

Paintings in the Age of VR Reproductions: Examining the Design of Virtual Reality Galleries

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ABSTRACT

Galleries, museums, and designers have been adopting virtual reality (VR) technologies to display paintings and create novel experiences with artwork. We contribute an analysis of 20 examples of these applications to examine the design of VR reproductions of existing paintings, raising questions about how art is mediated by VR applications. Our findings show that current design strategies dominantly reproduce many of the relatively passive characteristics of a traditional museum experience, signalling opportunities for design that leverages the affordances of VR to offer additional spatial, embodied, and playful experiences with paintings.

CCS CONCEPTS

• **Human-centered computing** → **Virtual reality**; • **Software and its engineering** → *Interactive games*.

KEYWORDS

Virtual Reality, Mixed Reality, Paintings, Art Galleries, Museums

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1 INTRODUCTION

In his well-known essay, *The Work of Art in the Age of Mechanical Reproduction*, Walter Benjamin [3] argues that even as reproductions of artwork create new opportunities to perceive and experience art, the quality is “depreciated” and the *aura* “withers.” Today, in addition to the innumerable print and digital reproductions of famous paintings that are traditionally housed in galleries and museums across the world, virtual reality (VR) has been a recent platform for novel reproductions. The *Mona Lisa*, for example, can now be viewed in VR in a reproduction by the Louvre [G4] as well as “non-official” reproductions by individual creators (e.g., [G13]).

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For Benjamin, “Even the most perfect reproduction of a work of art is lacking in one element: its presence in time and space, its unique existence at the place where it happens to be” [3]. Yet anyone lucky enough to have seen the *Mona Lisa* at the Louvre knows that its current “presence in time and space,” with throngs of tourists crowded into a room, creating their own hasty reproductions on smartphone cameras, is perhaps not the ideal way to experience the work. Moreover, recent theorizations of the *aura* of artwork have also pointed to the value and diversity of copies of artwork, arguing that these copies can instead be understood as a collective extension of the original work’s cultural production, with each copy potentially having its own affective relevance [13, 15, 17], and copies and digital objects in general have long had multiple uses within museums [6]. What, then, does VR offer to the reproduction of paintings, and how might it be used to communicate the experience of viewing paintings that are traditionally housed in galleries or museums?

In this exploratory work, we contribute an analysis of 20 examples of VR applications that present reproductions and remediations of existing paintings to begin to document how VR is currently being used in these contexts, how these experiences offer alternative interpretations of gallery spaces, and to what extent they are leveraging the specific spatial, interactive, playful, embodied, and narrative opportunities within VR. By foregrounding these aspects, our aim is to begin identifying how these reproductions use (or do not use) the capabilities of the medium. Our findings show that audiovisual reproductions in VR are currently the most common format, with the viewer cast in a relatively passive role within empty gallery spaces. While the reproduction in these cases also reproduces the primarily visual experience of the traditional museum-goer, our analysis also highlights novel and creative applications that use VR to challenge the conventional format of the museum experience. This, in turn, presents opportunities for designers to develop experiences that go beyond audiovisual reproductions. The gaps that we identify suggest opportunities for more embodied and agentic experiences of art than what is currently available in traditional spaces and their virtual counterparts.

2 RELATED WORK

Although recent work has examined the expressive and educational possibilities of VR applications for art education and/or to generate new interest in museums [12, 16, 21], experiences that are available to everyday consumers have received less attention. Because our analysis in section 4 and section 5 will describe and discuss the types of VR experiences that are available to consumers, in this section we situate our research alongside recent work by artists,

designers, and researchers who have been seeking to understand how VR might offer something new to the experience of art.

