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Simulacra and historical fidelity in digital recreation of lost cultural heritage: Reconstituting period materialities for the period eye

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Abstract

The advancement of digital technologies in art history has opened avenues for reconstructing lost or damaged cultural heritage, a need highlighted by the deteriorated state of many artworks from the 1785 Salon. Grounded in the concept of the "Period Eye" by art historian Michael Baxandall, which emphasizes understanding artworks within their original historical and cultural contexts, this study proposes a subfield focused on Reconstituting Period Materialities for the Period Eye. This methodology bridges comprehensive historical research with generative visual artificial intelligence (AI) technologies, facilitating the creation and immersive virtual reality viewing of artworks. Beyond mere visual replication, the approach aims to recreate the material and textural realities of the period, thereby enabling contemporary audiences to experience these works as they were originally perceived. The process includes replicating building materials using Quixel Megascans, employing AI for generating images of lost artworks, and utilizing normal maps for simulating painting textures, all contributing to an authentic reconstruction of the Salon's ambiance and materiality. This approach, met with some skepticism from traditional historians and archeologists, asserts that such digital reconstitution, backed by rigorous empirical research and detailed period-specific datasets, yields reconstructions of greater historical accuracy and contextual richness. This mirrors strides in sound archeology, endorsing a similar empirical approach in visual material recreation. The significance of this study is underscored by its potential to enrich our comprehension of historical artworks through a "Period Eye," blending historical insights with modern technological innovation for a deeper understanding and appreciation of cultural heritage.

Keywords: Digital reconstruction; Cultural heritage; Generative visual artificial intelligence; Period materialities; Period Eye

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1. Introduction

Advancements in digital technology have revolutionized the field of cultural heritage preservation, introducing innovative approaches for the reconstruction of ancient cities through three-dimensional (3D) modeling and the digital reimagining of interior architectural spaces.[1,2] These can be viewed with a variety of hardware from desktops, smartphones, and various extended reality (XR) devices. The latter encompasses various immersive technologies, including virtual reality (VR) which immerses users in a digital environment, augmented reality (AR) which overlays digital information onto the real world, and mixed reality (MR) which merges real and virtual worlds to produce new environments where physical and digital objects coexist and interact.[3] The advent of virtual environments and preliminary forms of digital twins has provided scholars and the broader public with unparalleled means to examine heritage sites and artifacts.[4,5] Noteworthy, among these are 3D scanning and photogrammetry technologies, which have been instrumental in creating detailed representations of art collections, notably the digital archiving of the extensive sculpture collection of the Uffizi Galleries.[6] These digital replicas are valuable not only for academic research but also as crucial tools for ongoing conservation efforts, aiding in the preservation, and preventing deterioration of these artifacts.[7,8]

While these technologies have represented initial steps in incorporating digital tools in cultural heritage, the evolution of generative artificial intelligence (AI) marks a significant shift. This cutting-edge approach has shown remarkable potential in the swift reconstitution of damaged or lost artworks.[9] The integration of handheld scanning devices with advanced rendering engines has rendered the creation of high-fidelity digital artifacts both practical and efficient.[10,11] Situated within this landscape of technological progression, this research endeavors to explore the possibilities and limitations of combining generative AI tools with conventional restoration methods. The aim is to expand current methodologies while simultaneously fostering a critical conversation on the ethical and esthetic implications of these combined restoration practices.

In the realm of digital humanities, where digital tools are employed to study arts, a critical aspect is the exploration of historical interiors, encompassing elements such as spatial configuration, object placement, acoustic properties, and the impact of musical activities within specific settings.[12-14] These aspects have been rendered tangible and subject to analysis through state-of-the-art technologies like photogrammetric scanning and game engine rendering.[15] These tools not only provide precise spatial measurements but also enable high-definition visualization and immersive experiences. The undertaking here focusing on the 1785 Parisian Salon exemplifies the application of these methods, aiming to digitally resurrect a significant pre-revolutionary art exhibition, complete with historically accurate figures and attire, grounded in extensive archival research, and meticulous on-site measurements. More specifically, this study focuses on the reconstitution of lost or damaged paintings using the latest AI technologies.

