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Haptic Preservation of Cultural Ephemera: an Extended Reality Solution Using Stereoscopic Experience Replication for Victorian Parlor Culture

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SHORT COMMUNICATION

Haptic Preservation of Cultural Ephemera: an Extended Reality Solution Using Stereoscopic Experience Replication for Victorian Parlor Culture

Conservación háptica de objetos culturales efímeros: una solución de realidad extendida que utiliza la réplica de experiencias estereoscópicas para la cultura de salón victoriana

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ABSTRACT

This study presents a solution to the problem of interacting with, while simultaneously preserving, fragile cultural heritage, such as Victorian parlor culture artifacts, which are essential cultural heritage items but at risk of damage and deterioration. The proposed multi-sensory experience uses extended reality (XR) technology, head-mounted displays (HMD) and haptic feedback via haptic gloves, providing an immersive experience that allows people to interact with these artifacts in a virtual environment. By replicating the experience of a Victorian parlor, this study provides a glimpse into the past and provides valuable resources for researchers. The proposed solution not only provides access to the public and researchers of a collection, but also addresses the conflicting demands of curators and conservators by preserving these artifacts while still engaging a modern audience. The approach mitigates incidents of further deterioration or vandalism, ensuring the long-term preservation of cultural heritage resources. Through XR technology, viewers can handle fragile examples of technology, such as stereoscopic images, stereocards, and stereographs, without risking damage to the original materials. Haptic feedback can simulate the texture of the objects, providing a more realistic and immersive experience. Moreover, this study highlights the importance of preserving cultural heritage leveraging emerging technologies and emphasizes the historical and cultural significance of these objects.

Keywords: Victorian Parlor Culture; Stereoscopes; Extended Reality; Cultural Heritage Preservation; Haptic Feedback.

RESUMEN

Este estudio presenta una solución al problema de interactuar con un patrimonio cultural frágil y preservarlo al mismo tiempo, como los artefactos de la cultura de salón victoriana, que son elementos esenciales del patrimonio cultural pero corren el riesgo de sufrir daños y deteriorarse. La experiencia multisensorial propuesta utiliza tecnología de realidad extendida (XR), pantallas montadas en la cabeza (HMD) y retroalimentación háptica a través de guantes hápticos, proporcionando una experiencia inmersiva que permite a las personas interactuar con estos artefactos en un entorno virtual. Al reproducir la experiencia de un salón victoriano, este estudio permite echar un vistazo al pasado y proporciona valiosos recursos a los investigadores. La solución propuesta no sólo proporciona acceso al público y a los investigadores de una colección, sino que también responde a las exigencias contradictorias de conservadores y conservadores al preservar estos artefactos sin dejar de atraer a un público moderno. El planteamiento mitiga los incidentes de mayor deterioro o vandalismo, garantizando la conservación a largo plazo de los recursos del patrimonio cultural. Gracias a la tecnología XR, los espectadores pueden manipular ejemplos frágiles de tecnología, como imágenes estereoscópicas, tarjetas estereoscópicas y estereografías, sin riesgo de dañar los materiales originales. La retroalimentación háptica puede simular la textura de los objetos, proporcionando una

experiencia más realista e inmersiva. Además, este estudio pone de relieve la importancia de preservar el patrimonio cultural aprovechando las tecnologías emergentes y subraya el significado histórico y cultural de estos objetos.

Palabras clave: Cultura de Salón Victoriana; Estereoscopios; Realidad Extendida; Preservación del Patrimonio Cultural; Retroalimentación Háptica.

INTRODUCTION

Victorian parlors were an essential part of the culture at the turn of the twentieth century, and these continue to offer a glimpse into the life of the people who lived during the period (figure 1). The typical decoration and furnishings of a standard turn of the century Victorian parlor reflected the values and tastes of the middle and upper class.[1,2]

Figure 1. South Sitting Room from East, First Floor of Morris-Butler House, 1204 North Park Avenue, Indianapolis, Marion County, IN. Photographed August, 1970.

