ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume X-M-2-2025
30th CIPA Symposium “Heritage Conservation from Bits:
From Digital Documentation to Data-driven Heritage Conservation”, 25–29 August 2025, Seoul, Republic of Korea

# Reconstructing an "Aura" of Digital Dunhuang: A Study Based on Benjamin Theory

Wenqi Zhang[1]，Juan Du[2*]

[1] School of Sociology and Ethnology, University of Chinese Academy of Social Science, China - zw79794@163.com

[2] Dunhuang Academy, Dunhuang, Gansu, China - dujuan0312@126.com

**Keywords:** Aura Theory, Digital Dunhuang, Cultural Heritage, Digitalization, High-precision Scanning, Virtual Reality.

**Abstract:**

This paper explores the impact of digital technologies on the preservation and re-presentation of Dunhuang’s cultural heritage as based on Walter Benjamin's aura theory, and investigates how digital technologies can reconstruct the aura of cultural heritage through the analysis of the Dunhuang digitization projects. The study shows that despite reducing the physical sense of "here and now" (das Hier und Jetzt), cultural relics still retain their aura in the digital realm through enhanced interactivity and immersive experiences that utilize high-resolution scans, virtual reality (VR), and other technologies to reshape the observer's gaze. Additionally, the Dunhuang Academy's "Digital Dunhuang" project integrates high-fidelity images with 3D reconstructions, VR tours, and other technologies to achieve widespread promotion and sharing of this cultural heritage while guaranteeing authenticity. This paper argues that rather than stripping away aura, digital technologies can reconstruct aura within a new medium, sparking a shift in how cultural heritage is valued in modern society. In this way, the digitization of cultural heritage assets provides a dynamic reconstruction of cultural significance and not just a record of history.

## 1. Introduction

Robust debate has spread through academic circles since Walter Benjamin first proposed his aura theory. While the aura theory originally used to analyze the fate of artworks in the age of mechanical reproduction, its influence has long since entended beyond the realm of art into fields of cultural studies, media studies, cultural heritage preservation, and more. With the rapid advancement of technology, the digitization of cultural heritage assets has recently become a global trend. Benjamin's aura theory provides an important theoretical framework for understanding the impact of digitization on cultural heritage.

The Mogao Caves of Dunhuang form a treasure trove of Silk Road art, famed for exquisite frescoes and sculptures that have preserved centuries of cultural and historical memory. However, the ravages of time and natural forces have placed these priceless cultural artifacts at risk of irreversible damage. The advent of digital technology has opened up new possibilities for the preservation and sustained legacy of Mogao Caves. Yet it also raises new questions: Can a digital reproduction still contain the aura of the original art? How can digital technology ever reproduce the artistic value and historical significance of Dunhuang's Mogao Caves?

This paper will integrate Benjamin's aura theory with the case study of the Dunhuang digitization projects to analyze how digital technology can reproduce the aura of Dunhuang’s cultural heritage assets. It also explore a new pathway for the preservation and continued legacy of cultural heritage in the digital age.

## 2. Research Literature

### 2.1 Benjamin's Aura Theory

Walter Benjamin's aura theory was one of the classic theories that emerged from early 20th–century art philosophy, and it was first elaborated in detail in T*he Work of Art in the Age of Mechanical Reproduction*. In this work, Benjamin explores the impact of mechanical reproduction on art in the modern age, especially the reduction or alteration of the uniqueness of a work's "aura."

Benjamin argued that the aura of traditional art exists uniquely as a presence in a specific time and space–the embodiment of historical vestiges and authority, originating from the interplay between the artwork's originality, authenticity, and contextual domain–such as religious rituals or historical events. It is precisely this unique “existence” that imbues the art with a layer of cultural and spiritual value, granting it an aura that cannot be reproduced. This aura is not merely derived from an artwork's historical background or the creative process but from an intimate relationship established with the observer.

However, the proliferation of mechanical reproduction technology (such as photography, cinematography, and printing) meant that art could now be reproduced on a vast scale, leading to the weakening of its aura. Reproduction causes the historical context and uniqueness of art to fade, thereby changing the emotional and cultural connection with the observer. Art has been transformed from something unique and original into a commodity that can be reproduced and diluted at will. Viewed this way, artworks no longer exist within a specific historical and cultural context, but rather function as commodified visual icons (Benjamin, 2018, p.1241).

### 2.2 The Diminishing of Aura

**2.2.1 Cultural Commodification and Symbolic Consumption:** The concept of "culture industry" was initially used as a critique of the commodification and standardization of art in capitalist societies (Horkheimer and Adorno, 2002). Horkheimer and Adorno (2002) argue that the culture industry exhausts the "aura" of an artwork by weakening its uniqueness and criticality in serving the twin needs of mass production and standardization. Adorno (2002) claims that millions of people are involved in the mandatory reproduction process of the culture industry, providing standardized products for the same

needs across innumerable places. Jameson (2016) also points out the "depthlessness" of postmodernism while analyzing some of its core features, which manifests in our weakening sense of history and is reflected in both our relationship between shared history and our own private timeline. Therefore, postmodern culture production has become deeply embedded into this logic of fragmentation and commodification. Baudrillard (1983) borrows from the semiotic tradition to show how, under the transformation of modern consumerist society with the expansion of global markets and the standardization of cultural products, digital media technology has reproduced millions of copies and images of artworks, and how artworks around the world have been absorbed and standardize–making it possible to consume and distribute works of art widely while also changing the status of art. Neither entirely a work of art nor fully a commodity, the asset remains in flux and ultimately loses all context and uniqueness. Placed in the context of globalization, the aura of cultural heritage here is not only reproduced but becomes further transformed into a kind of global cultural symbol, deleting that close connection to a specified time, place, and culture (Kellner, 2005).