The previous uses of 3D modeling software to elucidate historical contexts have met challenges.[1,16] While there are various efforts to reconstruct and understand lost historical artifacts and events, the process is often limited by the available evidence and the potential for multiple interpretations.[17] One example of a significant reconstruction effort is the *Lost Cause* narrative in post-Civil War American history, which has been the subject of analysis and critique.[18] In addition, the Reconstruction Era has been the focus of historical study and storytelling, with ongoing debates about the scope and relevance of these efforts.[19]

At the same time, AI has been used in various ways to reconstitute or recreate historical artifacts or works of art. One approach involves using AI to reconstruct ancient ruins and urban structures based on minimal information. For example, the ROSETTA Initiative at Purdue University is developing AI technologies to infer the prior structure of sparse remnants of ancient urban settings, such as those in Peru and Armenia.[20] In addition, AI has been used to restore missing pieces of artworks, such as the mutilated Rembrandt painting *The Night Watch*, where AI was used to reproduce missing tiles in the style of Rembrandt.[21] Furthermore, AI has been applied to digitally read old documents and reconstruct historical records, as seen in the Venice Time Machine project, which aims to digitize and reconstruct 1000 years of historical records from the Venetian state archives.[22] As such, the potential of the technology in art restoration and reconstruction is vast, as it can analyze and interpret damaged artworks, identify areas of deterioration, and reconstruct missing or deteriorated parts of the artwork with remarkable accuracy.[23] While AI has shown promise in these areas, there are also discussions about the ethical dimensions and potential distortions or wrong interpretations of history that AI could introduce.[24]

Such methods inherently involve assumptions and uncertainties, especially when historical information is filtered through subjective perspectives.[25] Diverse sources such as paintings, engravings, and textual descriptions each bear the unique viewpoints and interpretations of their creators. Compounding these efforts, many of the works selected for this study in the 1785 Salon have

been damaged, lost or since destroyed, which makes their accurate inclusion in historical interior recreations dubious considering past uses of technology.[26] Furthermore, the historical veracity of the reconstitution of works from history that no longer exist is a complex and ongoing topic. Historical reconstruction often faces challenges due to limited epistemic access to the deep past, as it lacks the ability to experimentally test hypothesized causal relationships among events.[27] This limitation can lead to a lack of certainty and the potential for multiple interpretations of historical evidence.[28] While there are various efforts to reconstruct and understand lost historical artifacts and events, the process is often limited by the available evidence and the potential for multiple interpretations. The historical veracity of such reconstructions is a subject of ongoing debate and scholarly inquiry.[29]

The integration of advanced digital technologies, particularly AI, into the field of cultural heritage preservation offers a transformative solution to the challenges historically faced in reconstructing damaged or lost artworks.[30] The limitations inherent in previous 3D modeling methods, coupled with the subjective interpretations of historical sources and the significant loss or damage to many artworks from the 1785 Salon, have necessitated a shift toward more innovative and reliable approaches in reconstituting these cultural treasures. Thus, this study aims to digitally resurrect the 1785 Salon with an unprecedented level of historical accuracy and material fidelity. The process begins with the assembly of diverse references and high-resolution scans to replicate the architectural and decorative elements of the Salon accurately, including using Quixel Megascans for texture replication and incorporating specific artistic inspirations to achieve historical authenticity in aspects such as room drapery.

In terms of painting selections, the study focuses on both documented and AI-generated visualizations of artworks, like those of French artists Jean-Joseph Taillasson (1745-1809) and Antoine Vestier (1740 – 1824), ensuring scale accuracy and historical verisimilitude. In addition, the painting materials aspect involves sophisticated techniques such as embossing and normal map generation to recreate the material properties of these paintings within a virtual reality setting, using the Unreal Engine for integration. The significance of this research lies in its potential to enhance our understanding and appreciation of historical artworks. Through the application of AI and digital technologies, the study not only confronts the challenges of past reconstruction efforts but also promises to deliver a richer, more accurate cultural and educational experience. This innovative approach to cultural heritage preservation is expected to enhance academic research, enrich public engagement with art history, and provide a replicable model for similar projects in the future. Thus, the project demonstrates the synergies of historical scholarship, digital technology, and artistic sensitivity, marking a significant advancement in the field of digital heritage conservation and education.

