

The Convergence of Art and Technology: Insights into the Intelligent Transformation of Chinese Art Exhibitions

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ABSTRACT

The application of high-tech elements in Chinese art exhibitions has become a transition from the conventional approach of art exhibition to intelligent exhibition. The purpose of this research is to examine how intelligent transformation to art exhibitions has been practiced in China through the application of the following technologies: Artificial Intelligence (AI), the Internet of Things (IoT), Radio Frequency Identification (RFID), and big data analytics. This intends to find out how these technologies improve the engagement of visitors, efficiency in the management of exhibitions, and the conservation of cultural artifacts. Altogether, with the help of the literature review and the case studies of such events as the integration of 3D data into the National Museum of China and AI in the content of the 1st Digital Art China, this research assesses the applicability of these technologies for enhancing the exhibition design and the visitors' experience. The study reveals that technology enhances the visitor experience, operations, and conservation of cultural heritage. Therefore, this study finds that the intelligent transformation of art exhibitions is necessary to enhance access and engagement of the public in art in culturally appropriate and innovative ways. The recommendations derived from the observations benefit cultural heritage managers, those who make policies on cultural and creative industries, and those who design technologies for future smart art exhibitions in China.

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Contribution/Originality: This study provides a comprehensive analysis of technological transformation in Chinese art exhibitions, examining multiple emerging technologies in a unified framework. It uniquely documents the evolution from traditional to smart exhibition spaces and analyzes the interplay between technological innovation, visitor experience, and cultural preservation in Chinese cultural institutions.

1. Introduction

Technological advances have impacted Chinese art exhibitions in a big way, transforming the exhibitions into smart art exhibitions that incorporate technological systems in both the interaction with the visitor and the operation of the exhibition. This evolution is not unique; it is an extension of a worldwide phenomenon where artificial advancements transform cultural encounters, making art easier and more engaging (Chen et al., 2022). This transformation is especially evident in China, for example, the National Museum of China uses and introduces 3D data acquisition and environmental capture to enhance the content of their exhibits (CGTN, 2023). Such developments thus call for research on the intelligent evolution of Chinese art exhibitions in a backdrop of advancing technological advancement.

The new information age has led to unprecedented technological changes that have impacted almost all sectors, including art. The use of AI, IoT, and big data has also been used in developing engaging and personalized art experiences, as noted by Li and Wang (2023). In China, it has been incorporated into art exhibitions, which broaden the art presentation by adopting these technologies, increasing viewership and the reach of cultural identity (China Academy of Art, 2024). This incorporation of technology aligns with similar changes happening worldwide in the arts, putting China at the frontline of this change.

The core of this research is the intelligent transformation of Chinese art exhibitions by integrating art and technology. The main goals are to outline what smart art exhibitions are, to identify their architectural foundations and design parameters, to discuss main technologies that enable smart management and audience-oriented services, and to evaluate efficiency-improving trends that are people-oriented, intelligent, and diverse innovative services-oriented. Thus, this research's goals are as follows: By realizing these objectives, the study aims to advance theoretical knowledge and real-world application of technology-supported art exhibitions in China.

The subject of this research includes a study of smart art exhibitions in China and contributions of AI, IoT, RFID, and big data analytics. The examples of recent exhibitions that will be reviewed in the study include the 1st Digital Art China Exhibition, which exhibited AI-generated content and VR (China Academy of Art, 2024), and the smart gallery of the National Museum of China with a focus on 3D data integration (CGTN, 2023). In methodology, this study will adapt the approaches of the case study, expert interviews, and literature review to ensure a comprehensive understanding of the intelligent transformation of Chinese art exhibitions.

It is especially important for cultural conservation and artistic development that one can grasp the hint of art technique in Chinese art exhibitions. The intelligent transformation helps to increase not only the accessibility and interactivity of art but also contributes to the modernization of storing cultural identity in enhanced and innovative technologies (Chen et al., 2022). Furthermore, this convergence supports social activity culture that improves public awareness and participation, which is well aligned with the current trend in museum digitalization and smart cultural hubs (Li & Wang, 2023). This research has practical implications for policymakers, cultural organizations, and technologies interested in developing the progression of art exhibitions in China.

As the application of digital technologies becomes more prevalent in Chinese art

exhibitions, this study will explore the impact of intelligent transformation on exhibition design, management, and experience as well as the conservation of cultural heritage. The study objectives are as follows:

- i. 1 To examine the technological transformation of Chinese art exhibitions through the integration of advanced technologies such as Artificial Intelligence (AI), Internet of Things (IoT), Radio Frequency Identification (RFID), and big data analytics, with a focus on their roles in enhancing exhibition management, visitor interaction, and cultural preservation.
- ii. 2 To analyze how smart exhibition systems, including interactive interfaces, intelligent management platforms, and personalized visitor services, contribute to improving the accessibility, engagement, and educational value of Chinese art exhibitions.
- iii. 3 To explore the practical applications and case studies of intelligent art exhibitions in China, such as the National Museum of China and the 1st Digital Art China Exhibition, identifying best practices and future development strategies for combining technology and cultural heritage in innovative and culturally appropriate ways.

2. Methodology

This article used the narrative literature review method to review the intelligent transformation of Chinese art exhibitions based on current state-of-art technologies, including artificial intelligence, the Internet of things, radio frequency identification, and big data analysis. This approach enabled various academic papers, industrial reports, and cases to present how technological advancements affect the design, operations, visitor experience, and conservation of exhibitions (Snyder, 2019).

2.1. Literature Search and Selection Process

The literature related to this study was identified from published academic articles, institutional papers, and industry reports. The PI selected WOS, Scopus, IEEE Xplore, and CNKI as the primary academic databases to include international and Chinese articles. Another search in Google Scholar included grey literature, such as white papers and reports from Chinese museums and cultural institutions (Xiao & Watson, 2019). Information from the National Museum of China and the China Academy of Art was obtained, including recent developments and technological cases.

2.2. Search Terms and Criteria

The author identified the search keywords and Boolean operators used in selecting the necessary articles and sources when conducting the technological transformation of Chinese art exhibitions. These keywords were smart art exhibitions, artificial intelligence in museums, the Internet of Things in the cultural sector, radio frequency identification in exhibitions, big data in museums, and digital visitor experience in Chinese museums. Only scholarly articles in English and Chinese that were published between 2015 and 2024 were considered to capture the recent technologies (Booth et al., 2016). Generally, only articles and papers that were relevant in understanding the historical background of the topic were considered if they were published before the year 2000.

2.3. Inclusion and Exclusion Criteria

The articles were selected based on whether they dealt with using smart technologies in art exhibitions with a focus on China. Priority should be given to the papers that address the issues of visitor engagement, exhibition information and control, and cultural content improvement with the help of technology. Any literature restricted to non-digital exhibition forms was also not considered for review. This ensured that the identified sources were relevant to the intelligent exhibition transformation research topic, as [Tranfield et al. \(2003\)](#) recommended.

