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Virtual Avatars in Digital Heritage: A Systematic Review of Design Evolution and User Experience

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Abstract

This systematic review synthesises findings from 22 peer-reviewed articles to examine the design evolution and multi-functional roles of virtual avatars in digital heritage. The literature under review represents an avatar as a cultural guide, a narrative character, an educational resource, and a social interface supported by artificial intelligence to enhance engagement, interpretation, and immersive learning. In the studies, the use of avatars has been found to correlate with greater user presence, emotions and quality of interactions in museums and heritage setting. Newer technologies, especially AIGC and the generation of avatars, are associated with advancements in realism of visuals, adaptive behaviours, and multimodal communication, which alters the perception of authenticity and responsiveness. Simultaneously, repetitive constraints are observed: vulnerability of trust, lack of emotion consistency, uncanny valley reactions and new ethical issues connected with AI-created representations. Furthermore, it provides the direction of both the practical and research on creation of a more culturally grounded and user responsive avatar system that can provide more meaningful and context sensitive digital heritage experience.

Keywords: Virtual avatars; Digital heritage; User experience; Design evolution; Technology
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Introduction

The digital heritage environment evolved rapidly over the last several years and now incorporates varieties of forms including virtual museums, immersive archaeological restructurings, and AI-based exhibits of heritage items. With the further development of such digitally-mediated contexts, it also becomes apparent that the production, access, and interpretation of cultural knowledge changes in some observable manner. The concept of virtual avatars has become more prominent within this larger trend as intermediaries between users and heritage content, especially within interactive and guided experiences. Avatar use in practice can involve either guide or characters in narratives though avatars are commonly also made to play the role of social interfaces because they allow users interacting with them facilitate cultural learning. According to the evidence presented in the works by the authors who examined issues related to virtual museums and heritage, the use of avatars when interacting with a heritage site can often be linked to heightened feelings of presence and trust, and sometimes even to more profound levels of emotionality (Sylaiou and Fidas, 2022; Teston, 2021). Simultaneously, further advances in generative AI, real-time rendering and high-fidelity character modeling are changing the way avatars are created and used, providing opportunities in respect of new possibilities of heritage interpretation, as well as a new range of design and ethical questions (Zhou et al., 2025).

Despite these advancements, studies on virtual avatars in the heritage related context remain fragmented through various fields of study, such as tourism research, HCI, XR design, digital heritage, and AI-mediated interaction investigation. Efforts made in those streams are usually paralleled instead of conducted under an inclusive analytical approach. Previous literature has addressed challenges like the authenticity of an avatar, visual realism, emotional display, and anthropomorphic design aspects (Angmo et al., 2025; Nukhu et al., 2025). The other contributions focus more on applying scenarios, such as in education, narrative settings, and saving intangible heritage practice (Liu et al., 2022; Gao et al., 2024). What is comparatively less common, though, is integrative reviews looking at how avatar implementation and design development contribute to influencing perception of users, their interaction quality, and cultural-oriented education results in heritage contexts. Such failure to synthesise these threads of evidence into one coherent analysis also indicates the necessity for a cohesive systematic synthesis.

In light of this, the current review builds upon a collection of peer-reviewed publications consisting of 22 to offer a systematic overview of the use of virtual avatars and evolution of their design in the context of digital heritage settings.

Literature Review

The study of virtual avatars has continued to evolve with the developments of AI and immersive technologies. The present work is quite diverse, including both stylised digital characters and very realistic AI-based agents that can act as a mediator between a user and a digital environment and facilitate new types of interaction and participation in culture. Older research largely dealt with entertainments settings, games and social communication scenes. Yet, as technology continues to advance, avatar use has now expanded into cultural heritage, museum experience, and narratives scenes and gained interdisciplinary interest.