2.1 Remediating the Museum

There is a long tradition in human-computer interaction research exploring how digitally mediated experiences might enhance or augment museums. Museums and gallery spaces have been at the heart of early considerations around applications for mixed reality interactions [2, 10], with foundations that help define more recent approaches to the use of VR to allow users to interact with objects in museums that are otherwise off-limits [25]. There are a variety of strategies and applications for digital remediations and reproductions of art and artifacts that are relevant for cultural heritage and expression. These include recreating 3D models [18], developing and displaying volumetric captures in VR [14], and using sonification as an audio augmentation based on the paintings' content [7]. These remediations can extend to the museum itself. For example, Tennent et al. [26] describe strategies to overlay and juxtapose the virtual and physical within the same environment, while Graves and Magerko [9] demonstrate the use of digital platforms to connect on-site visitors with online visitors to explore new social opportunities for museums.

In these applications, a key benefit of digital technologies is the ability to engage with and interact with artifacts and exhibits in ways that would otherwise be impossible in a traditional museum, offering alternative experiences to those the museum might otherwise provide. As Wang [27] writes, "Compared with traditional museums, which focus on collection, conservation, and education, museums employing virtual technology attach more importance to perception, dialogue, and creation." Parker and Saker [19] argue that VR provides opportunities for visitors to "move their bodies differently" than they would in a traditional museum, allowing for a closer view of the artwork. This also potentially offers new opportunities for access and for more complex sensory experiences, as Chen et al. [5] describe, or to showcase facets of cultural heritage that might be difficult to recreate in a traditional museum space [20]. Importantly, these kinds of considerations also require a balancing of new considerations for curators and designers. For example, in their examination of VR spaces displaying born-digital artworks in a social VR environment, Cao et al. [4] describe important tradeoffs where the inaccessible features of a museum are simply replaced with the inaccessible features of VR.

3 METHODOLOGY

Given that there is little research that directly examines how paintings are reproduced in consumer VR applications, our goal with this preliminary work was to begin identifying some of the common features and design characteristics of these experiences. We began with intentionally broad searches with keywords including "art," "gallery," and "painting" on three platforms that host VR content: VR Only games on Steam, the Meta games library, and the Oculus App Lab, which is often seen as a potential pipeline for the Meta Store, and includes content that is often by smaller studios and individual developers. We do not report exact numbers for each of these searches because they appeared to be inconsistent depending on the day, but these searches returned over 200 results. We

then reviewed the descriptions for each of these applications and iteratively removed entries based on a series of conditions to foreground work that was explicitly about reproductions of paintings in VR. For example, at the time of writing, the keyword search of "painting" on the Meta Store delivers 11 results, with the majority offering tools to paint or draw in 3D virtual space. None offer direct reproductions of existing paintings: the closest is a demo called First Touch [G19] that offers players a chance to paint over a line drawing of the *Mona Lisa*, but this was excluded because this was only a tangential feature of the experience.

We then removed applications that were related to cultural history or cultural heritage but without paintings, or digital artwork that was not a reproduction of existing paintings. Applications were also excluded if they were exclusively about existing artifacts from archaeological sites or about sculptures and ceramics, unless those applications also directly featured paintings. Reviewing the remaining applications at this stage, we identified three intentional inclusions: 1) we included examples of contemporary paintings, even if we could not verify that those paintings are currently displayed in art galleries; 2) we included VR remediations (not just reproductions) of well-known paintings, in part because one of the examples was produced by a museum (e.g. [G6]); and 3) we included examples from well-known museums that we were previously aware of even though they did not show up in the search (e.g. [G4]). Finally, because many of the examples were created by museums and available for free, we further refined the search by only including applications that were free. Overall, our goal was not to systematically identify and catalogue every possible application, but rather to begin identifying a relevant corpus to begin our analysis. The first author then downloaded all the available experiences and recorded the play-throughs to document the experience. All applications were experienced using a Meta Quest 2; when necessary this was connected to a PC using Steam VR and a Quest Link cable. Applications that did not load with this set up were also excluded, resulting in a final list of n=20 applications for analysis (see Appendix in supplementary material for a table listing these applications).

4 REPRODUCTIONS AND REMEDIATIONS

In this section, we summarize the applications included in the sample arranged from newest to oldest. These descriptions are intentionally brief to serve as an overview of the applications, and to provide a snapshot of some of their relevant features before providing a more in-depth analysis.