The primary aim of this study is to explore the innovative application of AI in the digital reconstruction of the ambiance of the Paris Art Salon, specifically focusing on specific artworks. This endeavor seeks to bridge the gap between traditional art historical research and contemporary digital humanities by leveraging cutting-edge AI technologies to offer a more immersive, accurate depiction of historical art environments. By reconstructing not only the visual aspects of lost or damaged artworks but also their material textures and the overall ambiance of the Salon, this study endeavors to provide a comprehensive understanding and appreciation of the cultural and educational significance of these historical spaces. This approach underscores the potential of digital technologies to significantly advance the field of cultural heritage preservation, offering new methodologies for academic research, enhancing public engagement with art history, and serving as a model for future digital reconstruction projects.

2. Literature review

The field of digital preservation within cultural heritage, examined through the lenses of digital art history and digital humanities, remains a burgeoning area of study, as evidenced by recent academic contributions.[31] The initial steps in digitizing cultural artifacts and spaces began in the early 2000s, primarily within academic and institutional circles. Early initiatives, like those by the Foundation of the Hellenic World, employed Computer-Assisted Virtual Environment technologies to construct digital versions of ancient sites. A notable instance is the digital reconstruction of Miletus, an ancient city with a history of Athenian and Roman rule.[32] Following these early projects, the relevance of such technologies to museums and heritage sectors gained recognition, as highlighted by Roussou,[33] who described the approach as a form of "edutainment."

Other examples from the early 2000s of digitizing cultural heritage artifacts and sites include the use of 3D digitization technologies such as photogrammetry and LIDAR scanning in museums and cultural heritage fields.[34] In addition, the digitization of cultural and heritage content, including historical documents, artifacts, and images, began to be commonplace across the heritage sector in this period, often for putting into institutional

repositories and featuring on websites to encourage remote viewing by online users.[35] Furthermore, researchers have been using XR tools and AI to present digital heritage, with a focus on creating virtual visits, online exhibitions, and cataloging inventory of heritage. For instance, in the same period, China supported a project to create a digital museum of ancient stone carvings to make cultural artifacts more accessible and protect them from erosion.[36]

The decade also saw technological advancements significantly contributing to the widespread adoption of XR experiences in museums. Notable examples include the Museum of Pure Form and the Virtual Museum of Sculpture, both developed for the general public and designed with time-limited experiences to regulate visitor traffic through exhibitions.[37] These initial physically-based experiences gradually transformed into entirely virtual museum spaces, as demonstrated by the Exploratorium and the CREATE initiative, funded by the European Union.[38] Concurrently, the application of augmented reality technologies facilitated the extensive digitization of museum collections, a process exemplified by initiatives at the Center for the Art of East Asia at the University of Chicago.[39] Importantly, the democratization of Virtual Learning Environments (VLEs) experienced a significant turning point with the launch of Google's Arts and Culture platform in 2011. This influence was further enhanced by the introduction of Google Cardboard in 2014, an inexpensive head-mounted display widely adopted in educational settings.[40] Subsequent years saw the rise of numerous VLEs, including those developed for institutions such as the Rijksmuseum and the National Archeological Museum of Marche.[41]

More recently, there has been a notable increase in the development and use of digital twins for the preservation of cultural heritage, a movement accelerated by global events such as the pandemic. Bevilacqua *et al.*[42] have explored applications from the digital twin of the First Parliament in Italy to the Charterhouse of Pisa in Calci. Meanwhile, Tan *et al.*[43] have focused on methodologies employed in Asia, specifically for the digital archiving of Xiegong, a distinctive architectural feature in historical Chinese structures. These diverse projects highlight the importance of interdisciplinary collaborations between technical experts and scholars to create effective digital models for the protection of cultural heritage.

Although there is an abundance of research covering digital twins in cultural heritage preservation, there remains a notable gap in the thorough examination of how generative AI tools can accelerate the reconstruction of damaged or lost cultural artifacts. However, there have been some explorations at the nexus of AI and cultural heritage preservation. Driven by advances in machine learning and computational capabilities, the use of AI in the conservation and restoration of cultural heritage is becoming an increasingly prominent research area, with a variety of studies introducing different methodologies and frameworks. For instance, the study by Kim and Lee[44] investigates the restoration of cultural assets using artificial neural networks to differentiate various types of roof tiles, showcasing the ability of the technology to discern subtle variations in cultural patterns, essential for precise restoration. Similarly, Li[45] emphasizes the integration of VR with AI in protecting cultural heritage, suggesting a comprehensive, multi-modal conservation approach.