2.4. Data Extraction and Thematic Analysis

Data identified and obtained from each source included technologies used, interactive design features, effects on visitors' behavior, and operation results. These data were then categorized to cluster constant themes, successes, and issues. This thematic analysis allowed for synthesizing technological developments in Chinese art exhibitions and extracting key strategies that blend culture with technology ([Snyder, 2019](#)).

3. Concept and Structure of Smart Art Exhibitions

3.1. Definition and Features

Smart art exhibitions are a new form of art shows that can be described by applying new technologies in the art show process. These exhibitions use intermediary technologies for learning, playing, working, and sharing, including the Internet of Things (IoT), multimedia systems, and communication interfaces to increase visitor attention and create an active art environment. For example, IoT technology in an art environment helps bring a deeper experience and sense of the audience to the artwork ([Zhang & Li, 2023](#)).

The application of technology in smart art exhibitions has various characteristics that are aimed at enhancing the visit. It becomes significant when integrated with audio-visual (AV) systems coordinating audio, visual, and light control and interactivity to create a seamless and imaginative display. This integration replaces the observer role with an active part: visitors can view and manipulate the content by touch screens, gestures, and other technology equipment ([Smith, 2022](#)). Such interactive elements enhance learning through fun and address learning preferences, thus enhancing and enriching the museum experience ([Johnson, 2022](#)).

The social roles of smart art exhibitions are complex in their nature, as they seek to bring change and create an engaging environment in which the audience can participate. Unlike conventional non-technical static displays, these approaches allow visitors to interact with the displays, sometimes using touch and movement. This approach erases the distinction between the observer and the participant, making it more entertaining and enjoyable ([Brown, 2023](#)). Furthermore, several studies have established that the application of technological advances in the running of museums has a great influence on exhibitions about effectiveness and visitors' satisfaction ([Wang & Chen, 2023](#)).

Technological systems integrated smart art exhibitions transform the conventional museum concept into an innovative one focusing on aesthetics and functionality. The incorporation of IoT, AV, and interactive technologies is about amplifying the aesthetics

of exhibitions and enhancing the educational affordance of art to help it become more open to the greater public. With museums changing with the nature of the modern world, the use of devices like smart technologies will feature heavily in the future as new benchmarks for art allocation are set. These characteristics and technological foundations shape the architectural framework, as discussed in the following section.

3.2. Architectural Framework and Exhibition Design

The structure of smart art exhibitions implies that the main technological innovations are incorporated into the very concept of the exhibitions and their execution. This framework comprises diverse system elements such as IoT, AV systems, and interactive interfaces. IoT technology can be used to change traditional painting exhibitions into a digital space so the audience can have deeper and more meaningful experiences with the painting (Zhang & Li, 2023). AV integration encompasses audio-visual, lighting, and interaction technologies to design and develop coordinated and stimulating exhibits to improve the visitor experience (Smithsonian Exhibits, 2018).

The design principles for smart art exhibitions include adaptability, openness, and interactive usage. This means it is possible to design architectural spaces that facilitate complex viewing conditions and offer a variable exhibition approach (University of Oslo, 2023). Moreover, it is appropriate to identify visitor interests and organize exhibit text to fit the receptive audience (Smithsonian Exhibits, 2018). Documentation, standards, and methodologies of exhibit development require input from curators, designers, and teachers to make the material correct and interesting for the audience and make input accessible to all visitors (Smithsonian Exhibits, 2018). As a result of such principles, smart art exhibitions can use technology to improve the visitor experience without compromising the displayed pieces' art and educational value.

4. Key Technological Applications in Smart Art Exhibitions

4.1. Intelligent Exhibition Management Systems

Smart Exhibition Information Systems (SIES) play a critical role in transforming art exhibitions by employing technology to drive improvements in exhibition management and visitor experience. The framework of an IEMS typically comprises several key components: a central archive of digital content, smart IoT devices for physical infrastructure monitoring, and engaging displays for visitors. These components complement each other to ensure an organized network that effectively addresses exhibitions' general management (Zhang & Li, 2023).

The cost-effective event management functions of an IEMS are quite diverse, they involve scheduling, planning and controlling resources as well as managing visitors. For example, event management software (EMS) is a communication platform and a data center; it helps send invitations, generate leads, and analyze the results after the event (Saravana et al., 2024). For instance, in art exhibition scenarios, the systems allow the curators to schedule and/or coordinate several display aspects, guaranteeing smooth operations and improved customer experience.

Having efficient data analysis abilities is a core necessity for the successful work of an IEMS. Data analysis tools mean that exhibitions can gather, standardize, sort, and evaluate vast numbers of data sets to gain useful insights. The data can be analyzed

through tools like statistics or machine learning, or the data can be presented in a graphical form (Splunk, 2023). This analytical capability helps the exhibition managers track visitor behaviors, choices, and levels of interaction and make well-informed decisions that improve the quality and appeal of the exhibition.

Furthermore, new intelligent data management systems based on AI technologies provide for data storage, identification, and secure control in different environments. This automation makes data easily available and safe, which also helps to enhance the organization of art exhibitions (Cohesity, 2023). With the help of these high-level data manipulation and processing tools, the exhibition managers can achieve better centralization of resources, a better understanding of the visitors' needs, and better compliance with future trends in the exhibition and art worlds.

The components of the Intelligent Exhibition Management Systems' framework, the diverse management functions, and the complex data analysis algorithms are the guidelines for an intelligent approach to management and personalized audience services in smart art exhibitions. These integrations of systems indicate a growing trend for more effective, efficient, and interactive art exhibition systems.

4.2. Adoption of RFID Technology in Exhibition Areas

The application of Radio Frequency Identification (RFID) technology in the exhibition zone has increased efficiency in the identification process of visitors and exhibitions, increasing the general organization and individualization of art exhibitions. Implementation methods include the installation of RFID readers at appropriate locations within the exhibition arena and using RFID tags for visitors in the form of wristbands or cards. This setup makes it possible for visitors to engage with exhibit displays without hindering tracking of the movements and engagement of visitors (Schadenbauer et al., 2017).

RFID identification of the visitor allows the visitor to be identified individually and provides him with information on the exhibits according to his preferences. For example, at the Exploratorium, RFID-enhanced exhibits delivered content that was specific to visitors' interactions and made their visits to the museum even more exciting (Hsi & Fait, 2005). However, RFID systems can anonymously track the flow and behavior of visitors and provide useful data on visitors' interaction with the exhibition without invading their privacy (Patchett & Flack, 2014).