The parlor was often the most decorated and formal room in the house, reserved for receiving guests and displaying wealth and status (figure 2). The walls were typically covered in wallpaper with elaborate patterns, and the floors were often covered in patterned rugs or carpeting. The furniture was usually heavy and ornate, featuring dark wood, intricate carvings, and plush upholstery.[3]

Figure 2. Estey Organ Co., ca. 1900

Popular furniture pieces included sofas, armchairs, and rocking chairs. Other common furnishings included heavy draperies, decorative mantelpieces, and ornate light fixtures such as chandeliers or gas lamps. The parlor was also often filled with decorative objects such as figurines, vases, and photographs. The overall aesthetic was one of luxury and elegance, reflecting the desire of the middle and upper class to demonstrate their status and refinement through their home décor.[3]

One of the most popular forms of entertainment in these parlors was the viewing of different stereoscopic images.[4] The stereoscope was a device that allowed people to view 3D images by using two side-by-side photographs taken from slightly different angles. When viewed through the stereoscope, the two photographs would merge into a single 3D image. The Victorian precursor to the modern head-mounted display (HMD), stereoscopes were an essential part of *fin du siècle* culture, providing a view of 3D images that were used for entertainment, education, and scientific research (figure 3).[5]

Figure 3. Holmes Stereoscope, 1861

Stereocards were produced commercially, sold in sets, and provided people with a view of distant or exotic locations, famous people, and events (figure 4).[6]

Figure 4. Beautiful Mirror Lake, Yosemite Valley, Cal. U.S.A, by Singley, B. L. (Benjamin Lloyd), ca. 1897-1905

Their ability to provide an immersive experience and display images from distant places made them popular amongst the masses, who were experiencing a growth in media consumption due to the Industrial Age and new methods of mass production.[7]

Consumers could purchase stereograph cards from catalogs, door-to-door salesmen, or studios. After the Great Exhibition of 1851, stereographs and stereoscopes gained popularity as a novelty and remained so until the 1930s. The demand for these images resulted in millions of cards being produced and sold to the public,

with a pack of six costing one dollar and individual cards costing as low as 3 cents.[5]

While anyone could purchase these cards, the upper and middle classes became the primary collectors as they became closely associated with leisure activities and were used for entertainment, education, and scientific research.[8]

The binocular images would be manually loaded for viewing each new scene, which included views of distant or exotic locations, as well as famous people and events (figure 5). In fact, the subject matter of the images was diverse and ranged from foreign places, such as the American West and the Middle East, to collections of antiques, ruins, portraits, and even pornography. Studios produced a variety of images to cater to a broad audience.[9]
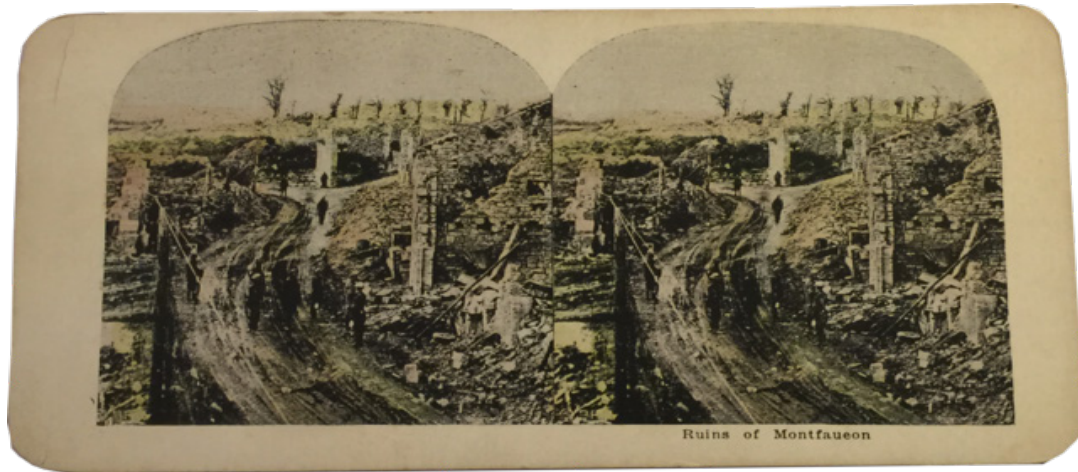
Figure 5. Ruins from the Meuse-Argonne Offensive during WW1

Replicating the experience of a Victorian parlor is a challenging task but is possible through a combination of historical research and modern technology. By studying historical records, photographs (figure 6), and other artifacts, it is possible to recreate the look and feel of a Victorian parlor.