4.1 Descriptive Features

4.1.1 MalovModernArt Virtual Museum [G2]. Users begin the experience in a central hub and choose galleries (often large spaces evocative of both real and unreal settings, featuring no other visitors) based on themes (e.g., avant-garde, sculpture). White-gloved hands serve as the representation of the user's body, and it is possible to grasp the artwork (3D replicas of sculptures and digital copies of paintings) to view it from multiple angles, with informational text boxes that appear above or below the artwork.

4.1.2 MalovMetaArt Metaverse [G1]. This application is similar to the previous entry in terms of interaction and experience but features more contemporary paintings and artwork in its galleries. As before, the virtual galleries are large spaces with no other visitors.

4.1.3 Missouri: Heart of The Nation Virtual Reality Exhibition [G9]. This virtual gallery features a lobby and six rooms, each dedicated to showcasing paintings that highlight different facets of Missouri, with audio and info cards that provide information about the artwork. Navigation options include motion controllers or gaze, and users can teleport to various points throughout the gallery. Users can approach each painting for a closer look, with the predefined teleport circle offering the best vantage point.

4.1.4 Great Paintings VR [G7]. This application offers several viewing formats: within gallery spaces, as individual paintings, or within photo galleries. One relatively unique feature is the option to personalize the experience, including the colour of the frames and walls, the background music, the exhibition form (as slides or a gallery setting), or organizational features (e.g., organizing artwork by date). Each piece of artwork comes with an info card and audio guide. The paintings can be examined in more detail using magnifiers. Gloved hands offer the only visual representation of the user's body.

4.1.5 Virtual Museum De Fornaris [G16]. This virtual gallery offers a real collection that does not have permanent museum space. The user can navigate the galleries in a predefined sequence or in alternate sequences with a 2D map. The map also provides a sense of the gallery's dimensions, and the space is modelled after the gallery where the artwork is currently on loan. Non-interactive silhouetted figures stand throughout the space. Menu options are presented in a circular belt format around the user, requiring the user to look downwards to access them. 2D info cards provide a brief description of the artwork.

4.1.6 ART Reflections [G12]. This virtual gallery features two rooms, one with seating around Salvador Dalí's *Mae West Room*, and another room that reconstructs the painting as a 3D space that the user can enter. This room features two characters (a gallery attendant and a visitor) whose gaze follows the user, but they are otherwise non-interactive. The gallery offers several minor interactions, including the ability to replace a painting on the wall, handle objects and furniture, take pictures, and even disable gravity to make objects in the room float, though there is no defined purpose to these interactions.

4.1.7 Two Worlds-The 3D Art Gallery [G15]. This virtual gallery is comprised of a conventional art gallery and a second world showing a damaged environment with scattered debris and paintings. Upon completing the first gallery, the user is automatically transported to the second world. From here, there is no clear way to exit the second gallery or to return to the first gallery.

4.1.8 VR-NISSAGE 3 - John Wentz Art Exhibition [G11]. This experience features artwork by a contemporary artist, John Wentz, with the artwork displayed on invisible walls in an outdoor environment. The artwork is accompanied by small information cards and a video in the background shows the artist at work. Some paintings are

placed on the ground and can be handled. The user's hands are represented as robotic.

4.1.9 Mona Lisa: Beyond The Glass [G4]. This experience is comprised of several distinct sections that each offer different modes of interaction. A key differentiating environment is "Discover *Mona Lisa*," which provides information about the artist and the artwork. The user cannot move around in this section or pause or stop the narrative, and the scene imagines the real-world of the painting. In other environments, users can learn more about the artist's other work, including a model for a flying vehicle that the user can board and fly, although the user has no control over its flight.

4.1.10 Art Plunge [G13]. This experience begins in a hallway with five paintings by Western masters (e.g., by Michelangelo, Vermeer, and da Vinci). Selecting a painting transports the user into the painting, expanding the environment depicted around the user with a similar colour palette and some sound effects for that environment. The user's position and movement are relatively restricted.