An increasing number of studies regard avatars as cultural guides and interpretive agents within the context of heritage-related places. As an example, Testón (2021) indicates that extended reality display digital avatars might offer a greater humanness in their guidance, thus resulting in clearer interpretation and reduced brain requirements. Similar research by Sylaiou and Fidas (2022) explores the role of virtual humans in the creation of more socially present feelings in museum visits, and how these individuals are able to interact with cultural information in a more emotional and direct manner. All of these suggest that avatars usually act as cultural brokers and help tourists to understand more complex heritage materials in many ways.

More recent research has been more focused on particular aspects of avatar design, specifically its visual realism, anthropomorphism, emotional expressiveness and identity transparency. The study of virtual influencers offers a similar line of evidence, indicating that human-like behavioural patterns and lifelike visuals can have an effect on perceived trust, involvement rates, and authenticity evaluations (e.g., Sorosrungruang et al., 2024; Angmo et al., 2025). The authors also claim that emotionally consistent signaling is likely to facilitate the development of user rapport, whereas inconsistent signals are prone to cause the loss of immersion. These remarks are particularly relevant to the contexts of digital heritage where credibility, cultural sensitivity, and emotional coherence usually are considered essential design requirements.

Avatars are often employed as either characters of narration or performance when it comes to intangible cultural heritage applications. They may also represent classical characters to promote a sense of culture (Liu et al., 2022), while in other instances, they act as conversationalists that aid in clarifying the meaning of context (Farella et al., 2022). All these uses indicate that there is a more general shift toward the notion that avatars can be considered as active participants of the meaning-making process and not just as passive objects of display.

Another constant theme is the issue of technological change. The advent of AIGC and associated generative models has made avatar systems less fixed and more autonomous, and able to express different variations, including dynamic dialogue, contextualised behaviour, and shortening of design iteration cycles (Zhou et al., 2025). Meanwhile, a number of researches warn that these innovations bring about new threats, namely, uncanny valley phenomena, misinformation produced by AI, and potential misrepresentation of culture (Yang et al., 2025).

Despite this increased academic curiosity, the literature is still scattered through various groups of scholars in areas of marketing, HCI, AI, and culture heritage studies without a universal synthesis methodology. The number of works combining the topic of avatar utilisation, evolution of design, and user experience results in digital heritage setting is relatively low. The absence of consolidation suggests the usefulness of a systematic review that would structure the current body of evidence, identify concepts trends, and provide clarity to what further research can do.

Methodology

This study utilises a systematic literature review approach. This research utilises the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) technique, a widely accepted standard for conducting systematic literature reviews. This section also covers key subsections such as identification, screening, eligibility, and data extraction.

Identification

According to the rules of PRISMA 2020, the literature search was arranged into three steps, comprising keyword identification, search string development, and database retrieval. This systematic review conducted comprehensive searches in various databases, including Scopus, Web of Science, ACM Digital Library, IEEE Xplore. The search utilised a structured strategy with Boolean operators and keywords(Table 1). Google Scholar was also utilised as an additional source to identify possible grey literature, which could have been helpful.

Table 1. The search strings

Scopus	**(artificial intelligen* OR AI OR AIGC OR "generative AI") AND (avatar* OR "digital human*" OR "virtual human*" OR "virtual character*" OR "virtual influencer*" OR "AI influencer*") AND (tourism OR heritage OR museum*) AND (experien* OR interact* OR engag* OR immers*)**
Web of Science, ACM Digital Library, IEEE Xplore	(artificial intelligen* OR AI) AND (avatar* OR "digital human*" OR "virtual human*") AND (tourism OR heritage OR museum*) AND (experien* OR interact* OR engag* OR immers*)

Screening

In order to ensure relevancy and methodological quality in the ultimate research pool, clear inclusion and exclusion criteria were set before the screening process started.At this stage, inclusion and exclusion criteria including language of publication, year of publication, type of article.