In addition, the pioneering work of D'Orazio *et al.* in 2023[46] examines the use of long short-term memory neural networks for processing maintenance requests, a development with significant implications for proactive conservation strategies that could prevent deterioration and reduce the need for invasive restorations. This aligns with the study by Moreno *et al.*[47] where the application of fuzzy logic in assessing environmental impacts on heritage buildings, proposing a multifaceted conservation strategy. Bordoni *et al.*[48] expanded the extensive capabilities of AI as a powerful tool for archiving, safeguarding, and engaging with cultural heritage. Their comprehensive review lays the groundwork for future research. Concurrently, the study by Ranaldi and Zanzotto[49] delves into self-empiricist logic, suggesting that modern AI technologies have the potential to revolutionize heritage conservation.

Within the extant scholarly landscape, two distinct paradigms are prevalent: the first emphasizes the restoration and conservation of physical artifacts and architectural structures, while the second delves into the more ephemeral aspects of cultural heritage. Whether it is employing neural networks for detailed restoration of physical artifacts or leveraging predictive algorithms for forward-thinking conservation strategies, this technology stands as a formidable agent of change in traditional cultural heritage management practices. Therefore, fostering a robust, interdisciplinary exchange between AI specialists and heritage conservation professionals is crucial for developing effective approaches in this field. However, it is noteworthy that most examples cited in the literature focus on employing technology to preserve or recreate existing cultural elements. The ensuing section will introduce a nascent third paradigm, proposing the use of generative AI as a groundbreaking tool in recovering lost or damaged elements of cultural heritage, thus venturing into the realm of reconstituting them which no longer physically exists.

In the evolving landscape of digital art reconstruction, the application of generative AI technologies has emerged

as a transformative force, enabling the recreation of historical artworks with unprecedented accuracy and depth. Among these technologies, past examples such as diffusion-simulated connectivity have proved useful, offering sophisticated capabilities for the generation of artworks that closely mimic the styles of renowned artists. This method, as detailed in recent studies, leverages deep learning algorithms to analyze and replicate the nuanced esthetic characteristics of existing artworks, facilitating the training of AI models on bespoke datasets.[50] The potential of such generative AI solutions extends beyond mere replication, promising to unlock new insights into historical art styles and techniques, thereby enhancing the fidelity of digital reconstructions.

3. Methodology

The Academic Salon, intimately linked with the Royal Academy of Paris, played a critical role in shaping French art from the 17th through the 19th centuries. The state significantly influenced the visual arts, particularly in oil painting, through its selection of academy members and financial support for artists trained at the Royal Academy. This influence propelled French art to a prominence that often eclipsed artistic developments in other European nations.[51] The Salon functioned as a crucial platform for artists, where their careers could be charted by their success or rejection in these exhibitions. Furthermore, the Salon was integral to the evolution of art criticism, with Enlightenment thinkers actively engaging with and debating the technical and moral qualities of the exhibited works.[52]

Acknowledging the central role of the Salon in shaping the French artistic milieu across the early modern and modern periods, a specialized team of researchers has embarked on recreating the Salon exhibition environment in a digital format. While individual artworks by artists provide insights into their stylistic and thematic evolution, and many key works from Salon periods are preserved at the Louvre, a complete collection of works from a specific Salon remains a daunting task. Nonetheless, digital technology offers a promising avenue. By interacting with a digitally reconstructed Salon, scholars and students can gain a deeper appreciation of the historical shifts in artistic values, styles, and themes. This study serves as a test case for reconstituting works that are lost or damaged using two specific examples. At the same time, the methodology to do so is built on related disciplines.

The approach taken for the study builds on cross-disciplinary research in other fields such as sound archeology. Recent advancements in the field of sound archeology, or archeoacoustics, have opened new avenues for understanding the auditory experiences of ancient cultures.[53] This interdisciplinary domain integrates techniques from acoustics, archeology, anthropology, and musicology, employing modern empirical tools to reconstruct historical soundscapes. Researchers in this field utilize a variety of acoustic methods – ranging from measurements and characterizations to simulations – to explore archeological sites, particularly those featuring rock art, and to comprehend how sound functioned within these specific landscapes.[54]

The application of archeoacoustics principles within the framework of our study serves as a foundational inspiration, guiding our approach to the digital reconstruction of the Paris Art Salon. While our research primarily focuses on the visual aspects of cultural heritage, the methodologies derived from archeoacoustics have significantly influenced our strategy for recreating the Salon's ambiance. Archeoacoustics, as outlined by Debertolis and Gullà,[55] offer a comprehensive framework for understanding the sonic dynamics of site-specific environments, providing insights into how ancient spaces were experienced audibly. This understanding of spatial acoustics and the psychological impact of sound on inhabitants and visitors of historical sites has been pivotal in shaping our approach to reconstructing not only the visual but also the sensory atmosphere of the Salon.