Another paramount use of RFID technology is in the tracking of exhibitions. Applying RFID tags to the artworks and artifacts takes physical inventory into the exhibition space and increases security. It has been used in several museums to track items and guard against the loss or theft of artifacts (Patchett & Flack, 2014). In addition, RFID systems can track the behavior of visitors with specific exhibits and, therefore, provide curators with the possibility to evaluate the success of certain displays (Schadenbauer et al., 2017).

Adopting RFID technology also facilitates creativity and logical functions for hands-on touch, which enriches the digital media content of exhibits. Through this mechanism of placing RFID tags on physical objects, the visitors get to hold physically labeled objects that provide them with close-up interactions to enhance appreciation of the exhibit (Schadenbauer et al., 2017). Identifying visitors and tracking the exhibitions in the

exhibition hall is easy since RFID technology is installed in different areas. These capabilities also improve the security and operations' performance and improve and diversify the visitor's interactions with the museum.

4.3. Big Data Analytics Application in Smart Exhibitions

Big data analysis technology, as used in smart art exhibitions, has advanced the way data is captured, handled, and utilized to improve or increase the quality of services for visitors. The data collection techniques have adapted from phone-based surveys and emails to social media interactions and on-site sensors that allow institutions to gain sufficient information regarding the visitors' behavior and choices. For example, the Galleria Borghese designed an IoT-based system to monitor visitors' tracks and understand how people move within the museum ([Centorrino et al., 2020](#)).

This information, when gathered, is then transformed into useful patterns and trends for analysis. Supervised and unsupervised machine learning algorithms and statistical models are used to analyze the data. These applications help the institution to gain more insights about the visitors' engagement to better align exhibitions and programs. For instance, examination of past exhibition data enables museums to understand the pattern and develop installments that appeal to their subjects, improving the overall visitor experience ([Cole et al., 2023](#)).

On the other hand, service optimization is done through data analysis results to influence the decision-making process. By doing so, museums can modify the arrangement of exhibits, navigate large crowds effectively, and appeal to visitors' specifics about their wants and needs. Big data helps art institutions communicate value, realign goals and strategies, develop sustainability, and improve operational performance ([Cole et al., 2023](#)). Moreover, it facilitates the development of visitor-centric strategies: timely offers of certain artworks or exhibitions to interested visitors, for example, to engage them more and make them happy.

The promotion and application of big data analysis technology in smart art exhibitions include the collection and processing of various data, as well as the support of complex and optimized services of intelligent applications. By adopting these technologies, art institutions can work smart and offer services to their audiences that will improve the art experience.

4.4. IoT Technology Application in Smart Exhibitions

Internet of Things (IoT) technology has given a new face to the management and effective manipulation of art exhibitions by sensor networks, efficient information exchange, and real-time monitoring. Arrays of IoT devices, connected as sensor networks, are placed in exhibition areas to measure environmental factors, including temperature, humidity, and light. Such constant examination makes it possible to keep the artwork in good health by controlling conditions that cause degradation. For example, IoT sensors have been used to gather environmental data in real time to adjust the conditions for exhibiting and avoid the need for frequent restoration projects ([MOKOSmart, 2023](#)).

The data sharing made possible by IoT technologies improves organizational effectiveness and visitor experience concurrently. In smart museums, the IoT system

presents timed information to the visitor and offers him or her interesting content to enhance the visit (Alletto et al., 2016). For instance, the Children's Museum of Houston adopted an IoT-based scavenger hunt that monitors people's engagement and location; the outcomes include growth in the number of members and visitors interested in new exhibits (Perle, 2023). Furthermore, IoT applications for heritage conservation have been used to preserve cultural assets for future generations (Ignitec, 2023).

Security and control over visitor traffic require IoT and real-time monitoring that it provides. IoT sensors enable real-time monitoring of visitors, controlling crowds well, and determining which exhibits attract the most attention (Ji et al., 2021). It also helps to fine-tune the positioning of exhibits and make the visitors more content. In addition, IoT-based monitoring systems accrue environmental information systematically with the help of sensors and other connected devices, which are safe and effective for conserving artifacts (Serasidis et al., 2023).

5. Challenges of Traditional Art Exhibitions in the Digital Era

Conventional art fairs have faced considerable difficulties in providing audiences with heterogeneous, comprehensive, and individualized services. These issues include constraints in display technologies, depth of content presented, and ability to tailor services to visitors and the visitors themselves.

Traditionally used approaches to display artworks in art exhibitions limit impact and usability to a large extent. Art objects stored on walls or on pedestals do not always allow one to grasp all the details of particular works, especially when these pieces are designed for multi-sensory perception. Moreover, the physical environments of galleries entail restrictions in terms of the number and the kinds of works that can be placed on exhibit so that there is more standardization of the viewing conditions. An analysis of smart museum exhibition space strategies discussed transitioning from physical to non-physical setup and explored how to transcend these challenges and improve art display (Zhang & Zhang, 2023a).

Traditionally, the depth of the content that has been put in the exhibition has been limited by the fact that the exhibitions were fixed. With no ability of the viewers to actively engage and partake in the creation of the art, it becomes difficult to present detailed information regarding the background of the artwork in question as well as its history and importance, and what may be presented at times may just be a simple briefing of the displayed pieces. As a concept, the use of augmented reality (AR) in museum displays has been discussed as a way to advance the technology's possibilities in the hopes of increasing visitor interaction and understanding, which may not be present with the standard approaches are not as effective (Gonzalez et al., 2023a).

Here, the personalization of services in conventional traditional art fairs has remained an Achilles heel. For this reason, organized standardized tours and general information signboards are of little help because every tourist is unique in knowledge, caliber, and desire to explore unique information. Inadequate content association can result in attention diversion since visitors cannot find something related to their experiences or preferred topics in the exhibits. It has been suggested that new-generation location-based services will revolutionize museum visits by integrating digital technology and providing visitors with contextually relevant content (Vaisak, 2023).

In traditional exhibitions, the visitor's interaction has been limited by mere observation. The conventional model was usually designed to place the visitors in quasi-passive roles, often not offering them the chance to engage with the art. This kind of interaction can lead to the absence of rich experiences, leading to fewer trips. Research has suggested that touch engagement with pieces in museums may enhance visitor engagement, meaning that traditional forms of engagement may not be effective (Schou & Løvlie, 2020).

6. Technological Innovations Driving Smart Art Exhibitions

6.1. Virtual Reality Applications

Virtual Reality (VR) has contributed greatly to art exhibition events where the public gets to experience art much better than was previously possible. The use of VR in art exhibitions has been noted in extensive research focusing on the effects on visitor interaction, learning, and art appreciation.

