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## STRATEGY OF DESIGN ONLINE MUSEUM EXHIBITION CONTENTS FROM THE PERSPECTIVE OF ARTIFICIAL INTELLIGENCE

**Purpose:** analyzes the use of artificial intelligence to improve artistic design in online museum exhibitions.

**Methodology.** The work combines a literature review with an analysis of design examples of online museums using artificial intelligence technologies. In particular, the following online museum cases were analyzed: the British Museum (England), the Louvre (France), the Shanghai Museum (China), the Vatican Museum (Vatican), as well as the Mei Lanfang digital project.

**The results.** As a result of the analysis, it was found that artificial intelligence has a profound effect on the artistic components of digital museum exhibits. Outlined, AI tools can dynamically adapt visual content and design elements, enriching the artistic narrative and aligning with the viewer's preferences to create more engaging visual experiences.

**Scientific novelty.** In the article, the principles of using artificial intelligence in artistic design processes in online museums were characterized for the first time. Systematized principles of combining artificial intelligence with artistic design as new methods for increasing the aesthetic consistency and thematic richness of online museum exhibitions.

**Practical significance.** The findings highlight the transformative potential of artificial intelligence in digital art presentations in online museums, particularly through its ability to improve key design elements such as color schemes, typography and user interface. The practical conclusions and recommendations formulated in the work are aimed at creating a design of more visually attractive and artistically rich online museums.

**Keywords:** artificial intelligence, online museum design, user experience, technological integration, personalization strategies, cultural heritage.

**Introduction.** In an era where digital innovation reshapes cultural engagement, the integration of Artificial Intelligence (AI) in online museums is revolutionizing heritage experiences. The adoption of Information and Communication Technologies (ICTs) transforms museum operations, allowing for immersive virtual exhibitions through virtual reality (VR), augmented reality (AR), and interactive archives [1]. This shift transcends physical boundaries, enhancing accessibility and personalizing visitor interactions with cultural artifacts. This paper explores AI's role in optimizing online museum content, aiming to increase visitor engagement and educational value. It addresses the digital challenges and examines AI's potential to refine interactions with cultural heritage, offering insight into the evolving landscape of digital museums.

**Analysis of Previous Researches.** The integration of AI into the fabric of online museum exhibitions is revolutionizing visitor interactions and learning opportunities. By weaving AI into both the content and the design of digital collections, this innovative approach is reshaping educational outreach and enhancing the way audiences connect with exhibits. This significant shift is ushering in a new era of the museum experience, making it more interactive, personalized, and accessible than ever before.

Personalization in Visitor Experiences is a critical area where AI's impact is profoundly felt. Studies underscore AI's ability to tailor exhibitions to individual preferences, enhancing engagement through customized content recommendations [2]. This personalization extends beyond mere content adaptation,

suggesting AI's potential in creating deeply resonant visitor experiences through design-centric approaches. Hyun-Kyung Lee proposes a new museum archiving system that uses artificial intelligence (AI) technology. He developed an image retrieval system based on metadata and transformed intangible emotions of design work into data. This work indicates that AI can effectively manage exhibition narratives and content, ensuring that exhibitions remain relevant and captivating [3]. The Educational Impact of AI-driven tools has also been a significant area of focus. Federica Dal Falco highlighted how AI interfaces could transform educational storytelling within online exhibitions, making them more interactive and thus more effective in conveying complex historical narratives [4]. We found that the use of digital art has a significant impact on museum online exhibitions, contributing to more interactive, immersive, and inclusive visitor access. The integration of ICT into the museum sector encompasses important design aspects such as color, typography, and interface design, which play an important role in the overall design of an online museum [5]. Drawing from this research, it's clear that AI offers unparalleled opportunities for enhancing online museum exhibitions, demanding a nuanced approach that bridges technology and design. The integration of AI into the digital curation of online museum experiences marks a pivotal intersection of design and technology, posing unique challenges, and opportunities for enhancing user engagement, educational outreach, and accessibility. This convergence necessitates a nuanced understanding of design principles to navigate the ethical and practical complexities inherent in employing AI within such culturally significant spaces. Key challenges include adhering to data privacy standards like General Data Protection Regulation (GDPR) [6], addressing biases in AI-curated content to ensure the historical integrity and inclusivity of narratives, and bridging the digital divide to democratize access to technology-enhanced cultural

education. Furthermore, the dynamic nature of AI systems requires a design-centric approach to ensure adaptability and responsiveness to ethical considerations and user needs over time. This study focuses on the critical role of design in effectively integrating AI technologies in online museums, aiming to explore strategies that balance innovative engagement with ethical stewardship. The primary problem is to develop design methodologies that facilitate the responsible use of AI, thereby enriching the museum experience without compromising on privacy, equity, and the authenticity of cultural heritage narratives, ensuring a meaningful and inclusive access to global cultural resources.