The only research to be kept involved studies written in English to ensure that terminology and analytical interpretation used would be the same across sources. Besides, an application of a publishing window between 2021-2025 was considered. The timeframe was selected because this is the time when virtual avatar technologies are evolving at a higher speed, AIGC-based systems, and digital heritage applications are being developed, which makes the chosen timeframe more relevant to the modern-day research environment.Only peer-reviewed journal articles, conference papers, and review articles that offered empirical evidence, conceptual discourse, or technology analysis of virtual avatars in digital heritage settings were eligible as sources. Peer-reviewed journals do not include books, book chapters, editorials, organisation reports, and theses because they are evaluated on different grounds than indexed scholarly works.

Eligibility

Of those eligible, several studies were additionally eliminated at the eligibility stage. The major exclusion reasons were non-relevance to digital heritage or virtual avatars, poor correlation with the set research interest and methodological weakness including lack of empirical rigor or lack of information on the methodology. After these procedures had been undertaken, 22 studies met all the requirements and were kept in the final synthesis.

The procedure flow for selecting articles for the study is depicted in Fig. 1, which shows the elimination procedure.

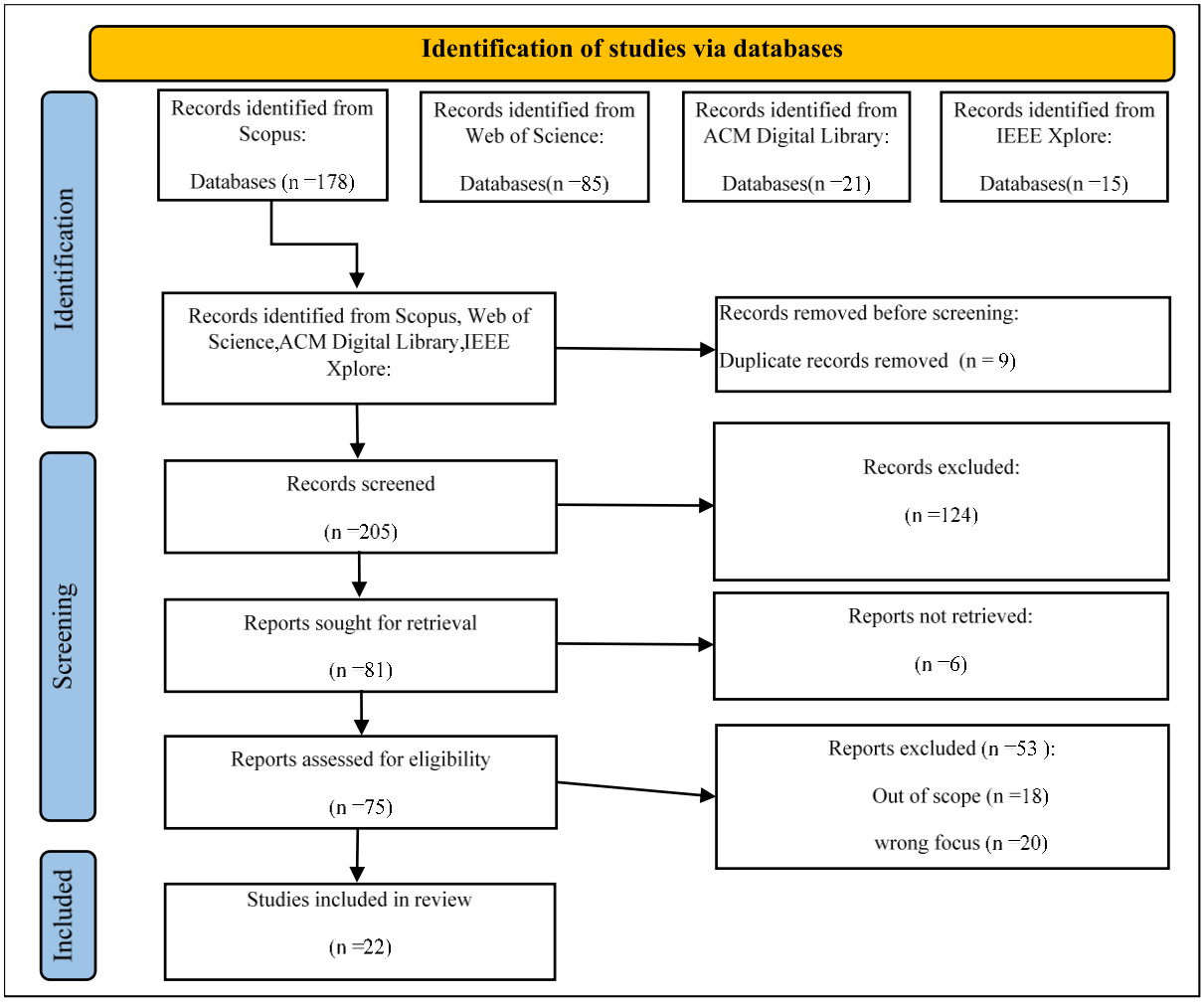

Figure 1. PRISMA 2020 Flow Diagram of the Study Selection Process

Data Extraction

Each of the 22 eligible studies was reviewed and coded on its own to identify recurrent ideas, variables and interpretational trends. Following this initial round of coding, the material that had been extracted was thematically integrated, grouping similar observations under general analytical categories. The repeated comparison and refinement of categories led to the consolidation of three common-cross cutting themes used to organise the outcomes of the review i.e., Avatar Application, Design Evolution, and Heritage Experience.

The coded data were reviewed several times to verify that each theme has an internal coherence and that the themes are conceptually distinct. If coding discrepancies or classification ambiguities were noted in the course of coding, these were addressed by a re-examination of the initial publications and uniformity of coding choices between them.

When both considered together, this systemised extraction and theme-building process can assist to ensure an equilibrium and detailed portrayal of the existing studies on the topic of virtual