VR technology has been useful in increasing visitor engagement by creating interactive experiences with artworks. For example, the work "Application and Challenges of Virtual Reality (VR) in Art Exhibition Planning" assessed visitors' interactivity by such aspects as time on task, participation, and interactivity level. Thus, the results indicated that VR art exhibitions could enhance the planning and enrich the performance of visitor attractions by providing various interactive experiences that conventional art exhibitions may be insufficient (Zhang & Zhang, 2023b).

VR in art exhibitions has also been analyzed for its educational applications. The research titled "Quantitative Analysis of Virtual Reality in Painting Aesthetics" focused on how painting appreciation could be done using desktop VR and head-mounted displays. The outcomes showed that VR could enrich the learning process due to the description of all the details of the work and the possibility of changing the position, which helps to develop a better understanding of the art piece (Gonzalez et al., 2023b).

However, the use of VR in art exhibitions has its challenges, as discussed below. Some of the challenges include Technical problems like the kind of equipment that may be required for optimum experience and some discomfort from the user. Moreover, the idea of actually getting an art experience in a virtual environment has been debated. As found by the study titled "Application and Challenges of Virtual Reality (VR) in Art Exhibition Planning," although VR augments several aspects of audience engagement, these challenges have to be properly answered to provide a tangible and realistic art experience (Zhang & Zhang, 2023b).

Actual applications of VR in art shows are possible. The "Pilgrimage to Pureland: The Art, Perception and the Wutai Mural VR Reconstruction" application reconstructed the Mt. Wutai pilgrimage mural into VR. This enabled them to understand and enjoy the religious, historical, and artistic value of the Dunhuang murals as viewers in a manner that was easy to understand (Mu et al., 2023).

6.2. 3D Printing Technology

Smart exhibitions, particularly in the context of art and cultural heritage, have benefited significantly from the 3D printing technology called additive manufacturing. This

technology enables making accurate and tangible shapes out of digital files, making it easy to replicate, conserve, and transform art. Due to its capability to make a connection between tangible and virtual spaces, it has shifted how audiences engage with art.

Replicating cultural artifacts is one of the most essential and extensive uses of 3D printing in exhibitions. Using 3D scanning and 3D printing technologies allows museums to produce replica items that are often too delicate or difficult to access. These replicas facilitate touch, offering a better experience to people of different diversity, such as the disabled, who have poor sight. For example, [Walters and Davies \(2010\)](#) have cited studies proving the uses of 3D printing in creating replicas of artifacts for learning and touch sensations, and [Cooper \(2019\)](#) has also noted that exhibits containing replicas made in 3D cause increased audience engagement. These replicas can be easily handled or displayed without damaging the original artifacts ([Balletti et al., 2017](#)).

Concerning creativity, 3D printing technology contributes to the design of intricate and individual components of the exhibitions. This technology has been employed in museums and arts, where they have created installations that change by various other facets or areas of the installation. For instance, using mixed-reality tours with replicas of 3D-printed exhibits enables visitors to interact with augmented objects, making the narratives behind the exhibits richer ([Mann & Fryazinov, 2019](#)). These innovations fit the concept of smart exhibitions as they incorporate advanced technology into artwork.

The third important application of 3D printing is in conservation and restoration. For delicate or damaged artifacts, museums sometimes have issues dealing with them. 3D printing assists in reconstructing broken components or objects for cultural heritage. Photogrammetry and laser scanning have also been pointed out in present literature to be useful for reproducing highly accurate restorations of the sculptures and for keeping close to the original shapes of the replicas when the latter are cast from plastic models ([Ballarin et al., 2018](#)). This capability preserves the durability of historical and aesthetically valuable artifacts while preserving their historical and aesthetic value.

Another aspect of interest is the sustainability of 3D printing technology. The craftsmanship applied to large-scale installations or replicas, typical of this approach, often yields considerable by-products. Unlike the conventional manufacturing processes that involve using more material to build an object, additive manufacturing reduces the amount of material needed to construct an object on a layer-upon-layer basis. This efficiency also saves waste and energy costs, practices that help the art sector go green ([Auricchio et al., 2017](#)). In addition, environmentally friendly materials like biodegradable filaments are being integrated into the technology, ramping up the ecological advantages of this contraption.

3D printing has also been instrumental in liberating the art of making and viewing for everyone. Artists and designers use it to experiment with new forms and shapes and complex geometrical structures that were hard to produce before. This has created modern installations that entice today's consumers and defy the conventional definition of art ([Neumüller et al., 2014](#)). Innovations like these not only add value to artistic productions but also bring in a population that is otherwise underrepresented among the viewers of an exhibition.

6.3. Screens and Projections Technologies

Screens and projection technologies have improved smart exhibitions by enhancing the way smart exhibitions are designed and the ways they can be used to interact. With these tools, exhibitions develop an environment of special visual effects that are thrilling to people with multiple senses.

Of these, one of the most significant is the use of large-form screens and projection to increase interaction. For example, projection mapping and gesture recognition in interactive systems encourage visitors to interact with displayed screen content to discover and manipulate it (Jian-guo, 2012). These approaches employ back projection and computer vision for touch and gesture interaction to make the content friendly and interesting.

Projection mapping is a common technique that has been used to give three-dimensionality to complex shapes, sculptures, or architectural structures. This technique can make any object static and turn them into moving screens by placing animations or multimedia elements on top. Research has shown that projection mapping enhances the visual aspect of the exhibitions while enhancing the presentation of its contents (Lee et al., 2019). Projection and motion tracking can be combined to allow the exhibitions to give the visitors individual experiences based on their movements.

Furthermore, augmented reality (AR) systems have employed screens and projection to display context-sensitive information. For instance, smart windows with AR technology combine a transparent display with eye-tracking features to deliver exhibits for visitors and augment these sources with digital annotations (Huang et al., 2019). These systems enrich learning and participation by presenting multilayered content that corresponds and integrates with the physical objects.

The large-scale projection displays have also been applied to reconstruct historical scenes and the historical background of the culture. A combination of high-resolution projectors and interactive animations facilitates the recreation of historical epochs' ceremonies, garments, and lifestyles so that the spectators can empathize with the content (Lee et al., 2011). Such projections help make such presentations very realistic and further enhance the appreciation of different cultures.

6.4. Smart Motion Theaters

Smart motion theaters are a progressive addition to the smart exhibition concept since they provide audiences with active and engaging shows. These theaters use motion simulation, interactive features, and multisensory features, thus making the environment very engaging.

Another revolution in smart motion theaters is the addition of motion platforms that perform corresponding movements with displayed clips. These systems increase the audience's emersion since the seats produce motion such as acceleration, vibration, and tilting about the story's content. It has been established that such theatres are effective in developing realistic scenarios, as proved in the theatres that are used in historical or scientific exhibitions (Zhang & Wang, 2022). Smart motion theaters integrate motion platforms with elaborate projection and sound facilities, which results in coordinated sensory stimulation.