Drawing from the principles of psychoacoustics, which delve into the psychological and physiological responses to sound,[56] our methodology incorporates considerations of how sound would have interacted with the architectural elements and artworks of the Salon. Though our project does not engage directly with the creation or simulation of historical sounds, the insights gained from archeoacoustics research inform our reconstruction of the Salon's ambiance, ensuring a holistic representation that extends beyond the visual to encapsulate the experiential essence of the space.

The methodology of archeoacoustics provides a template for the proposed research in employing generative AI to reconstruct lost or damaged elements of cultural heritage. Building on the interdisciplinary framework established in archeoacoustics, the proposed research extends this approach to visual elements of cultural heritage. The methodology involves employing generative AI to recreate lost or severely damaged artworks and architectural elements. This process will be informed by historical research, empirical data, and cross-disciplinary insights, ensuring that the reconstructions are not only visually accurate but also contextually and culturally relevant.

The first step in this methodology involves collecting comprehensive datasets from the period under study. These data include historical texts, paintings, engravings,

architectural plans, and any surviving physical remnants. The gathered information will undergo a thorough analysis to extract relevant style, esthetic, and contextual details pertinent to the period. Following data collection, generative AI models will be employed to synthesize this information and create digital reconstructions. These AI models, trained on the collected data, will generate high-fidelity visual representations of lost artworks and architectural elements. The models will be fine-tuned to ensure that the generated outputs align closely with historical accuracy and the esthetic sensibilities of the period. The final phase of the methodology involves integrating the AI-generated reconstructions into a VR environment. This integration will facilitate an immersive experience, allowing viewers to engage with the reconstructions in a context that closely mirrors their original settings. The immersive environment will be designed to replicate the original architectural and spatial configurations, enhancing the overall authenticity of the experience.

At the same time, historical veracity need be considered. It is thus noteworthy that one of the foremost advances in AI relevant to cultural heritage preservation is its ability to discern and replicate trends, patterns, and stylistic characteristics inherent in artworks.[57] Generative AI algorithms can analyze extensive datasets, encompassing an oeuvre, stylistic elements of a particular era, or specific artistic movements.[58] By training on these datasets, AI models are capable of generating outputs that not only mimic the style of a particular artist or period but also adhere to the prevailing aesthetic norms. This capability is pivotal in reconstructing artworks that are no longer extant, as AI can synthesize aggregate data to create plausible representations based on similar works, thereby addressing concerns over historical veracity.[59]

The use of technology, particularly AI, in recreating lost artworks serves a dual purpose. First, it aids in the preservation of cultural heritage by providing a digital surrogate for artworks that have been damaged or lost. Second, these recreations can significantly heighten public interest in the surviving examples of a work or a specific period of art. The digital resurrection of lost artworks not only pays homage to the original creations but also stimulates broader engagement with and appreciation for the remaining cultural artifacts. This is why, even in instances where the AI-generated aggregate versions of lost artworks are not entirely accurate, their value extends beyond mere historical precision. These reconstructions play a crucial role in drawing attention and awareness to subjects that might otherwise remain overlooked or underfunded, particularly in scenarios where there are no physical artifacts to exhibit.[59] By presenting a visual representation, although an aggregate one, AI-generated artworks can catalyze public interest and potentially garner support and funding for further research and preservation efforts in the field of cultural heritage. However, in considering a methodology and strategy to guide such efforts, expanding on existing examples is necessary.

The concept of the "Period Eye," as articulated by Michael Baxandall[60] underscores the importance of understanding artworks within their historical and cultural context. The approach aligns seamlessly with the capabilities of modern technologies in reconstituting period materialities and, therefore, the proposed subfield of "Reconstituting Period Materialities for the Period Eye" is thus warranted, given the advancements in AI and other digital technologies. These tools enable us not only to recreate lost artworks but also to embed them within their original cultural and temporal contexts. By doing so, they provide a more holistic understanding of the artwork, as seen through the eyes of contemporaries of the period, thus bridging the gap between past perceptions and present-day interpretations. This subfield represents a significant evolution in art history and digital humanities, leveraging the power of AI to foster a deeper, more nuanced engagement with cultural heritage.