Figure 6. Victorian style parlor, USA, early 1900s

Replicating the experience can be accomplished by selecting appropriate furniture, art, and other trappings that were commonly found in Victorian parlors. The impetus for recreating such a space is driven by the subject matter itself. The problem of ephemeral media in cultural heritage collections is a significant issue that needs

to be addressed. Ephemeral media refers to media that is fragile and can deteriorate over time, such as photographs, film, and other types of media.[10] In the case of stereoscopes and stereographs, these artifacts are particularly fragile and require special care to preserve them for future generations.[4]

In order to address the conundrum of giving access to historical artifacts to the viewing public while preserving them, this study proposes the historical recreation and repatriation of a traditional Victorian parlor in extended reality (XR). While XR refers to a variety of technologies that combine the physical and virtual worlds, including virtual reality (VR), augmented reality (AR), and mixed reality (MR), the simulation here would be completely immersive using VR.

By using XR technology, a virtual environment can be created that would allow viewers, who otherwise would be unable to, handle fragile examples of Victorian parlor culture ephemera, such as stereoscopic images, or stereocards. In fact, the immersive technology allows for a viewer to experience the 3D images in a way that is not possible with traditional display methods. The Victorian parlor and stereoscope were an important part of *fin du siècle* culture.

By replicating the experience of a Victorian parlor, it is possible to provide people with a glimpse into the past and to preserve cultural heritage for future generations. The problem of ephemeral media in cultural heritage collections can be addressed by using XR technology to provide a virtual environment for viewers to handle fragile examples of cultural heritage.

The proposed solution provides an opportunity to interact with these artifacts and gain a deeper understanding of the past, offering a more complete picture of the historical and cultural significance of these objects.

Digital Cultural Heritage Preservation

Preserving cultural heritage in the digital age has become a critical area of interest in the fields of digital art history and digital humanities. The concept of digital cultural heritage preservation has gained significant traction in recent years, becoming an essential aspect of academic and cultural practice.[11]

The emergence of digital twin technology, a rapidly evolving field, has further expanded the possibilities for cultural heritage preservation.[12] However, as this field is still in its infancy, the full potential of digital twin technology for preserving cultural heritage has yet to be explored in depth by the scholarly community.

The digitization of cultural heritage sites began in the early 2000s, with initial efforts focusing on existing and ancient locations. Access to these digital resources was initially limited to researchers within the field; however, the potential for broader applications was evident. Early virtual environments were developed using CAVE technology, as exemplified by the Foundation of the Hellenic World (FHW), a cultural heritage institution in Athens. The FHW's pioneering efforts in digitally reconstructing ancient cities, starting with Miletus, showcased the transformative potential of such technology.[13]

The benefits of digital preservation for museums were immediately recognized, with researchers like Gaitatzes et al.[14] advocating for its adoption to augment exhibitions in physical museum spaces. The concept of "edutainment," a fusion of education and entertainment, emerged as a driving force behind this movement.[15]

The adoption of digital preservation technology has grown significantly in recent years. The benefits of this technology for cultural heritage preservation and exhibition have been widely recognized, with scholars exploring various applications of digital twin technology in the preservation and exhibition of cultural heritage artifacts.[16,17]

From 2001 to 2010, a growing number of museums began embracing digital cultural heritage preservation, including The Museum of Pure Form and The Virtual Museum of Sculpture. These institutions designed their virtual reality (VR) experiences for the general public, with experiences intentionally brief to maintain visitor flow within a given space, in contrast to more prolonged VR experiences developed for medical or scientific fields. As technology evolved, fully virtual museums emerged, such as The Exploratorium and The CREATE project, an EU-funded initiative that enables users to reconstruct archaeological sites.[18]

Concurrently, the digitization of entire collections and museums for immersive realities, such as augmented reality (AR) and VR, increased. Starting in 2006, the Center for the Art of East Asia at the University of Chicago (CAEA) developed technology to digitize, archive, and view East Asian painting and sculpture collections.