**Statement of the Problem.** This research aims to develop an strategy that harnesses AI's strengths while addressing its limitations through thoughtful design and ethical considerations. This strategy seeks to create online museum experiences that are personalized, engaging, and educationally enriching, yet mindful of accessibility and cultural integrity.

**Results of the research and its discussion.** This study illustrates the transformative impact of AI in online museums, highlighting initiatives from the British Museum, the Louvre, and the Smithsonian. These cases reveal AI's ability to personalize visitor experiences, enhance educational outreach, and improve accessibility through recommendation systems, interactive virtual guides, and image recognition technologies. However, integrating AI also presents ethical challenges, such as ensuring data privacy and avoiding biases in historical narratives. Despite these concerns, AI significantly enhances the engagement, inclusivity, and educational value of museum experiences. The research underscores the need for museums to balance innovation with ethical responsibility, advocating for careful AI deployment to maintain integrity in cultural heritage presentation. Future directions should explore strategies for ethical AI use and address the

digital divide, ensuring equitable access to enriched cultural education.

Consider the example of the British Museum, which launched a virtual tour and online gallery facilitated by AI technology (Fig. 1) [7; 8]. This initiative employed personalized recommendation systems that adjusted the presented content based on user behavior and preferences. The system tracked which artifacts and eras users spent the most time exploring and subsequently suggested similar items or themes. This approach not only made the online experience more engaging but also helped the museum understand visitor interest patterns. The use of AI-driven virtual guides, particularly in the form of chatbots equipped with NLP, effectively engaged visitors in two-way communication, making the educational aspect more interactive. For instance, visitors could ask the AI about the Rosetta Stone and receive detailed explanations, context, and even translations of the inscriptions. This interactive experience contributed to a deeper understanding and a more memorable visit.

Additionally, the Louvre museum's online collection utilized image recognition AI to enhance accessibility [9]. Users could upload photos of artworks they were curious about, and the AI would match these images to its database, providing detailed information about the artwork and the artist. The Collections database consists of entries for more than 500,000 works in the Musée du Louvre and Musée National Eugène-Delacroix. Updated on a daily basis, it is the result of the continuous research and documentation efforts carried out by teams of experts from both museums (Fig. 2) [10]. This feature not only improved accessibility for those unable to physically visit the museum but also served educational purposes for students and researchers worldwide.

In terms of predictive analytics and automated curation, the Smithsonian's online exhibitions incorporated AI to analyze visitor data, leading to more informed decisions about

future exhibits and the arrangement of current ones. By predicting visitor preferences, the Smithsonian could adapt its online content to public interest, thus increasing engagement and visitor numbers.

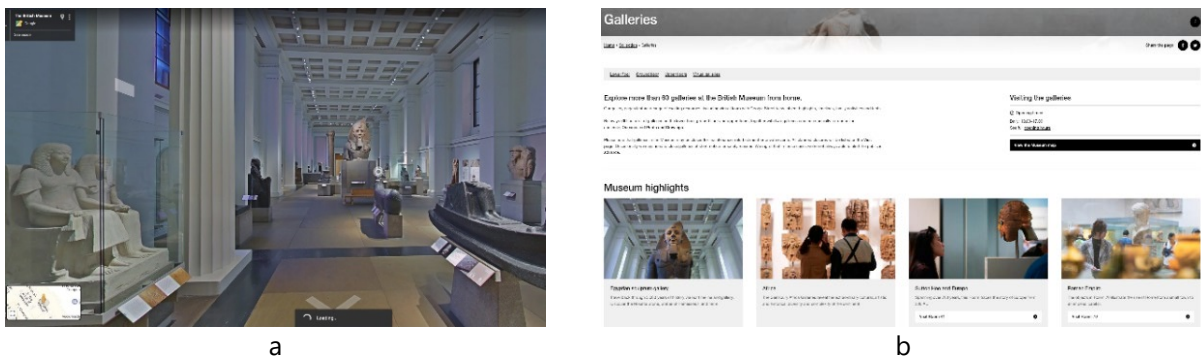
However, the deployment of such AI applications has not been without challenges. For instance, the AI recommendation engine at the British Museum faced ethical questions regarding user data privacy. The museum had to ensure compliance with data protection laws like GDPR while still providing a personalized experience. Moreover, ensuring the AI did not perpetuate biases in historical narratives was a significant consideration for both the British Museum and the Louvre, emphasizing the need for continuous oversight and adjustment of the AI systems.

