.org/10.16604/j.cnki.issn2096-0360.2022.03.002>
- [8] Wu, J., Cao, X., & Zhou, X. (2023). Research on smart museum guide design from the perspective of service design. *Packaging Engineering*, 44(06), 345–347, 351. <https://doi.org/10.19554/j.cnki.1001-3563.2023.06.038>
- [9] Liu, X., Li, K., Geng, G., et al. (2025). Research progress on virtual reality technology in cultural heritage protection. *Journal of Computer-Aided Design & Computer Graphics*, 37(04), 545–560.
- [10] Liu, T., Wang, M., Deng, L., et al. (2025). An efficient facial expression recognition method based on pleat primitive relational perception. *Journal of Wuhan University (Natural Science Edition)*, 1–15. Advance online publication. <https://doi.org/10.14188/j.1671-8836.2025.0014>
- [11] Wu, Y. (2019). Where is the "immersion" in immersive exhibitions? *Art Observation*, (12), 30–31.
- [12] Bahreman, A., et al. (2022). The Smell Engine: A system for artificial odor synthesis in virtual environments. 2022 IEEE Conference on Virtual Reality and 3D User Interfaces (VR), Christchurch, New Zealand, 241–249. <https://doi.org/10.1109/VR51125.2022.00043>