Projects such as The Scroll Paintings Project and The Chinese Buddhist Caves Temple Projects aimed to increase access to art-historical resources and foster collaboration and scholarship for often inaccessible works.[19]

Overall, the adoption of digital cultural heritage preservation technology has facilitated new methods of access and interpretation of cultural heritage resources for a broader audience, such as the recent use of virtual learning environments (VLEs) for delivering cultural heritage content has become increasingly prevalent.

This has been achieved through digitizing real museums or creating computer-generated versions. In 2011, Google launched its Arts & Culture platform, which enabled virtual visits to museums for anyone with a smartphone. The subsequent release of Google Cardboard in 2014 further democratized the technology, allowing users to engage with head-mounted displays for more immersive experiences.

Various VLEs have been developed to facilitate virtual tours of real or virtual museums (VMs), including the National Archaeological Museum of Marche in Ancona, Gyeongju VR Museum in South Korea, and the Rijksmuseum in Amsterdam.[20]

In 2021, the Louvre digitized over 480 000 pieces from its collections and made them accessible on their online platform. Additionally, game engines like Unreal Engine and Unity have been employed to create virtual museums for educational purposes, such as the project developed for art history students at the Universidad Nacional de San Agustin de Arequipa in Peru.[20]

The use of VLEs has facilitated new and innovative ways to engage with cultural heritage artifacts and collections for a broader audience. It has enabled greater accessibility to cultural heritage resources, particularly for those who may not have had the opportunity to visit physical museum spaces. The continued development of VLEs, along with advancements in digital twin technology and haptic feedback, offers exciting possibilities for the future of cultural heritage preservation and education.

UNESCO oversaw one of the most significant recent initiatives in the field of digital cultural heritage preservation between 2017 and 2020, which entailed the creation of comprehensive virtual tours of World Cultural Heritage Sites.[21]

As the field of digital cultural heritage preservation continues to advance, it is essential to recognize the potential of these technologies in making cultural heritage more accessible and engaging for audiences worldwide. Since the onset of the pandemic, the use of digital twins for cultural heritage has experienced significant growth, with adoption occurring in various regions worldwide.

Bevilacqua et al.[22] detail several examples of VR applied in cultural heritage, including reconstructive digital modeling and a prototype VR application that renders the interior space of the now-nonexistent provisional hall of the First Italian Parliament for visitors to Palazzo Carignano in Turin.

The adoption of these technologies has facilitated new and innovative ways to engage with cultural heritage resources, offering immersive experiences that provide insight into the historical and cultural significance of these artifacts and collections. The continued development of digital twin technology and haptic feedback, along with the integration of VR and AR technologies, holds promise for the future of cultural heritage preservation and education.

These technologies offer opportunities to make cultural heritage more accessible and engaging for audiences worldwide, promoting greater understanding and appreciation of our shared cultural heritage. For instance, the creation of a digital twin of the Charterhouse of Pisa in Calci is another noteworthy example of the growing use of digital twin technology for cultural heritage preservation. This virtual environment features a 3D reconstruction of the illusory space depicted in quadraturist frescoes and a 3D representation of the cloister's layout throughout its most significant historical phases. Similar to the examples provided by UNESCO, the development of such digital twins may have been initially driven by tourism, but they have also opened new avenues for researchers globally.[23]

The growing body of literature on digital twins for cultural heritage preservation reveals a diverse range of methods and approaches being utilized worldwide. While European scholars employ certain processes to recreate or reconstitute architecture, Asian researchers, such as those presented by Tan et al.[24], adopt different techniques. Their study on Xiegong, a unique element of Chinese historic buildings, highlights the urgency in the field of archaeology to capture and preserve the physical properties of these structures before they succumb to erosion and decay.