avatars in the context of digital heritage sites and offer a basis based on methodology, which will be useful in conducting the synthesis reflected in the Findings section.

Findings

The section presents a summary of all the integrated results that were obtained after conducting 22 studies that formed part of the ultimate review sample. Analysis of the extracted evidence in terms of the themes gave rise to three higher-level thematic groups: (1) Avatar Applications, (2) Design Evolution, and (3) Heritage Experience. Through these three theoretical themes, you get an organised view of the way virtual avatars are implemented in the real world, the manner that has evolved design paths of virtual avatars and how such use affects user experiences within any digital heritage setting.

Avatar Applications

The evidence of the reviewed studies demonstrates that virtual avatars play multifunctional roles in digital heritage settings with many of them acting as cultural mediators, narrative participants and responsive social agents. One common form of use that is mentioned often is cultural guidance whereby avatars are substituted, or complement traditional human guides. As an example, according to Testón (2021), avatar-led tours in museums that are part of an extended reality exhibition offer human-like interpretative help to visitors and also help them explore complex digital environments. Other similar results of Sylaiou and Fidas (2022) indicate that the virtual people may enhance perceived social presence in museum scenarios, allowing cultural content to appear more accessible, personally relevant, and engaging to the audience.

A different group of applications revolves around the concept of narrative mediation, especially regarding situations involving intangible culture heritage. Liu et al. (2022) illustrate how avatars can be used to facilitate embodied storytelling through the manifestation of traditional characters or cultural-specific expressions, as well as the organisation of emotionally evocative sequences of stories. Their findings link the use of avatars to tell a story to the impression of higher authenticity, increased emotionality, and greater cultural meaning continuity, in particular, when the stories are strongly tied to a particular heritage tradition.

A number of other contributions view avatars as interpretive facilitators that help the users comprehend layered or technical complexities of the heritage. To illustrate, interactive 3D environments utilise NPCs with natural language processing capabilities to provide contextual explanations and dynamic interpretive signals to increase cultural awareness and decrease interpretive uncertainty (Farella et al., 2022).