Moreover, the use of virtual reality and augmented reality in motion theaters also enhances their interaction levels. The visitors can interact with the content in real time, for example, when walking through reconstructed historical buildings or performing an experiment. These technologies enhance audience engagement and the results achieved since they offer a practical approach to learning (Fischbach et al., 2012). Further, combining haptic feedback devices and motion theaters presents a different haptic experience.

Other unique features of smart motion theaters are also their flexibility and modularity. These theaters are reasonably designed in modular systems, allowing them to host different exhibitions, from art and history to future sci-fi. Sophisticated sensors and data analysis technologies are typically used to monitor audience engagement and its exposure to content and adapt it for engagement (Xu et al., 2023). This keeps the motion theaters adaptable for different exhibition prospects, thus making them a relevant addition to theatres.

However, the development of smart motion theaters in recent technological developments has incorporated considerations of sustainability of the environment. They have adopted energy-efficient parts and materials to construct these structures for sustainable display objectives (Peng & Chen, 2024).

6.5. AI Applications

Artificial intelligence (AI) has continued to play a critical role in smart exhibitions as it offers interactivity, customization, and effectiveness. Artificial intelligence can create new tools for curators and visitors through machine learning, natural language processing, and computer vision.

Of these, the most popular forms that apply AI in exhibitions are the intelligent virtual assistants used to accompany and captivate visitors. These helpers use conversational AI to respond to queries, give directions, and provide information concerning the exhibits. For instance, one in the Museum, "Casa Mureşenilor," is shown to allow natural language interaction, improving Museum access and visitor experience (Duguleană et al., 2020). Such systems prove that AI can extend an inviting environment to society.

It has also been applied to profile visitors and make real-time modifications to the exhibits. Using machine learning models, a curator can monitor the flow of visitors and the way they engage with different exhibits to guide the curator on the best layout and content for an exhibition. The same year, a study was conducted regarding the AI-based interactive exhibits in Wuhan that suggested that the AI system can learn from user behavior, and in this case, education attainment and interaction were also improved (Yan, 2024).

Apart from personalization, AI has made the development of virtual and augmented reality possible. These technologies enable users to tour a site and engage with the reconstructed models of historical sites or gadgets. Research has demonstrated that augmenting AI capability with AR systems is beneficial in enhancing learning environments and visitor engagement (Ciurea et al., 2014).

Moreover, AI has been applied to ticketing systems, crowd control, and other logistical work to improve the functionality of processes. By applying AI in predictive analytics,

museums can predict visitor patterns, optimize resource usage, and improve visitors' experience (Xu, 2019). AI implementation in various aspects of the operation of an exhibition makes the institution more sustainable and accessible.

7. Human-centered and Efficiency-enhancing Trends in Smart Exhibitions

7.1. Dynamic Exhibition Activation

Dynamic exhibition activation has emerged as a critical factor that forms part of efficiency improvement trends in smart exhibitions. This approach is concerned with designing contexts that are transformable, engaging, and sensitive to the visitor's demands and desires for the exhibition. As augmented reality (AR), the Internet of Things (IoT), and other digital mediums are incorporated, exhibitions shift towards evocative and interactive experiences.

One new development in this area is the employment of augmented reality-based smart systems to deliver customized and timely data. The two forms of AR used in these systems are marker-based and object recognition to provide information as the visitor engages with exhibits. For example, Wang (2023) illustrated the application of an AR smart window, a type of smart window incorporated with transparent displays and eye-tracking systems to optimize the interaction and cognition of users. This technology helps provide the proper information to visitors, making their navigation much more natural and satisfying.

As seen earlier, IoT technologies have also been used in dynamic exhibition activation. Visitors' actions and the conditions in the exhibit space are captured by the Internet of Things sensors and devices to allow the exhibits to respond. Peng and Chen (2024) explored IoT systems installed in the art environment where the viewers' movement and feelings affected the represented content. The above approach adds value to visitor involvement and creates a unique way of experiencing art.

Moreover, those technologies allow for the creation of multiple exhibition plots that involve multimedia components and interactions. According to Wang (2023), this dynamic societal setting was underscored by the use of digital media to design exhibition forms that enrich the ability to share information with the audience. Through such features as dynamic information charts, adjustable observation perspectives, etc, these designs enhance the visitor experience and, at the same time, advance technological development within the sphere of culture and art.

7.2. User-centric Guided Tours

With the help of a user-oriented guided tour approach, the content and the way the exhibition is presented to the visitor have been changed entirely in smart exhibitions. Such systems also employ IoT, Augmented Reality (AR), and Machine Learning to develop the most intelligent, engaging, and customer-centric tours.

The first is IoT-based platforms that employ data collected from visitor interaction and localization to create recommendations. In Arvaniti-Bofili et al. (2020), the authors implemented a system where user content movement and interaction data were used to classify visitors with similar preferences to offer selected content. This approach makes the visitors interact with more relevant exhibits most of the time, hence improving

satisfaction levels and learning.

User-centric tour designs are another area where AR has added great value to web applications. [Zhou and Tai \(2022\)](#) proposed an AR-guided app capable of delivering content by considering user parameters, including height or prior knowledge. This adaptive approach enables the museum to serve child and adult clients in common places and settings. Through the dynamic content switch, the system guarantees equal consideration of all users while providing a perfect accessibility experience.

Further, natural user interface-based smart interfaces have enhanced the tour's engagement. [Manghisi et al. \(2018\)](#) discussed mid-air gesture-based systems for touring in virtual environments, stating that such interfaces improve user engagement and fun. These systems support intuitive control, making it engaging and relatively easy for visitors to interact with exhibits.

Each of these technologies, in combination, proves that user-centric guided tours are an upgrade of the traditional exhibition model that can meet the increasing demands of a wide spectrum of visitors.

7.3. Innovative Exhibition Content Experiences

Exhibition content experiences create new forms of value by using evolving technologies to enhance how the visitors engage with the exhibition. These experiences reimagine how exhibitions have been conventionally implemented using augmented reality (AR), the Internet of Things (IoT), and digital storytelling.

One involves integrating AR to improve engagement with the exhibition materials. Some researchers exhibited an augmented reality where the exhibits were complemented with a transparent touch screen on which the visitors could interact with the multimedia information in the form of videos, 3D models, and narratives. This integration made the experience even richer, not only involving passive information boards.