Thus, the use of digital twin technology offers significant potential for the preservation and interpretation of cultural heritage artifacts and collections. It enables researchers and the general public to engage with these resources in new and innovative ways, facilitating greater accessibility and understanding of our shared cultural heritage. The continued development of these technologies, along with advancements in haptic feedback and extended reality, promises to expand the possibilities for digital cultural heritage preservation in the future.

Tan et al.[24] developed a methodology that combines digital twin technology with the chronology of forms to achieve their goal of preserving deteriorating structures. Their multi-methodological approach includes laser scanning, oblique photogrammetry, and BIM, ensuring consistency between 2D and 3D expressions with geometry and semantics. Their work on Xuanluo Hall in Sichuan, China, serves as an example to verify this approach. Other studies, including those by Rosa (2022) and Wang et al. (2022), confirm the viability of using digital twin technology for archaeological research and preservation of deteriorating structures.

These studies highlight the potential of digital twin technology in cultural heritage preservation, particularly in archaeology. The ability to capture and preserve the physical properties of deteriorating structures using multi-methodological approaches provides opportunities for researchers to better understand and interpret these artifacts.

The continued development of digital twin technology, along with advancements in extended reality and haptic feedback, promises to expand the possibilities for digital cultural heritage preservation and interpretation in the future. While much of the research on digital twin technology in cultural heritage preservation has

focused on architecture and historic sites, there is a growing recognition of its potential for preserving and interpreting more ephemeral cultural heritage artifacts, such as Victorian parlor culture ephemera.

The ability to replicate the experience of viewing stereoscopes through extended reality with haptic feedback can both preserve the original Victorian parlor culture experience and the fragile objects themselves. The following section will explore the potential of digital twin technology in preserving and interpreting Victorian parlor culture ephemera, highlighting the challenges and opportunities presented by this unique cultural heritage resource.

Victorian Parlor Culture Ephemera

The cultural heritage implications of preserving stereoscopes and their associated stereocards are significant, as they provide a unique window into the past. These artifacts were an important part of turn-of-the-century culture and are a testament to the technology and artistic advancements of the time. They were also a popular form of entertainment, education, and scientific research, and are therefore valuable resources for researchers. However, due to their fragile nature, these artifacts are at risk of damage and deterioration. If thousands of visitors handle these objects every year, it could lead to irreparable damage, making them inaccessible to future generations. Therefore, preserving these artifacts is of utmost importance to cultural heritage.

First, the enduring legacy of the Victorian era should be investigated along with the cultural and historical significance of the stereoscope and its relationship to Victorian domestic culture in the United States and Europe. The following summary shall provide an overview of scholarship on the topic beginning with Babbitts (2004), who argues that the stereoscope and other visual media played a significant role in constructing American visual culture.

Meanwhile, Coddington[25] examines the cultural significance of the *carte de visite*, a photographic innovation that enabled the mass production and dissemination of images during the Victorian era, which he likens to the Facebook of the 1860s.

Clark[26] likewise examined how domestic architecture served as an index to social history in America during the Romantic Revival era. He argues that the cult of domesticity and its emphasis on privacy, domesticity, and femininity shaped the design of domestic architecture.

Meanwhile, Belisle[27], Thaddeus-Johns, and Ventura (2021) explore the overlaps between stereoscopic, cinematic, and digital depth, examining how these mediums create a sense of presence for the viewer. Duguid[28] examines the artistry of the "Victorian avant-garde" and the emergence of still photography as an innovative art form and Henderson[29] discusses the connection between Victorian physics and photography, arguing that the stereoscope and other photographic innovations were influenced by the principles of formalist realism.