This methodology, grounded in the principles of archeoacoustics and expanded through the use of generative AI, represents a significant leap in cultural heritage preservation. By enabling the digital resurrection of lost cultural artifacts, the research not only contributes to the academic understanding of historical periods but also provides a tangible connection to the past for contemporary audiences. The use of AI and VR technologies in this context exemplifies how modern tools can bridge the gap between the past and the present, offering innovative ways to experience and appreciate cultural heritage.

4. Results

The meticulous reconstruction of elements from the 1785 Salon in a virtual environment involved a detailed and methodical approach to replicating the architectural, decorative, and artistic elements of the exhibition. The endeavor outlined here to reconstitute two specific works was segmented into three distinct phases: building materials, painting selection, and painting materials, each contributing uniquely to the overall authenticity and historical accuracy of the virtual reconstruction.

The approach to creating the virtual environment commenced with an assemblage of diverse references and templates to accurately replicate architectural and decorative elements of the Salon. A crucial reference was an image of the entrance to the Salon Carré at the Louvre,

which guided the architectural reconstruction. For the textural elements, Quixel Megascans, a comprehensive library of high-resolution scans, provided the base textures. Arabescato marble scans were used to simulate marble components, while a template of reclaimed wood emulated the wooden flooring, walls, and ceilings. The intricate details, such as room drapery, drew inspiration from Samuel F.B. Morse (1791 – 1872) and his *Gallery of the Louvre* (1831 – 1833) (Figure 1), adopting altered carpet scans to resemble the depicted drapery, with specific adjustments to color and texture parameters to achieve historical fidelity.

For the virtual environment, diverse references and templates were used to replicate architectural and decorative elements. Figure 2 (top left), captured at the Louvre in Paris, France, portrays the entrance to the Salon Carré, serving as a pivotal visual reference. Quixel Megascans were used as the base textures for the building materials. A megascan representing arabescato marble (Figure 2**,** top right) served as the foundation for replicating the marble elements observed. The flooring, walls, and ceilings of the Salon, known to be wooden, found their emulation through a template of reclaimed wood. Considering Pietro Antonion Martini (1738 – 1797), entitled View of the Salon of 1785 (Figure 3), which was the primary reference for laying out and constructing the scene, the discernibility of room drapery or the intricate decorative details described in the *Livret* remained ambiguous.[61] Drawing inspiration from Morse's Gallery of the Louvre, which depicts red drapery adorning the walls, a scan first representing a carpet underwent alterations to emulate the color and texture reminiscent of the drapery in the portrayal. More specifically: the albedo tint was set to a maroon color; base specular was set to 0.25; the specular desaturation value was adjusted to 0.8; the specular override was set to 0.7; and the normal strength was set to 3.

Two distinct paintings, *Philoctete à qui Ulisse & Néoptolème enlèvent les Alèches d'Hercule* (1784) by Jean-Joseph Taillasson and *La nonchalante, tenant une brochure, prête à lui échapper de la main* (1785) by Antoine Vestier, were chosen for a comprehensive study on material composition. The painting by Taillasson is notably adorned on the east wall of the Salon, as evidenced by its portrayal on the right wall in Martini's engraving (Figure 4). In contrast, the location of the painting by Vestier remains elusive (Figure 5); the engraving offers no corroboration with the description of a man about to lose a flyer. While the former artwork endures today, Vestier's creation has yet to be located, necessitating the use of AI to generate an image for research purposes, and Taillasson's piece providing a concrete basis for analysis (Figure 6). As a

Figure 1. Samuel F.B. Morse, *Gallery of the Louvre*, 1831 – 1833, oil on canvas, 73 ¾ × 108 in. (187.3 × 274.3 cm). Terra Foundation for American Art, Daniel J. Terra Collection 1992.5; on view in The New Britain Museum of American Art from June 17, 2017.