Another area of investigation is avatars as AI-informed social agents, with anthropomorphic cues affecting user perceptions and patterns of engagement. Recent studies indicate that generative AI–based avatars can improve user engagement and well-being through more personalised and emotionally responsive interactions (Liu et al., 2025). Engagement strategies such as visual presentation, narrative framing, and interaction have been shown to influence user acceptance and engagement (Han et al., 2025). Previous findings on virtual influencers reveal that realistic-looking faces and body gestures, and unique communication styles correlate with higher levels of user confidence and emotional identification. Despite being largely located beyond the confines of museums, much of this literature has implications directly applicable to digital heritage platforms that aim to enhance visitor connections and interpretive involvement.

Another key direction in which a significant application area is navigation and orientation support. The recent research papers are focused on avatar-assisted navigation systems as a tool towards enhancing spatial orientation and interpretability during cultural exploration tasks. The authors Khorshed et al. (2025) also indicate that avatar-based guiding agents are associated with more successful task execution, increased spatial comprehension, and greater perceived utility within heritage-focused digital platforms. Ancillary AI-based strategies such as adaptive prompts and customised guidance programs are also found to enhance the level of participation of visitors.

When combined, these threads of evidence show avatars as versatile and multi-functional agents in digital heritage ecosystems. They are not utilised to perform a particular communicative role but to facilitate cultural interpretation, narrative immersion, guided exploration, and socially defined interaction which enhance the way users experience and interpret heritage material.

Design Evolution

The given literature also records a significant advancement in conceptualisation and implementation of virtual avatar design, with repeated emphasis on technological innovation, visual realism, anthropomorphic characteristics, emotional signaling, and perceived reliability of avatars. One of the significant triggers of the recent design change is the distribution of AIGC (Artificial Intelligence-Generated Content) methods. Zhou et al. (2025) state that generative models facilitate high fidelity avatar creation by means of adaptive visual configuration, behaviour, and multimodal interaction functionalities. Consequently, avatars that are applied in digital heritage systems become more and more characterised by increased responsiveness, awareness of context, and visual persuasiveness.

The visual realism will remain as one of the main axes of design. Instead of having a single goal state, researches report on a spectrum of stylised representations versus hyper-realistic rendering,

where design choices shape user responses across this spectrum. According to Angmo et al. (2025), overly lifelike looks can induce uncanny valley effects, which is why balancing recognisability and comfort can be treated as a design concern.

Current talks expand the concept of avatar realism to not only appearance but to more durable, human-like virtual personas. The author discusses so-called post-mortem avatars, demonstrating the manner in which facial reconstruction and behavioural models and archival data can be used together to ensure identity continuity and cultural memory after death (Wilkinson et al., 2024). While the majority of this literature is still found in paleoanthropology and archaeology, it suggests a larger design trend whereby avatars are used as carriers of cultural meaning over time instead of interactive beings that persist only on a shorter timescale, an approach that has obvious relevance to the way heritage is represented and perceived as authentic.

Anthropomorphism has also been frequently analyzed as a dimension. Empirical research, such as Nukhu et al., (2025), and Qu et al., (2025) report that users are prone to ascribe personality, agency, and emotion to virtual characters under conditions of human like cues. In heritage contexts, these cues usually enhance relatability and intuitive interaction between the user and the digital guide. Meanwhile, those same studies also remind us that high anthropomorphic messages could create the illusion of human-like performance or emotional stability, which is not necessarily met.

Emotional expressiveness is also one of the central trends in design. As Zhang et al. (2025) demonstrate, an avatar that presents consistent and coherent emotional communication is more prone to foster user trust and rapport between individuals. On the other hand, slow or inconsistent emotional reactions may reduce immersion specifically when it takes place in culturally sensitive interpretive frameworks. According to Zhang et al. (2024), complementary results reveal that the AI agents, which can create context-relevant affective clues are related to increased user satisfaction, perceived warmth and communicative trust.