These case studies highlight the transformative impact AI can have on online museum exhibitions. While AI can significantly enhance personalization, interactivity, and accessibility, museums must navigate the associated ethical and operational challenges carefully. Implementing AI is not just a technological upgrade but a strategic decision that requires museums to balance innovation with responsibility.

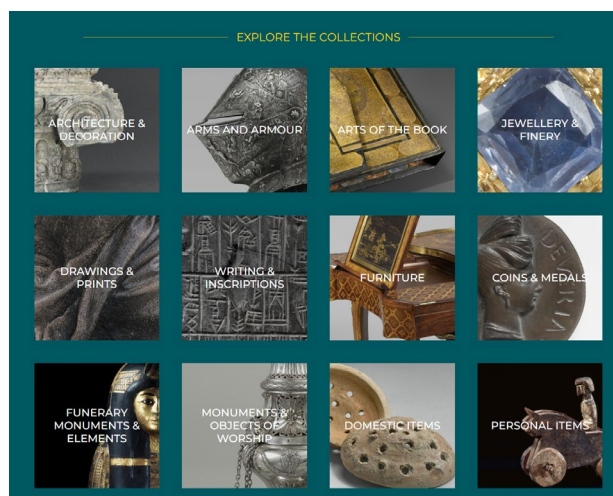
### **Enhancing User Experience with AI and Technological Integration**

The application of AI and advanced technologies in online museum exhibitions represents a significant leap forward in enhancing user experiences. This innovative approach is fundamentally rooted in a data-driven personalization strategy that leverages visitor behavioral data. By doing so, it allows for the dynamic presentation of content that not only aligns with individual interests but also evolves in real-time to meet the changing preferences of visitors. AI plays a critical role in this process by creating engaging narratives that connect artifacts and events, thereby making the museum experience more meaningful and resonant for each visitor.

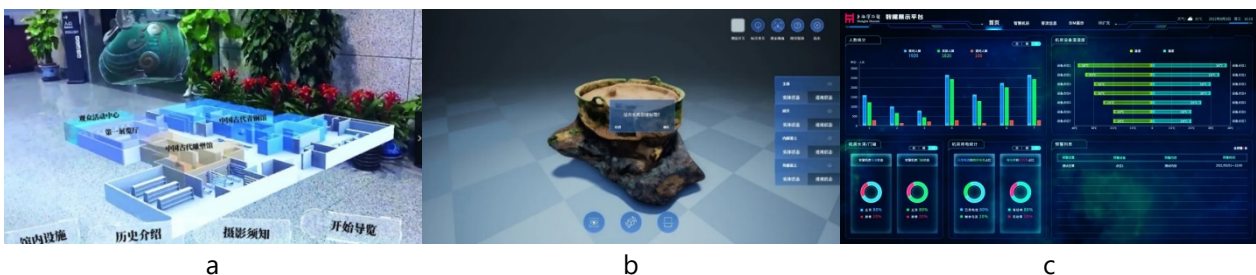
The integration of AI into online museums goes beyond mere content



**Fig.1** The British Museum online:  
 a – "Museum of the World" online platform [7]; b – Online gallery[8] (UK, 2024)



**Fig.2.** The Collections database in the Musée du Louvre and Musée National Eugène-Delacroix [10] (France, 2024)



**Fig. 3.** Shanghai Museum (China, 2024): a - Intelligent museum tour;  
 b - Intelligen assistance in cultural relic restoration; c - Venue information visual display platform [12]

personalization. It extends to increasing interactivity through the use of simulations, gamification, and AR. These technologies cater to various learning styles, significantly broadening the appeal of museum content and making learning both fun and engaging. This approach not only enriches the educational aspect of museum visits but also ensures that the content remains fresh and relevant through

the use of predictive algorithms. These algorithms anticipate updates and changes, keeping the content educationally potent and engaging for visitors.

Moreover, AI significantly enhances visual accessibility in online museums. Through the application of image recognition and AR, visual elements can be transformed into auditory or haptic feedback, making exhibitions accessible

to visitors with visual impairments. This aspect of AI application underscores the importance of inclusivity in the digital age, ensuring that museums can be enjoyed by a diverse audience.