4.1.11 Smithsonian American Art Museum "Beyond the Walls" [G18]. This virtual gallery is a recreation of the Smithsonian Museum, featuring reproductions of paintings and sculptures. The user can teleport throughout the rooms, and there are also predefined teleport locations on the floor to indicate the optimal viewing position. Artwork includes information cards and audio. In some cases, there is an option to be transported to a related environment, e.g., an outdoor environment to show the northern lights, or to the original location of a sculpture. One unique feature is the inclusion of a holographic recording of one of the contemporary artists featured in the exhibit.

4.1.12 The Homestead [G17]. This virtual gallery is a 3D scan of a gallery located in Auckland, New Zealand. The use of photogrammetry within Unreal Engine 4 offers realistic texture and lighting for the environment and the artwork. The three rooms exhibit paintings, sculptures, videos, and photos, and include info cards and audio.

4.1.13 Infinite Art Museum [G5]. This virtual museum has six levels, including a rooftop, each exhibiting paintings by different artists. The project has the stated goal of offering an "ever-expanding" collection to display and sell prints of artwork by contemporary artists, though this version has not been updated since 2019.

4.1.14 Immerse Yourself - Aga Khan Museum [G10]. This virtual gallery was designed for a web experience allowing users to navigate the 360-degree photographs of the Aga Khan Museum. Because the application is akin to a 360-degree real estate tour, the experience is not calibrated for VR.

4.1.15 The Finnish Virtual Art Gallery [G14]. This gallery is on a space station. Two rooms display paintings on their walls, akin to a traditional art gallery. A floating robot follows the user and a robotic voice provides the audio information for the paintings. Another room, resembling a garage, displays unused assets such as floating robots. A video on a screen in this room demonstrates how the gallery was created in a game engine. There is diegetic sound from a nearby radio. The user can go 'outside' to see a moon or planet nearby.

4.1.16 *The Kremer Collection VR Museum [G3]*. This virtual gallery is structured with a circular floor plan, with a central 2D video introduction (holograms of the owners of the collection) leading to five connected hallways. To navigate, the user can choose a portal to jump to the gallery rather than teleporting step-by-step. Each painting has an audio guide and info card. At the end of each hallway, there is a gift shop (currently empty).

4.1.17 *Dreams of Dalí [G6]*. This experience offers an expansive world inspired by a Salvador Dalí painting. The user navigates using gaze controls. The environment is not interactive but offers sound design to accompany the various aspects within the scene. Originally created for The Salvador Dalí Museum in Florida, the experience is deliberately linear and approximately five minutes long.

4.1.18 *Eye of the Owl - Bosch VR [G21]*. This experience explores *The Garden of Earthly Delights* and is relatively unique in terms of situating the user in an imagined studio where Bosch created the work, with a nearby NPC studying the artwork. The artwork includes several icons, sound effects, and animations. There are some additional interaction features: e.g., the user is equipped with a magnifying lens to help enlarge the smaller details of the painting, and in another mode, the user can be shrunk to miniature size to see a much larger version of the artwork while listening to an NPC who provides additional information.

4.1.19 *The Night Cafe: A VR Tribute to Vincent Van Gogh [G20]*. This experience presents a 3D recreation of Van Gogh's artwork with the entire environment exhibiting his brush technique. There is some animation, including animation for Van Gogh, who is seated in one of the environments, but there is no direct interaction with the environment.

4.1.20 *Boulevard [G22]*. The user begins in a main lobby with five banners of different art exhibitions. The application is imagined as a VR partner or platform for several existing collections and uses some of the same overall strategies as other applications to navigate the environments or to listen to audio guides. There is, however, no other way to interact with or handle the artwork.

5 DISCUSSION: PAINTINGS IN VR

In this section, we provide a preliminary analysis of the applications that we identified in our data, contributing considerations for future VR design that engages with consumer platforms for reproductions and/or remediations of paintings. We organize our considerations thematically, with each subsection outlining common characteristics that motivate opportunities for future work.