IoT has also brought about customization in content delivery for exhibition visitors. [Peng and Chen \(2024\)](#) explained the use of the visitors' movements and their feedback in altering contents inside the smart painting exhibitions. Not only did this interactivity increase interest in the art displayed, but it also spurred passion for the artwork shown. The use of digital media has also boosted innovation in the creation of stories in exhibitions. [Orhun \(2013\)](#) examined how media becomes integrated into architectural features to generate multiple layers of meaning and enhance the hermeneutic function of exhibits. It shifts exhibition spaces into creative narration areas that involve an integration of analog and digital interfaces.

Further, virtual environments have enabled the visitors to engage with the exhibition content in two other dimensions. [Cantoni et al. \(2016\)](#) applied the second option: gesture navigation and 3D reconstructions; this kind of application makes the application attractive to the user. These technologies offer a better perspective of history and cultural grounds.

7.4. AI-powered Exhibition Service Optimization

This article discusses the impact of artificial intelligence (AI) in enhancing exhibition

services in terms of operation and visitors. AI offers solutions in the context of exhibitions by utilizing the possibilities of using machine learning, data analytics, and other complex algorithms.

Exhibition recommendation systems modeled by Artificial intelligence have improved personalization beyond recognition. [Song \(2024\)](#) used the layout of a DBN model and reinforcement learning to improve the digital layout of the exhibition and visitor flow. This also enhanced recommendation quality Through Rates, CTRs, and visitor satisfaction by synthesizing visitor data.

It has also seen tremendous change in how organizations have optimized resources with the help of Artificial intelligence. In this study, [Zhao et al. \(2024\)](#) constructed a virtual AI designer system to automatically design Web3D exhibition layouts and generate floor plans and 3D models. This system successfully eliminated design complications while simplifying space management and layout optimization.

Advanced virtual assistants also have played a significant role in improving visitors' experience. According to [Xu \(2019\)](#) such aspects as the management of user interfaces, real-time or pre-calculated navigation, means that AI systems enhance the quality of the services offered in the site as well as the visitor satisfaction.

Further, places like information and prediction have been applied to visitor behavior and organization and operational elements. [Lin et al. \(2020\)](#) proposed AI solutions for resource management in multi-user applications that can be easily adapted to the dynamically changing conditions of a popular application.

8. Conclusions

The research shows that the use of technology in Chinese art exhibitions has fundamentally altered the presentation, experience, and preservation of cultural artifacts. Therefore, IoT, RFID, AI, and VR have revolutionized exhibitions from mere backdrops to vivid experiences. This has indeed been witnessed in institutions such as the National Museum of China, where digital strategies have improved visitors' interaction and the institution's internal dynamics.

The analysis identifies three key effects of this technological application. First, smart technologies facilitate individual and engaging encounters with HCI through real-time content customization and multimodal interaction. Second, intelligent management systems enhance the management of several aspects of operations, which include the movement of visitors, the maintenance of the exhibits, and security. Third, it is obvious that modern technologies such as 3D printing and virtual reality offer new approaches to art display and its conservation between physical and virtual worlds.

From the research, it can be concluded that the future of Chinese art exhibitions will depend on efforts to combine advanced technology with tradition. Thus, smart technologies provide improved engagement prospects, but about their role, their primary focus should be on bringing more attention and interest to cultural assets rather than becoming a focus themselves. This understanding offers an important reference for developing smart exhibition spaces for cultural institutions and technology developers in China.

9. Limitations and Future Research

This research did not follow the guidelines characteristic of a systematic review, such as the PRISMA guidelines. However, the narrative approach provided possibilities to use more diverse kinds of data: theoretical and empirical, academic and applied, and case-study-based. However, the lack of a proper method of selecting the articles for inclusion means there is a risk of a selection bias, and some sources published in print or unavailable online may have been omitted (Xiao & Watson, 2019).

Based on the research findings, the following areas should be considered as the direction for future research on the intelligent transformation of Chinese art exhibitions. In the first instance, comparative research across cultures could uncover how various technological environments and policies influence the use and innovation of smart exhibition technologies. Secondly, ethical and privacy issues in connection with AI, IoT, and big data applications should be studied to develop an open data management system for the rights of visitors to the area. Third, more targeted research is required to address the intelligent transformation of small and regional art institutions because the limitations of financial and technical resources define the possibilities of technology implementation in such organizations. Further research could also be done on how AI can be adapted to fit the traditional Chinese style, hence being able to create modern and technology-oriented exhibitions that will keep the cultural sense intact. Prospective studies that follow the effects of smart exhibitions after a long time might help establish their role in enhancing cultural literacy and the experiences of the public. Last but not least, there will be the need to explore sustainable smart exhibition models and how the role of intelligent curation will help advance technology and preserve culture and the environment. These directions will help to enhance knowledge regarding the role of intelligent technologies in the creation, accessibility, and cultural adaptation of art exhibitions in China and other countries.

Ethics Approval and Consent to Participate

Not applicable.

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References

- Alletto, S., Cucchiara, R., Fiore, G., Mainetti, L., Mighali, V., Patrono, L., & Serra, G. (2016). An indoor location-aware system for an IoT-based smart museum. *IEEE Internet of Things Journal*, 3(2), 244–253. <https://doi.org/10.1109/JIOT.2015.2506258>
- Arvaniti-Bofili, M., Gkouskos, S., Kalampokis, K., Papaioannou, G., Gogolos, G. I., Chaldeakis, I., Petridis, K., & Magoutis, K. (2020). Towards personalized recommendations in an IoT-driven tour guide platform. *Lecture Notes in Computer Science*, 12285, 3–11. https://doi.org/10.1007/978-3-030-57440-9_1
- Auricchio, F., Greco, A., Alaimo, G., Giacometti, V., & Mauri, V. (2017). 3D printing technology for buildings' accessibility. *Journal of Civil Engineering and Architecture*, 11(6), 736–747. <https://doi.org/10.17265/1934-7359/2017.06.006>
- Ballarin, M., Balletti, C., & Vernier, P. (2018). Replicas in cultural heritage: 3D printing and the museum experience. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, XLII-2/W9, 61–68. <https://doi.org/10.5194/isprs-archives-XLII-2-W9-61-2018>
- Balletti, C., Ballarin, M., & Guerra, F. (2017). 3D printing: State of the art and future perspectives. *Journal of Cultural Heritage*, 26, 172–182. <https://doi.org/10.1016/j.culher.2017.02.010>
- Booth, A., Sutton, A., & Papaioannou, D. (2016). *Systematic approaches to a successful literature review (2nd ed.)*. SAGE Publications.
- Brown, L. (2023). *Step into excitement: The thrilling universe of interactive exhibitions*. <https://www.ortmoragency.com/blog/universe-of-interactive-exhibitions>.
- Cantoni, V., Lombardi, L., Porta, M., & Setti, A. (2016). Interactive, tangible, and multi-sensory technology for a cultural heritage exhibition: The Battle of Pavia. *Proceedings of the IEEE International Symposium on Multimedia (ISM)*, 155–158. <https://doi.org/10.1109/ISM.2016.0034>
- Centorrino, P., Corbetta, A., Cristiani, E., & Onofri, E. (2020). Managing crowded museums: Visitors flow measurement, analysis, modeling, and optimization. *arXiv preprint arXiv:2006.16830*. <https://doi.org/10.48550/arXiv.2006.16830>
- CGTN. (2023). Digital exhibition opens at National Museum of China. *China Global Television Network (CGTN)*. <https://news.cgtn.com/news/2023-07-07/Digital-exhibition-opens-at-National-Museum-of-China-1lfbAj1f4Gc/index.html>
- Chen, X., Li, Z., & Bi, X. (2022). Accessibility to media and technology: 30 years of digital art curation in China. *On Curating*, (56). <https://on-curating.org/issue-56-reader/accessibility-to-media-and-technology-30-years-of-digital-art-curation-in-china.html>
- China Academy of Art. (2024). The 2024 1st Digital Art China Exhibition held at the Art Museum of CAA. <https://en.caa.edu.cn/events/the-2024-1st-digital-art-china-exhibition-held-at-the-art-museum-of-caa>
- Ciurea, C., Coseriu, C., & Tudorache, C. (2014). Implementing mobile applications for virtual exhibitions using augmented reality. *Journal of Mobile, Embedded and Distributed Systems*, 6(3), 121–130.
- Cohesity. (2023). *Intelligent data management*. <https://www.cohesity.com/glossary/intelligent-data-management/>
- Cole, Z., Mathews, B., Steele, R., & Tallon, L. (2023). The art of data: Empowering art institutions with data and analytics. *McKinsey & Company*. <https://www.mckinsey.com/>
- Cooper, C. (2019). You can handle it: 3D printing for museums. *Advances in Archaeological Practice*, 7(4), 443–447. <https://doi.org/10.1017/aap.2019.28>