Holmes[30] discusses the cultural impact of the stereoscope and sun paintings on Victorian society, highlighting the ways in which these innovations transformed the way people saw and experienced the world. Finally, Marsh[31] examines the social construction of domestic space in American suburbs during the Victorian era, arguing that the design and layout of homes reflected cultural beliefs about gender roles, privacy, and social status.

This brief overview can be further examined in terms of the themes of the Victorian home as a symbol of cultural and social norms with a historical legacy, as well as the themes on which they drew. For instance, in "Better for Haunts" Burns (2012) explored the cultural significance and evolution of Victorian houses in the modern imagination. She argues that the Victorian house has been transformed from a symbol of middle-class domesticity and morality in the nineteenth century to a site of Gothic horror and "hauntedness" in the twentieth and twenty-first centuries.

This transformation has been driven by cultural shifts, such as the rise of horror literature and film, as well as changing attitudes towards the past and nostalgia. Burns also examines the ways in which the Victorian house has been portrayed in art and literature, highlighting the tension between the house as a symbol of both comfort and confinement. Ultimately, she suggests that the enduring fascination with the Victorian house in popular culture reflects a desire to reconcile modernity with the past, while also acknowledging the complexities and contradictions of both.

Likewise, Clark had also previously argued for the significance of Victorian domestic architecture that moved beyond the functional. In his "Domestic Architecture as an Index to Social History," Clark (1976) argued that domestic architecture can be used as a lens through which to examine broader social and cultural trends. Specifically, he focuses on the Romantic Revival and the Cult of Domesticity in America during the mid-19th century, examining how these movements were reflected in the design and decoration of homes.

Clark suggests that the Romantic Revival, which emphasized a return to traditional forms and values, was reflected in the architectural styles of the period, which drew on historical models such as Gothic and Tudor architecture. Similarly, the Cult of Domesticity, which emphasized the importance of the home as a refuge from the outside world, was reflected in the design of homes that featured private spaces for women and children, as well as a separation between public and private areas. Clark argues that by examining domestic

architecture, we can gain insights into broader cultural and social trends, and better understand the values and aspirations of the people who lived in these homes.

Together, these sources provide a comprehensive exploration of the cultural and historical significance of the stereoscope and its connections to Victorian domestic culture. The sources reveal that the stereoscope played a key role in shaping visual culture in the United States, capturing the fascination with depth and realism that characterized the Victorian era. The sources also highlight the close relationship between Victorian domestic culture and the development of the stereoscope, as well as the wider cultural practices of *tableaux vivants* and parlor theatricals. Encapsulated in the Victorian parlor, the interwoven fabric of technology and daily life can be seen as a microcosm of the multifaceted cultural and historical significance of the stereoscope, and its continued relevance in contemporary art and media practices, though the historical remnants of which is quite fragile.

Therefore, through the use of XR technology, a solution that allows for the preservation of these artifacts while still engaging a modern audience can be reached. With XR technology, viewers can interact with the artifacts in a way that provides a more complete understanding of the historical materials. For example, haptic feedback can be used to simulate the texture of the objects, providing a more immersive experience. Olfactory feedback can also be used to provide the viewer with a sense of the environment, such as the scent of the parlor or the materials used in the stereocards.

In fact, as Plunkett[32] proposed in his "Feeling Seeing": Touch, Vision and the Stereoscope," the relationship between touch and vision was central to the experience of using a stereoscope. Plunkett argues that the stereoscope, a popular Victorian optical device used to view 3D images, challenged traditional understandings of vision by emphasizing the role of touch in perception.

Using a variety of historical sources, Plunkett traces the development of the stereoscope and examines the ways in which it was experienced by users. He suggests that the stereoscope enabled a new kind of visual experience that was grounded in touch, as users were required to physically handle the device in order to see the images. This, in turn, challenged traditional notions of sight as a purely visual sense. Plunkett also explores the ways in which the stereoscope was marketed and popularized, arguing that it was often presented as a kind of magic or illusion that could transport users to new and exotic places.