5.1 User experience and technological limitations

Reviewing the sample revealed several limitations in technical implementation and user experience (UX). As we previously noted, any application that frequently crashed or did not load with the setup we used was not included in the sample, yet even the playable applications demonstrated UX issues that have been a broader problem in VR. Noting these factors is not an attempt to disparage any of the individual creators, especially as some of these applications

were created by individuals or small teams, and some are likely intended as exploratory proofs of concept rather than fully-fledged products. Moreover, as these experiences range from applications created as the first consumer headsets were about to be released to more recent productions with larger budgets, they also provide a snapshot of a VR design community learning to implement best practices for movement options, options for seated or standing experiences, interactions with controllers, tutorials, spatial sound, strategies to mitigate cybersickness, control customization, and optimization for different headsets. These UX considerations are not new, but collectively they point to opportunities for applications that differentiate themselves by applying current best practices for usability and accessibility. If these applications are to offer an accessible alternative to physical museums and galleries, there continues to be an opportunity to demonstrate that standard in VR. Future work might examine whether these issues remain for paid applications, and to incorporate analyses of UX in relevant settings (e.g., in museums, in classrooms, at home).

5.2 Space and Artwork

For the most part, the virtual galleries and museums in the applications resemble physical galleries and museums, in some cases deliberately creating a virtual copy of a real-world space (e.g., [G17], [G18]). These architectural features extend to the ways that the paintings are displayed, including the ways that paintings are hung on bare walls at eye level, as well as sitting areas such as chairs and benches, though these are often aesthetic rather than interactive features. These design choices play a role in defining how users are expected to move through these environments. Even with various movement options (e.g., teleportation), these spaces suggest the kind of movement that is expected in traditional museums and galleries, moving from one painting to another with no additional incentive to stay with a painting very long beyond the possible reading of an info card or listening to an audio guide. These kinds of expectations are also present in non-traditional environments, whether outdoors [G11] or on a space station [G14].

A contrast to these repurposed or imagined gallery spaces includes examples that reinterpret the space of the artwork in various ways. *Dreams of Dalí [G6]*, for example, puts the user inside a painting, as does *The Night Cafe [G20]*, and *Art Plunge [G13]*. Each offers a spatial interpretation of the artwork, recreating the world of the artwork as a 3D space that the user can navigate, though it is likely that the technological scope of those applications limited the possible navigation options. Another missing factor within these spaces is other people (though again, earlier applications were limited by available technologies and platforms). There is a general lack of social experiences and/or interactions with NPCs and the user is expected to navigate these spaces in isolation.

Overall, considerations about space and artwork raise questions about who and what is included in these spaces, how users interpret or engage with art differently based on different display options, and how the common architectural and curatorial conventions of museums and galleries are maintained or disrupted (e.g., one positive disruption is that VR galleries can remove geographical and time-based barriers to seeing art). While some applications experimented with creating unconventional gallery spaces (e.g.,

[G5, G14]), future design work might take inspiration from recent calls for more architectural creativity in metaverse spaces [11], perhaps leveraging and reimagining the affordances of virtual spaces that do not have to replicate or conform to real-world counterparts.

5.3 Interaction and Artwork

As with the designed spaces of the VR applications, the possible interactions also dominantly replicate the inability to interact with the artwork in galleries beyond a distanced viewership. When the user's hands are represented, gloved hands are evocative of the cotton gloves of a curator or archivist, but without the agency to interact with or handle a painting in the way that a curator or archivist might. While a lack of tactility and haptic feedback is also a limitation of current controllers, many of the experiences were designed without any expectations of using the hands, suggesting a larger missed opportunity to consider how users might physically interact with the paintings or the gallery spaces in ways that offer a contrast to traditional museum spaces. One exception in terms of the curatorial opportunities for interaction is *Great Paintings VR* [G7], which gives the user the opportunity to change the colour of the walls, the frame of the painting, or to sort the paintings in various ways, which could help viewers to personalize the experience and reflect on the ways that these features also communicate meaning within gallery spaces.