In addition to realism and emotional coordination, it has been shown in various studies that avatar design development is related to the mechanisms of meaning transfer. Digital human influencers could be used to convey perceived authenticity, symbolic value and emotional significance of the cultural artifacts they offer, as demonstrated by Huang et al. (2025). Other research has indicated the significance of identity transparency and culture matching. As Nalivaike and Miliukaite (2024) explain, there is a higher positive response among people when the identity, the communicative role, and the cultural framework of an avatar are clear whereas cultures mismatched symbols or highly generic visual design will negatively affect credibility and authenticity.

Also in the more recent literature I note a tendency towards adaptive and semi-autonomous interaction models. Avatars have been depicted as increasingly more personalised, sensitive to context, and able to make modestly autonomous choices through advances in AI-assisted dialogue and behaviour production. The change has a stronger focus on avatar agency whereby virtual characters engage in culturally significant interactions without being fully dependent on set scripts. All of these design directions taken collectively indicate avatars which are not merely more visually plausible but also socially believable and emotionally resonant with user expectations within digital heritage settings.

Heritage Experience

This reviewed evidence also considers the role virtual avatars play in shaping the user experience in digital heritage settings, and it is continually highlighted that cultural interpretation, immersion, presence, and emotional involvement are the aspects considered to be important. One common perception is the cultural presence, defined as the felt feeling of someone being accompanied on a tour through a culture by a guide or character. It has been reported by Sylaiou and Fidas (2022) that avatar-based representation within the context of a virtual museum setting has positive perceptions of companionship and even reduces feelings of isolation experienced by individuals exploring digital exhibits.

Immersive involvement is also an often-mentioned outcome dimension. Gong et al. (2024) discover that interaction between avatars and the cultural exhibits of virtual reality can help ensure easier flow of interpretation and allow the visitors to comprehend culture in a more intuitive and holistic way. The immersive nature especially matters when speaking about the digital heritage where spatial consistency and symbolic legitimacy positively affect the construction and perception of heritage significance.

User trust remains a constant mediator of cultural interpretation. According to Nalivaike and Miliukaite (2024), avatar credibility based on identity transparency and emotional stability, and the ability of communication impacts whether or not users accept, challenge or go beyond cultural narratives provided. Trust is especially important in cases when avatars are applied to explain complicated, controversial or historically sensitive sources of cultural heritage.

Another level of impact is emotional involvement. Liu et al. (2022) have demonstrated that intangible cultural heritage performances by avatars can induce emotional resonance and intensify cultural appreciation. In case emotional cues seem real and in a good fit with the context, people are more prone to develop significant relationships with heritage materials that would seem remote or conceptual under other conditions.

Simultaneously, the literature identifies various threats that relate to the design. The reported challenges are uncanny valley responses (Angmo et al., 2025), inconsistent emotional response (Zhang et al., 2025) and AI hallucination or fake news impact (Yang et al., 2025) which can erode user trust and interpretative clarity. Such cautionary implications underline the relevance of culturally informed design choices and attention to calibration when an avatar is integrated into a heritage-focused system.

When combined, the existing studies describe virtual avatars as experience boosters in the framework of digital heritage. In the case when the design decisions are well-matched with cultural context and user expectations, avatars can enhance perceived presence, credibility, emotional engagement, and interpretive meaning, hence making heritage experiences more interactive and culturally significant.

Discussion

The given review puts virtual avatars more in the framework of a cultural mediator rather than a standalone technical feature of a digital heritage system. In the course of the analysis of the reviewed research works, one can see that the functional multiplicity of the studies and their further development of design are strongly associated with the ways in which users interact with the heritage materials and form cultural meanings in online spaces. Avatars become not just interface objects but occupy the space of interpretation, assistance, and communication more and more frequently.

This synthesis indicates that there is a steady directional trend in avatar design usage as well as increased focus on visual realism, anthropomorphic signaling, emotional expression and autonomy supported by AI. This is supported by recent research showing that AI-driven avatars enhance immersive storytelling and engagement in digital heritage (Bartolini et al., 2025). Taken altogether, these trends suggest that the area of overlap between virtual human studies, HCI design concepts, and heritage interpretation models has begun developing. At the same time, technological complexity does not inherently guarantee improved user experience. A number of researchers point out that very realistic or emotionally unstable avatar may be uncomfortable or decrease perceived credibility or distract attention on the cultural element. This implies, in the context of design, that innovation is not enough - perceptual comfort, cultural appropriateness, and interpretive transparency become just as important evaluation criteria.