Figure 2. Materials investigated for the Salon 1785 project. (Top left) Photo of the doorframe in the Salon Carré at the Louvre. Source: Photograph taken by Dr. Trenton Olsen in November 2022. (Top right) Arabescato marble texture taken from the Quixel Megascan database (ID# ufojbixl). (Middle right) Reclaimed wood texture taken from the Quixel Megascan database (ID# ucemfcsg). (Bottom left) Doorway to the Salon Carré as depicted in the 1785 VR simulation. (Bottom right) Salon Carré as depicted in the 1785 VR simulation, showing the floor, ceiling, and windows using different versions of the reclaimed wood material, arabescato marble, and modified carpet drapery. Imagery created with Unreal Engine 5 and Quixel Megascans.

frame of reference, the sizes for both paintings are listed in the *Livret*: Taillasson's piece was recorded as 284.5 cm tall and 228.6 cm wide, while Vestier's painting is 109.2 cm tall and 83.8 cm wide.

To enhance the material representation within the VR environment, normal maps were crafted for the two

selected paintings. Initial steps involved embossing the original images by adjusting brightness and contrast settings, preserving brush strokes' visibility while mitigating background noise. These embossed renditions served as bump maps and were processed through a dedicated normal map generator (https://cpetry.github.io/NormalMap-Online/; accessed January 6, 2024). Specific settings included: a strength value of 2; a level setting of 8; blur/sharpness intensity set to 2; utilization of the Sobel filter; and a displacement parameter set at 0.2. The generated normal maps, accompanied by ambient occlusion and specular information, were seamlessly integrated into the material setup within the Unreal Engine framework. Further, adjustments ensued, flattening the map by 5% to refine its visual impact. Additional material properties were configured, setting metallic values to 0.3, while both specular and roughness were fine-tuned to 0 and 0.05, respectively.

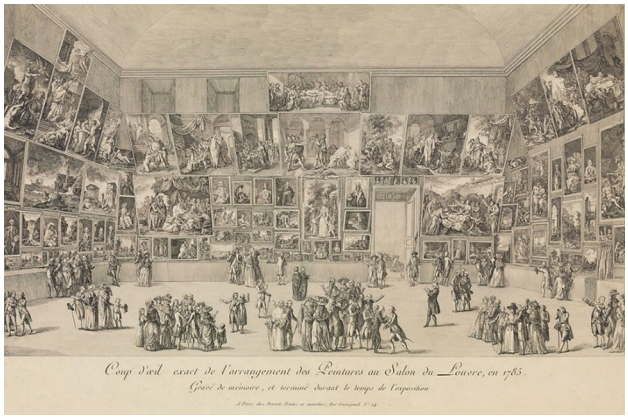

Figure 3. Pietro Antonio Martini, *View of the Salon of 1785*, engraving. The Metropolitan Museum of Art, New York. Creative Commons Zero, Public Domain Dedication.

5. Recommendations

Drawing on the results from the digital recreation of the 1785 Salon, focusing on Jean-Joseph Taillasson's *Philoctete à qui Ulisse & Néoptolème enlèvent les Alèches d'Hercule* and the AI reconstruction of Antoine Vestier's *La nonchalante*, several key recommendations emerge to guide future endeavors in the digital reconstruction of cultural heritage. In the reproduction of existing artworks like Taillasson's, the employment of advanced image editing techniques is paramount. Addressing issues such as glare, stretch, and skew in the original photographs ensures a more accurate foundation for subsequent digital processes. The creation and utilization of bump and normal maps from these edited images are critical steps. These techniques allow for the successful replication of the textural qualities of the original paintings, contributing significantly to the realism and authenticity of the digital replicas.

Furthermore, the project's success in utilizing AI for the reconstruction of Vestier's lost work underscores the potential of AI in reconstituting missing cultural artifacts. This approach can be expanded by incorporating photogrammetry to recreate lost materials. The combination of AI and photogrammetry, underpinned by rigorous art historical research and methodologies, opens new avenues for reconstructing materials that have not survived to the present day. This method not only aids in the visual reconstruction of artworks but also contributes to our understanding of the materiality and techniques used in the original creations. These strategies, blending technological innovation with traditional art historical research, represent a substantial advancement in the field of digital humanities. They not only facilitate the preservation

Figure 4. Jean-Joseph Taillasson, *Philoctete à qui Ulisse & Néoptolème enlèvent les Alèches d'Hercule*, 1784. (Left) Picture edited to remove glare, stretch, and skew. (Center) Bump map from the original picture. (Right) Normal map generated from the bump map. Imagery created with Unreal Engine 5 and Quixel Megascans.