When paintings can be touched or grabbed, while rare examples offer the chance to replace a painting on the wall (e.g., [G12]), the current purpose of touching or grabbing paintings seems to be mainly to hold them up for a closer look, or throw them away. In other cases, the hands or additional tools provide options to view details of the paintings in more structured ways, including the use of magnifying lenses (e.g., [G7, G21]), or handheld info cards and screen capture tools. Given that these interactions and content are sometimes considered a form of mediation, future work here might examine the designed intention and effect of the types of mediation that are possible within a VR application, as well as when and why particular forms of mediation are applied, ranging from the 'traditional' forms of mediation like audio guides and info cards, to more immersive and embodied forms of mediation [23]. For example, despite a range of other applications offering opportunities to paint in VR (e.g., [G8]), the applications we analyzed did not offer any option for a similar or related interaction. As many of these paintings are studied in educational contexts, however, there are perhaps opportunities to offer more embodied and experiential interactions to teach differences in brush strokes, styles, combinations of colour, or how different kinds of paint (e.g., oil, acrylic, watercolour) are used on different kinds of surfaces (e.g., paper, canvas, wood). Moreover, the materiality of the paintings is often lost in 2D digital scans which are more akin to postcards or reproductions in books in the ways that they flatten the textures of the painting. Future design work, especially in the CHI PLAY community, might turn to research that strives to bring back some of the 'somaesthetic' materiality of artwork that is otherwise inaccessible or impossible in museums [22] using tangible interaction techniques within playful applications.

5.4 Narrative and Artwork

The broader use of VR and extended reality (XR) across the arts shows experimentation that leverages traditions in other domains, including theatre and film [1], often providing opportunities to situate the audience within the action of the narrative. In the applications we analyzed, these more deliberate examples of narrative experience were rare. The narrative was often suggested, or presented in a linear informational context, suggesting opportunities for future work to explore more playful, agentic interactions.

The other analytical categories can also be applied to raise narrative questions: reproductions of galleries also reproduce the ideological narratives and rituals of galleries as spaces that capture and curate, imposing and expecting particular types of viewers and viewing experiences [8]. If a VR experience reproduces a lack of interactions, or if a reliance on visuals communicates an ocular-centric sensory position, how might interactive narratives challenge these models? Future design work might consider the interpretive role (and responsibility) of VR or XR galleries, and how the design can strive to bring new conversations and critical orientations to art experience [24]. In these cases, experiences that disrupt 'traditional' ways of presenting art raise design opportunities for what it means to situate the viewer in the narrative world of a painting (e.g. with sounds, novel interactions, etc.), or narratives that provide additional embodied or experiential interactions.

These characteristics are perhaps most evident in applications like *Eye of the Owl* [G21] or *Beyond the Glass* [G4], which add characters and soundscapes and experiential aspects of the artwork, like the ability to fly one of Da Vinci's contraptions, or to be transported to the environments that may have inspired various aspects of the painting. This is also the case in the Smithsonian exhibit [G18], with some of the paintings transporting the viewer to real-world locations to get a sense of where the original sculpture exists. For future work that leverages new digital reproductions of cultural heritage objects and sites, considerations about how the broader contexts and communities are involved in the process opens important questions about whose stories are recorded and reproduced [13].

6 CONCLUSION

In our preliminary analysis of 20 examples of VR reproductions of paintings, we note several areas of interest for future work. Each of the thematic areas that we identify—Space, Interaction, Narrative—presents questions about how current work does or does not leverage VR's experiential capabilities. This includes considerations about how virtual space enables or constrains particular forms of movement, and what kinds of spaces and social relationships are reproduced. The analysis also raises questions about how, when, and why the interactions in VR either reproduce or challenge the distanced viewership of a traditional gallery or museum. These kinds of questions can also have broader significance in terms of the ways that art is shared and experienced. Despite the interactive affordances of the medium of VR, the few examples that deliberately create playful, or experiential, or narrative interactions suggest opportunities to more directly examine the effect of VR experiences that challenge the sensory paradigm that is the norm within traditional galleries or museums.

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