A common thought is the extent of which avatar effectiveness can be influenced by the alignment of the user-centred focus. Outcomes vary depending on user requirements, emotional expectations, cultural background, and the desired style of interaction. Previous literature links trust,

presence, and emotional resonance to greater engagement on heritage-related settings. This is further supported by research indicating that interaction and display configurations of virtual humans significantly influence users' sense of co-presence (Kim & Jo, 2022). Users are likely to report greater interpretive involvement and more intense experiential connection when avatars have coherent identities, stable emotional cues, or consistent visual or behavioural signals of culture. Such effects are consistent with findings that the relationship between avatar identification and user attraction is fully mediated by immersion (Li et al., 2024). Conversely, schemes that fail to acknowledge culture framing or misinterpret user expectations are more frequently connected with low levels of immersion as well as poor learning results.

The discussed literature also indicates a number of unaddressed tensions and risks. Often stated ones are uncanny valley reactions, misinformation generated by AI, ethics of digital human images, and the danger of cultural reductionism or simplification. The repetition of such problems indicates that interdisciplinary cooperation in avatar creation in heritages is useful, since it does not rely solely on technical design and the ability to operate an AI, but also on culture studies, heritages theory, and evaluation frameworks based on the ethics perspective. In general, the evidence shows that virtual avatars have significant potential to enhance the experience of digital heritage, but their positive effects are most reliably linked to design solutions that are culturally rooted, interpretively clear, and attentive to the needs of users.

Conclusion

The synthesis of these 22 studies provides critical implications for the design of heritage-focused avatars. There is one clear message that unites all of the reviewed articles: the significance of responsive design to users. Visitor-driven avatar creation is more successful than when it is dictated solely by the technical sophistication or the complexity of features, since the avatar creation has become increasingly oriented towards visitor needs, emotional expectations, cultural background, and chosen styles of interaction.

The design calibration also turns into a pivotal element. The data indicates that excessive visual realism and erratic emotional behaviour detract from user comfort and credibility, while moderate realism with consistent emotional signs might be more conducive to trust and interpretive engagement. Viewed in those terms, close monitoring of levels of realism and emotional compatibility should be seen as a useful tool in practice in heritage related avatar systems.

Cultural sensitivity is also one of the basic conditions. As it is repeatedly stated in the reviewed work, the design of an avatar should be deliberately concerned with the symbolism of appropriateness, narrative framing, and heritage specificity. Careful incorporation of cultural references, and elimination

of generic or culturally un-fitting imagery, assist toward ensuring interpretative legitimacy and perceived authenticity.

These results also indicate a number of areas of study that should be explored in more detail. The long-term behaviour of users and avatars has not been studied enough, neither has the interaction process across different cultures in the way that people perceive and react to avatars. The issue of identity transparency and moral management of AI-produced avatars is likewise becoming topical as the number of deployments grows. Future empirical research should investigate the connection between the use of avatars and the cultural aspects of learning, memory, and visitor satisfaction when using either all virtual or hybrid museum sites.

With the development of digital heritage ecosystems, virtual avatars are bound to be an important interface component between people and cultural information. Their role is most significant when they make design choices sensitive to the context, culturally based, and well-matched to user requirements, which enables heritage experiences to be more interactive, as well as more meaningful, interpretable, and coherent.

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Authors' Bio

Yan Peng, graduated from Qingdao University, Shandong Province, China, with a master's degree, is currently studying for his PhD degree at Universiti Pendidikan Sultan Idris, Perak, Malaysia, with research interests in film and television animation, Since 2016, he has been engaged in teaching basic theory courses and specialised courses in animation and digital media technology. In the teaching and research work, he has published six professional papers.

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