Figure 5. AI reproduction of Antoine Vestier, *La nonchalante, tenant une brochure, prête à lui échapper de la main*, 1785. (Left) AI-generated image of Vestier's painting. (Center) Bump map from the original picture. (Right) Normal map generated from the bump map. Imagery created with Unreal Engine 5 and Quixel Megascans.

Figure 6. Taillasson's reproduction and AI-generated version of Vestier's painting in the VR Salon scene. Materials were generated using the normal maps. Specular, metallic and roughness values were all adjusted to give the artwork more of an oil painting glossiness inside of the scene. The modified Quixel Megascan is shown in the background. Imagery created with Unreal Engine 5 and Quixel Megascans with permission.

and understanding of cultural heritage but also enhance the accessibility and engagement of modern audiences with historical art. Moving forward, the integration of these approaches will be crucial in the ongoing efforts to protect, study, and celebrate our rich cultural past.

6. Conclusions

The endeavor to digitally reconstruct the 1785 Salon within the project encapsulates a pivotal advancement in the realm of digital humanities and art history, interfacing with cutting-edge technological innovation. This initiative, however, raises crucial considerations around the balance between awareness and reverence, the ethics of monetizing cultural heritage, and the potential pitfalls in reconstructing lost works without sufficient reference points. Thus, the success of the project in employing advanced image editing, AI-driven reconstruction, and photogrammetry highlights the significant potential of technology in resurrecting lost or damaged artworks with remarkable accuracy. Yet, it also necessitates a dialogue about maintaining reverence for the original works and their creators. The act of bringing back to life artworks like Vestier's *La nonchalante* underscores the capacity of technology to bridge gaps in cultural heritage. However, this process must be approached with a deep respect for the historical context and the artistic integrity of the original creations.

Moreover, the project confronts the dilemma of the influence of popular culture on funding and attention in cultural heritage. There exists a tension between the need to engage a wider audience through digital recreations and the risk of commodifying cultural heritage. This issue is particularly pertinent in light of examples like Monash University's recreation of Angkor Wat, Virtual Angkor (https://sensilab.monash.edu/research/virtual-angkor/), representing a civilization only accessible through secondhand descriptions. A significant ethical consideration arises when attempting to recreate lost works without any images or reference points. The use of AI in these circumstances risks producing reconstructions that may not align with the period style or aesthetics, leading to fictionalized versions of history. This concern emphasizes the need for rigorous research and a deep understanding of the historical context in which these artworks were created.

Given these complexities, the study recommends the establishment of a new subfield within art history: Reconstituting Period Materialities for the Period Eye. This proposed discipline would focus on the meticulous digital recreation of historical artworks and environments, ensuring that they are not only visually accurate but also contextually and culturally faithful to their original periods. This subfield would serve as a nexus of technological prowess, historical acumen, and ethical mindfulness, guiding future endeavors in cultural heritage preservation toward more informed and respectful reconstructions of our past.

The implications of employing AI and photogrammetry in art reconstruction extend beyond technical achievement;

they invite a reevaluation of how we engage with and preserve our cultural heritage. This project underscores the transformative potential of digital technologies in making the inaccessible accessible, breathing life into artworks and environments that have been lost to time. However, it also highlights the ethical and methodological challenges inherent in such endeavors, from ensuring historical accuracy to navigating the complexities of cultural commodification.

Looking forward, the establishment of the proposed subfield, Reconstituting Period Materialities for the Period Eye, provides a focused framework for addressing these challenges. Future research within this discipline should prioritize the development of more sophisticated AI models that can navigate the nuances of historical styles and materials with even greater precision. In addition, there is a need for interdisciplinary collaborations that merge technological expertise with deep historical and cultural insights, ensuring that digital reconstructions are not only visually compelling but also richly contextualized. Exploring the integration of virtual and augmented reality technologies could further enhance the immersive experience of digital reconstructions, offering new ways for individuals to engage with and learn from our cultural heritage. Ultimately, the journey of digital reconstruction is ongoing, with each project bringing new insights, challenges, and opportunities. By fostering a dialogue between technology and tradition, and by continuously refining our methodologies and ethical approaches, we can ensure that our digital endeavors respect and honor the past, even as we use them to educate and inspire the present and future.

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Conflict of interest

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