The multilingual and cross-cultural capabilities of AI are indispensable for global accessibility. By providing sensitive and accurate translations of exhibition content into multiple languages, AI facilitates a deeper understanding and appreciation of cultural artifacts across different linguistic and cultural backgrounds. This not only enhances the educational value of museum visits but also promotes cultural exchange and understanding on a global scale.

The Shanghai Museum's pilot AI project exemplifies the comprehensive intelligent

transformation of museum experiences [11]. By employing AI, big data, and the Internet of Things (IoT), the museum has developed a "4 Platforms + 6 Applications" model that encapsulates the entire spectrum of technological advancements in the museum sector (Tab. 1). This model includes applications ranging from information visualization to intelligent guidance and cultural relics restoration, all supported by a robust architecture comprising infrastructure, data, capability, and application layers.

The use of 3D virtual technology for automated tours and interactive roaming experiences represents another frontier in the digital transformation of museums. Coupled with mixed reality (MR) and AR technologies for

**Table 1**

**Shanghai Museum AI experience architecture**

Layer	Component	Description
Application Layer	Intelligent Management System	A system for intelligent management and control of operations.
	Smart Guide	A system providing automated guiding services.
	Smart Ticketing	A system for the automation of ticket sales and management.
	Cultural Relic Restoration	A specialized system for the preservation and restoration of cultural relics.
Capability Layer	AI Capability Platform	A platform offering AI services such as speech synthesis and semantic parsing.
	IoT Platform	A platform for asset management, IoT control, and other IoT services.
	Big Data Platform	A platform for big data processing services like data visualization and integration.
	BIM + FM Platform	An integrated platform combining BIM and facility management.
Data Layer	Data Warehouse	A centralized system for storing enterprise data.
	People Flow Data	Data recording and analyzing the flow of people.
	Ticketing Data	Data containing ticketing information.
	Cultural Relic Data	Detailed data on cultural relic collections.
Infrastructure Layer	Infrastructure	The physical and virtual resources supporting the IT environment.
	Storage Devices	Hardware devices used for data storage.
	Network Devices	Devices that support network connectivity and communication.
	Security Devices	Devices used to protect the system's security.
	IoT Devices	Devices used for implementing IoT functionalities.

intelligent guidance and cultural relics restoration, these advancements offer visitors immersive and experiential ways to engage with museum content (Fig. 3) [12]. Additionally, smart visitor flow analysis through online real-name reservation systems exemplifies how AI can enhance operational efficiency and service quality by optimizing visitor management (Fig. 3, c). The integration of AI and advanced technologies in online museum exhibitions not only personalizes the visitor experience but also makes it more interactive, inclusive, and educational. By employing a data-driven approach, leveraging predictive algorithms for content relevance, and enhancing accessibility through visual and auditory adaptations, AI is transforming the way we interact with cultural heritage.

#### **Artificial intelligence-driven online museum design strategy**

The integration of AI in online museums marks a pivotal shift towards more personalized and interactive experiences. Leveraging AI through natural language processing and machine learning transforms online exhibitions by optimizing narrative content and creating immersive virtual environments. This holistic approach, encompassing narrative strategy, virtual space construction, virtual identities, and interactive enhancements, not only improves user engagement but also streamlines the dissemination of knowledge.

**Narrative Content strategy,** Enhancing Knowledge Dissemination Efficiency. Utilizing AI technologies such as natural language processing and machine learning can optimize narrative content to make it more engaging, understandable, and personalized. AI assists curators in comprehending user behavior and preferences, thus offering customized narrative paths and content. For instance, based on users' previous interactions, the system can recommend related exhibit stories and background information, enhancing the coherence and appeal of the narrative. Moreover, leveraging big data analysis allows for the identification and presentation of

narratives across temporal and spatial dimensions, expanding the boundaries of "museumization" by connecting different cultures and historical periods through storytelling. The Palace Museum's digital platform serves as an exemplary case of narrative content strategy. Utilizing AI, the platform provides personalized exhibition content based on users' browsing habits and interests. By analyzing user behavior, the system recommends exhibits on similar themes or delves into historical periods of interest to the user. Additionally, the digital narrative of the Palace Museum employs interactive timelines and maps, enabling users to explore artifacts across different historical times and geographical locations, thereby achieving a rich narrative spanning time and space.