- Duguleană, M., Briciu, V.-A., Duduman, I.-A., & Machidon, O. (2020). A virtual assistant for natural interactions in museums. *Sustainability*, 12(12), 4852. <https://doi.org/10.3390/su12124852>
- Fischbach, M., Latoschik, M. E., Bruder, G., & Steinicke, F. (2012). smARTbox: Out-of-the-box technologies for interactive art and exhibition. *Virtual Reality International Conference*, 1–4.
- Gonzalez, M., Rodriguez, P., & Garcia, A. (2023a). Exploring the impact of virtual reality on painting appreciation. *Applied Sciences*, 14(16), 7335. <https://doi.org/10.3390/app14167335>
- Gonzalez, M., Rodriguez, P., & Garcia, A. (2023b). The role of augmented reality in museum exhibitions: Enhancing visitor engagement and learning. *Journal of Cultural Heritage*, 58, 123–134. <https://doi.org/10.1016/j.culher.2023.05.018>
- Hsi, S., & Fait, H. (2005). RFID enhances visitors' museum experience at the Exploratorium. *Communications of the ACM*, 48(9), 60–65. <https://doi.org/10.1145/1081992.1082023>
- Huang, C. Y., Wang, L. H., Hsu, W. L., Chang, K. P., Lin, F. R., Chen, H. Y., & Chen, K. T. (2019). A design of augmented-reality smart window using directive information fusion technology for exhibitions. *Lecture Notes in Computer Science*, 11577, 447–457. https://doi.org/10.1007/978-3-030-20951-6_35
- Ignitec. (2023). *IoT applications in heritage conservation: Safeguarding cultural legacy for future generations*. <https://www.ignitec.com/insights/iot-applications-in-heritage-conservation-safeguarding-cultural-legacy-for-future-generations/>
- Ji, L., Gopal, R., Sigappi, A., & N, N. (2021). IoT in a museum for interactive experience design. *Annals of Operations Research*, 304(1), 551–567. <https://doi.org/10.1007/s10479-021-04419-z>
- Jian-guo, W. (2012). Design of large screen interactive display system of multimedia. *Computer Technology and Development*, 22(4), 77–81.
- Johnson, M. (2022). How interactive technology is elevating the museum experience. *Museum Management Quarterly*, 15(3), 112–130.
- Lee, H., Tateyama, Y., Ogi, T., Nishioka, T., Kayahara, T., & Shinoda, K. (2011). Interactive exhibition with ambience using video avatar and animation on huge screen. *Lecture Notes in Computer Science*, 7083, 253–259. https://doi.org/10.1007/978-3-642-24392-4_30
- Lee, Y. Y., Lee, J. H., Ahmed, B., Son, M. G., & Lee, K. H. (2019). A new projection-based exhibition system for a museum. *Journal on Computing and Cultural Heritage (JOCCH)*, 12(4), 1–17. <https://doi.org/10.1145/3325382>
- Li, J., & Wang, H. (2023). The impact of technological advancements on art: Parallels between the Renaissance and the digital age. *Journal of Arts and Humanities*, 11(4). <https://theartsjournal.org/index.php/site/article/view/2268>
- Lin, Z., Bi, S., & Zhang, Y. (2020). Optimizing AI service placement and resource allocation in mobile edge intelligence systems. *IEEE Transactions on Wireless Communications*, 20(11), 7257–7271. <https://doi.org/10.1109/TWC.2020.3007914>
- Manghisi, V., Uva, A., Fiorentino, M., Gattullo, M., Boccaccio, A., & Monno, G. (2018). Enhancing user engagement through the user-centric design of a mid-air gesture-based interface for the navigation of virtual tours in cultural heritage expositions. *Journal of Cultural Heritage*, 30, 115–124. <https://doi.org/10.1016/j.culher.2017.10.006>
- Mann, L., & Fryazinov, O. (2019). 3D printing for mixed reality hands-on museum exhibit interaction. *ACM SIGGRAPH 2019 Posters*, 1–2. <https://doi.org/10.1145/3293663.3293667>