Finally, he suggests that the experience of using the stereoscope can shed light on broader cultural and historical trends, such as the growing interest in science and technology in the Victorian era, and the changing relationship between humans and the natural world. Therefore, being able to replicate the haptic sensations as part of the viewing experience is crucial for an authentic, historical recreation of said experience.

Bringing the two arguments together, Gurevitch[4] noted how the experience was closely tied to immersion and spectacle. In the exploration of the historical and cultural significance of three-dimensional (3D) imaging technologies, particularly the stereoscope, from the mid-19th century to the present day, Gurevitch argued that 3D imaging have been driven by a "spectacular paradigm" that emphasizes spectacle, entertainment, and immersion. Using a variety of historical sources and examples, Gurevitch traces the development of 3D imaging from its earliest origins to its current use in popular culture and entertainment.

He suggests that throughout this history, 3D imaging has been closely tied to ideas of spectacle and the desire to create immersive, exciting experiences for viewers. Gurevitch[4] also explores the ways in which 3D imaging has been used to shape cultural and political narratives, and suggests that it has the potential to be a powerful tool for both domination and resistance.

Ultimately, he argues that 3D imaging has become an integral part of the cultural landscape, and that its significance extends far beyond the realm of entertainment and spectacle. Related to the proposed cultural heritage experience here, the use of emerging technologies is no mere "parlor trick" or "gimmick." The use of XR in general is the next phase in the evolution of 3D imaging and cultural experience in a social setting, only now the experience is not a simulacrum and demonstrates the idea of "art imitating life imitating art."

The use of virtual reality technology to replicate the experience of a stereoscope with a head-mounted display (HMD) offers a unique and immersive way to preserve the cultural heritage of turn-of-the-century Victorian parlors, as well as the objects themselves. By using VR technology, it is possible to recreate the environment of a Victorian parlor, including the furniture, art, and other artifacts that were common during this period, providing a deeper understanding of the historical and cultural significance of these objects. Moreover, the HMD can simulate the original viewing experience of a stereoscope, providing an accurate representation of the original experience while also enabling viewers to interact with these artifacts in ways that are not possible with traditional display methods.

Importantly, the use of VR technology allows for the preservation of fragile and ephemeral cultural heritage artifacts, such as stereoscopes, by creating digital replicas of the objects that can be interacted with in a virtual environment. This not only ensures the preservation of the original artifacts but also allows for valuable resources for researchers, who can study these objects in detail without risking damage to the original materials. This technology can provide critical insights into the historical and cultural significance of these

objects, allowing for a more comprehensive understanding of the past. Finally, the use of VR technology to replicate the experience of a stereoscope with a HMD offers a novel and engaging approach to preserving cultural heritage, providing a deeper understanding of the past while also enabling future generations to interact with these artifacts. This technology can serve as a valuable resource for researchers, ensuring that these objects remain accessible and relevant for years to come.

CONCLUSION

Therefore, the latest immersive technologies that provide immersion and spectacle to modern viewers is actually in historical alignment with the experience of Victorians. The purpose of stereoscopes and the Victorian parlor as setting promised escape and travel to exotic locales and a shared experience. The preservation and interpretation of cultural heritage artifacts and collections is a rapidly evolving field, with digital twin technology playing an increasingly prominent role. This chat has explored the potential of digital twin technology in the context of preserving Victorian parlor culture ephemera, highlighting the challenges and opportunities presented by this unique cultural heritage resource.

The ability to replicate the experience of viewing stereoscopes through extended reality with haptic feedback provides a means of preserving the original Victorian parlor culture experience, while also safeguarding fragile objects. This innovative approach to cultural heritage preservation offers new avenues for researchers and the general public to engage with these resources, fostering greater accessibility and understanding of our shared cultural heritage. Moving forward, it is crucial to continue exploring the possibilities of digital twin technology, along with other emerging technologies such as haptic feedback, VR and AR, and extended reality. By doing so, we can ensure the preservation and interpretation of cultural heritage artifacts and collections for future generations, while also making them more accessible and engaging for audiences worldwide.

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CONFLICTS OF INTEREST
None.

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