#### **Constructing Virtual Spaces,**

Replicating Presence in Scenes. High-precision 3D modeling, VR, augmented reality (AR), and digital twin technologies can be used to create or replicate three-dimensional visuals of historical scenes and artifacts, offering users an immersive experience. The application of these technologies allows users to experience art and artifacts in new ways, such as "stepping into" historical scenes through VR technology or exploring the historical background and detailed information of artifacts through AR. Digital twin technology enables real-time interaction and content synchronization between virtual exhibitions and physical museums. The Vatican Museums' VR experience allows users to visit the Sistine Chapel from home using a VR headset, providing an unprecedented immersive experience. High-precision 3D scanning technology has successfully replicated the interior details of the Sistine Chapel, including Michelangelo's frescoes (Fig. 4) [13]. This technology not only enhances the user's sense of presence but also offers a valuable cultural experience to those unable to visit the Vatican in person.

**Applying Virtual Identities, Granting Visitors an Immersive Experience.** The

creation of virtual guides and digital avatars for visitors using deep learning and 3D modeling technologies significantly enhances user immersion and engagement. Virtual guides can offer personalized commentary services, providing customized content based on the interests and interaction history of the audience. Likewise, visitors can explore the museum through their virtual identities, interacting with other visitors or virtual guides, and even participating in virtual social activities, thereby increasing the exhibition's interactivity and sociality. The "Digital Mei Lanfang" project, utilizing high-precision laser scanning and 3D modeling technologies, has recreated performances of the Peking opera master Mei Lanfang, allowing audiences to experience Peking opera performances virtually (Fig. 5) [14]. Interacting with the digitized Mei Lanfang not only allows viewers to watch performances but also to learn about the culture and history behind them. This application of virtual identity technology provides audiences with immersive learning

and experience opportunities, enhancing the interactivity between audiences and exhibition content.

Enhancing Interactive Modules, Strengthening User Co-creation Experience. Technologies such as VR, AR, motion capture, and 5G can create richer and more interactive exhibition experiences [15; 16]. Audiences can interact more directly with exhibition content through these technologies, such as participating in virtual archaeological digs through motion capture technology or "placing" historical artifacts in their living environment using AR. Furthermore, open creative platforms allow audiences to participate in the creation process of exhibition content, such as co-creating a virtual exhibition or participating in online cultural projects, thereby deepening the interaction and co-creation between audiences and museums. The Museum of Modern Art (MoMA) offers a series of interactive workshops and art creation courses through its online platform, allowing audiences to engage in art creation.

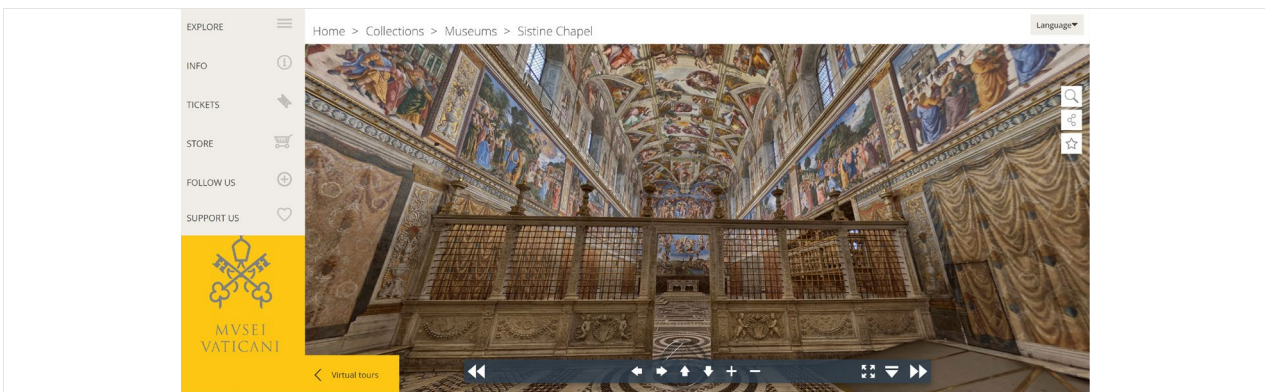


Fig.4. VR gallery of the Sistine Chapel, Vatican Museums [13] (Italy, 2024)