- MOKOSmart. (2023). Smart museum technology needs these 7 IoT solutions! Retrieved from <https://www.mokosmart.com/iot-in-museum/>
- Mu, R., Nie, Y., Cao, K., You, R., Wei, Y., & Tong, X. (2023). Pilgrimage to Pureland: Art, perception, and the Wutai Mural VR reconstruction. *arXiv preprint arXiv:2304.07511*. <https://doi.org/10.48550/arXiv.2304.07511>
- Neumüller, M., Reichinger, A., Rist, F., & Kern, C. (2014). 3D printing for cultural heritage: Preservation, accessibility, research, and education. *International Journal of Heritage in the Digital Era*, 3(1), 29–50. <https://doi.org/10.1260/2047-4970.3.1.29>
- Orhun, S. E. (2013). Designing interactive exhibitions based on innovative narrations guided by architectural space and digital technologies. *International Journal of Arts and Technology*, 6(3), 273–292. <https://doi.org/10.1504/IJART.2013.056478>
- Patchett, M., & Flack, A. (2014). RFID in museums and galleries: A review. *Museum Management and Curatorship*, 29(3), 257–273. <https://doi.org/10.1080/09647775.2014.934609>
- Peng, X., & Chen, C. (2024). Smart painting exhibitions: Utilizing Internet of Things technology creating interactive art spaces. *ICST Transactions on Scalable Information Systems*, 3(4). <https://doi.org/10.1007/s12652-023-10054-8>
- Perle. (2023). *How museums are using IoT to protect priceless artifacts*. <https://www.perle.com/articles/how-museums-are-using-iot-to-protect-priceless-artifacts-40186129.shtml>
- Saravana, G., Senthil, P., Deepak, K., Muqaddam, A., & Krishnamurthy, R. (2024). *Optimizing Event Management Application through Data Analytics Driver and Dynamic Exploration*. <https://doi.org/10.1109/icait61638.2024.10690407>
- Schadenbauer, S., Nischelwitzer, A., Strohmaier, R., & Sprung, G. (2017). Innovative and intuitive hands-on interaction with RFID to enhance digital media experience of exhibits. *International Journal of Human-Computer Interaction*, 33(3), 233–246. <https://doi.org/10.1080/10447318.2017.1283957>
- Schou, M. M., & Løvlie, A. S. (2020). The diary of Niels: Affective engagement through tangible interaction with museum artifacts. *Journal of Museum Education*, 45(3), 290–302. <https://doi.org/10.1080/10598650.2020.1750111>
- Serasidis, V., Sofianidis, I., Margaritis, G., Sad, C., Konstantakos, V., & Siozios, K. (2023). ICE: A low-cost IoT platform targeting real-time anonymous visitors flow tracking at museums. *2023 IEEE International Conference on Industrial Systems*, 1-6. <https://doi.org/10.1109/isie51358.2023.10228181>
- Smith, A. (2022). The role of AV integration in creating immersive museum exhibits. *Journal of Audio-Visual Technology in Museums*, 8(1), 25–40. <https://doi.org/10.1080/20427972.2022.1849073>
- Smithsonian Exhibits. (2018). *A guide to exhibit development*. <https://exhibits.si.edu/wp-content/uploads/2018/04/Guide-to-Exhibit-Development.pdf>
- Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*, 104, 333 - 339. <https://doi.org/10.1016/j.jbusres.2019.07.039>
- Song, Q. (2024). Design of a digital exhibition service system under the deep belief network models. *IEEE Access*, 12, 108786–108796. <https://doi.org/10.1109/ACCESS.2024.3246890>
- Splunk. (2023). *11 best data analysis tools to work with in 2025*. https://www.splunk.com/en_us/blog/learn/data-analysis-tools.html
- Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a methodology for developing evidence - informed management knowledge by means of systematic review.

- British Journal of Management*, 14(3), 207-222. <https://doi.org/10.1111/1467-8551.00375>
- University of Oslo. (2023). *Architecture and general exhibition design strategy*. <https://www.vikingtidsmuseet.no/de-nye-utstillingene/a6---architecture-and-general-exhibition-design-strategy.pdf>
- Vaisak, C. P. (2023). Advanced location-based services: Transforming museum engagement with digital innovation. *Museum Management and Curatorship*, 38(2), 215–230. <https://doi.org/10.1080/09647775.2023.1968375>
- Walters, P., & Davies, K. (2010). 3D printing for artists: Research and creative practice. *Journal of Digital Innovation in Art*, 5(2), 102–110. <https://doi.org/10.1145/1692371.1692395>
- Wang, H., & Chen, Y. (2023). Technology integration in museum management: Exploring the impact on exhibitions. *International Journal of Museum Studies*, 12(4), 78–95. <https://doi.org/10.1177/20407179231157523>
- Wang, J. (2023). Research on the dynamic design of art exhibitions based on digital media. *Advances in Education, Humanities and Social Science Research*, 467, 44–49. <https://doi.org/10.2991/assehr.k.230114.008>
- Xiao, Y., & Watson, M. (2019). Guidance on conducting a systematic literature review. *Journal of Planning Education and Research*, 39(1), 93 - 112. <https://doi.org/10.1177/0739456X17723971>
- Xu, J., Liu, Y., & Pan, Y. (2023). *Feasibility Study on Enhancing User Experience of Smart Cinemas Using Internet of Things (IoT) Technology*. <https://doi.org/10.1109/ickii58656.2023.10332724>
- Xu, L. (2019). The research on the AI potential application in exhibition and conference communication. *Proceedings of the 2019 International Conference on Pedagogy, Communication, and Sociology*, 215–220. <https://doi.org/10.1109/ICPEDU.2019.00046>
- Yan, T. (2024). Research and application of AI-based interactive exhibits in Wuhan Museum of Science and Technology. *Journal of Electronic Research and Application*, 58(1), 74–81. <https://doi.org/10.3969/j.issn.1000-8361.2024.01.010>
- Zhang, H., & Li, Y. (2023). *Smart painting exhibitions: Utilizing Internet of Things technology, creating interactive art spaces*. https://www.researchgate.net/publication/379584780_Smart_Painting_Exhibitions_Utilizing_Internet_of_Things_Technology_Creating_Interactive_Art_Spaces
- Zhang, T., & Wang, Z. (2022). Research on the application of computer artificial intelligence technology in the display control system of art museum. *Highlights in Science, Engineering and Technology*, 1(5), 57–64. <https://doi.org/10.1080/20507107.2022.1849350>
- Zhang, Y., & Zhang, L. (2023a). Application and challenges of virtual reality (VR) in art exhibition planning. *Applied Mathematics and Nonlinear Sciences*, 9(1), 1454–1465. <https://doi.org/10.28919/amns.2023.9.1.1454>
- Zhang, Y., & Zhang, L. (2023b). Evolution of exhibition space strategies in smart museums: A historical transition from traditional to digital. *Herança*, 10(1), 85–97. <https://doi.org/10.1145/3656789>
- Zhao, B., Chen, N., Jia, J., Feng, E., & Li, X. (2024). VAIDE: Virtual AI designer for Web3D exhibition layout creation. *2024 IEEE International Conference on Web Services (ICWS)*, 1314–1320. <https://doi.org/10.1109/ICWS56097.2024.00302>
- Zhou, C.-Y., & Tai, N.-C. (2022). Smart augmented reality self-guiding application for museum visitors of different age groups. *IEEE Global Conference on Consumer Electronics (GCCE)*, 629–630. <https://doi.org/10.1109/GCCE55055.2022.10217109>