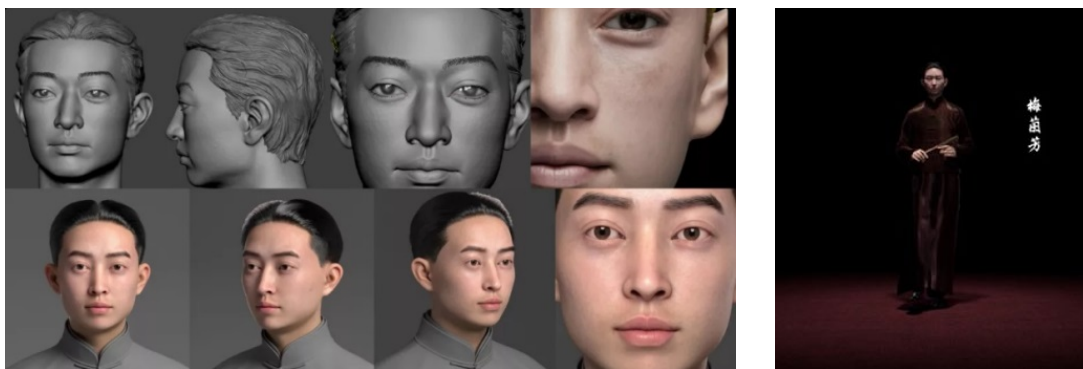


Fig.5. Real statues of digital people of the "Digital Mei Lanfang" project [14] (China, 2024)

These workshops utilize various digital tools, such as AR applications and online canvases, enabling participants to create art in virtual environments, even collaborating with other participants worldwide. This approach not only offers a new way of experiencing art but also fosters social interaction and cultural exchange among audiences.

**Conclusion.** This study identifies three key strategies for employing artificial intelligence in the design of online museum exhibitions, with an emphasis on artistic principles:

1. AI-driven systems can tailor visual content to individual preferences, dynamically adjusting themes, colors, and artistic styles to enhance viewer engagement and aesthetic experience.

2. AI can optimize interface elements such as typography, layout, and navigation in real-time, based on user interactions, to improve usability and visual appeal.

3. Leveraging AI for interactive storytelling allows for the creation of enriched, contextual narratives around artworks that

adapt and evolve with visitor interactions, deepening the educational and emotional impact of the exhibition.

This research delves into the transformative impact of AI on online museum exhibitions, highlighting its significance in reshaping visitor experiences, content management, and educational narratives. By leveraging AI technology, museums can offer personalized and interactive experiences that cater to diverse audiences, ultimately enhancing accessibility and engagement. Overall, the integration of AI technology elevates museum services to a more sophisticated and intelligent level, opening up new possibilities for innovation and advancement in the industry. Future research endeavors should explore the full potential of AI applications in optimizing museum exhibitions, driving creativity, and revitalizing design practices to create more dynamic and engaging museum experiences.

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## СТРАТЕГІЯ ДИЗАЙНУ КОНТЕНТУ ЕКСПОЗИЦІЇ ОНЛАЙН-МУЗЕЮ З ТОЧКИ ЗОРУ ШТУЧНОГО ІНТЕЛЕКТУ

**Мета:** проаналізувати застосування штучного інтелекту для вдосконалення художнього дизайну в онлайн-музейних виставках.

**Методологія.** В роботі поєднано огляд літератури з аналізом прикладів дизайну онлайн-музеїв з застосуванням технологій штучного інтелекту. Зокрема, проаналізовано такі онлайн музеї: Британський музей (Англія), Лувр (Франція), Шанхайський музей (Китай), Музей Ватикану (Ватикан), а також цифровий проєкт Mei Lanfang.

**Результати.** В результаті проведеного аналізу виявлено, що штучний інтелект має глибокий вплив на художні компоненти цифрових музейних експонатів. Окреслено інструменти штучного інтелекту можуть динамічно адаптувати візуальний контент і елементи дизайну, збагачуючи художню розповідь і узгоджуючи з уподобаннями глядача, щоб створити більш привабливі візуальні враження.

**Наукова новизна.** В статті отримали вперше схарактеризовано принципи використання штучного інтелекту в процесах художнього дизайну в онлайн-музеях. Систематизовані принципи поєднання штучного інтелекту з художнім дизайном, як нові методи для підвищення естетичної узгодженості та тематичної насиченості онлайн-виставок музеїв.

**Практична значущість.** Отримані дані підкреслюють трансформаційний потенціал штучного інтелекту в презентаціях цифрового мистецтва в онлайн музеях, зокрема завдяки його здатності вдосконалювати ключові елементи дизайну, такі як колірні схеми, типографіка та інтерфейс користувача. Сформульовані в роботі практичні висновки та рекомендації спрямовані на створення дизайну більш візуально привабливих і мистецьки насичених онлайн-музеїв.

**Ключові слова:** штучний інтелект, дизайн онлайн-музею, досвід користувача, технологічна інтеграція, стратегії персоналізації, культурна спадщина.

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