**2.2.2 "Aura" and Technical Contemplation:** Aura Theory places emphasis on art having unique historical and cultural context inherent in the original, and this uniqueness is intimately connected to the art's "existence". However, with the development of modern technology, aura has been wiped out by digital technology due to factors such as "lack of physical location, no substance, no degradation, infinite reproducibility, and lack of ownership" (Jeffery, 2015). Once digitized, works of art and cultural heritage are no longer physical assets. Despite the convenience in distribution and preservation that this offers, it also makes the connection between these works and their original environment far more fragile, losing the deep correlation between the original historical and cultural context. Art can no longer express its "original essence" or its "emotional uniqueness". Once reproduction of art is normalized, the process of dematerialization destroys the uniqueness and historical context of a work until its aura is gradually stripped away.

Extending this line of thought, Zielinski (2008) argues that the impact of modernity on art and culture is evident not only in technological advancements, but also in the ways technology itself is perceived and embedded in human understanding. That is, technology shapes how individuals interpret and engage with the world across different contexts. The erosion of the "aura" seen in modern art and cultural heritage is not merely the result of advances in technology, but is also influenced by modern attitudes toward technology (Zielinski, 2008). As technological development advances, the aura of art and cultural heritage has been gradually redefined and transformed into something more controllable, mediated, and technical. Consumers no longer perceive aura through direct contact with a work but rather gain satisfaction through viewing, participation, and experience. This change has ultimately caused a fundamental shift in the relationship between art and observer, further weakening the history and emotionality unique to an artwork and thereby accelerating the disintegration of its aura. While discussing the shifting identities of museums in a globalized and commercialized context, Krauss (1990) also remarks that the ever-growing commercial nature of museums has caused a significant change in their methods of operation which also impacts the way in which artworks are exhibited and understood.

## 3. Methods and Methodology

To preserve the Dunhuang Caves and make them permanently accessible, the Dunhuang Academy began exploring digitization in the early 1990s (Fan, 2004), and has now amassed a rich repository of digital resources and digitized creative achievements. Yang and Chen et al. (2024) classify these digital cultural resources into nine different categories based on how they were produced and what they are used for: high-fidelity digitized relic images; art/relic photos; digitized art palimpsests; 3D digital reconstructions; VR tours; 2D digital narratives; audio-visual narratives; display library platform; and other digital resources.

Taking Benjamin's five pillars of aura as its foundation (Yijun, 2017), this paper selects several representative digital initiatives launched by the Dunhuang Academy as case studies to examine how digital technology perpetuates or redefines the aura of the Dunhuang cultural heritage site.

## 4. Analysis and Discussion

### 4.1 Digitization of Cultural Heritage and Preservation of Authenticity as Driven by Quality Culture

Benjamin argues that mechanical reproductions do not change the physical existence of an original, but almost always reduce its existing quality. Therefore mechanical reproduction in essence diminishes the authenticity of a relic and, based on this, impacts its historical value while casting doubt on its authority to convey meaning. A copy's aura depends on its quality, which may directly impact the observer's experience and by extension its intrinsic effectiveness as a cultural relic (Bruno and Adam, 2001; Latour & Lowe, 2011). Low-level digitization can distort the coloring found in originals (Schanda & Lanyi, 2007), and can even lead to cross-cultural miscommunication (Grincheva, 2014). The quality of a copy often depends on its value, technical complexity, and the level of expertise invested into the craft, and these standards are difficult to meet using cheap manufacturing practices(Latour & Lowe, 2011) .

With the advance of the International Dunhuang Project (IDP) and Digital Dunhuang project, the Dunhuang Academy has established partnerships with several international collections, research institutions, and technical organizations. These collaborations aim to promote the digitization of Dunhuang’s cultural heritage to a more international and more professional technical standard.

This digitization process involves a wide range of technologies, including high-precision scanning and photography, multispectral and infrared imaging techniques, image stitching and restoration techniques, blockchain-based preservation, database and cloud storage technologies, virtual reality, augmented reality, 3D-printed and simulated technologies, online platforms and digital displays, digital monitoring and simulation, international collaboration and technology standardization, digital narrative creation, and copyright sharing.

After years of trial and error, the research team has developed a professional, standard operating procedure for the acquiring digital images. This includes the control of lighting, calibration of photographic equipment, use of standard color cards, and post-photographic color correction. In terms of presentation, the “Digital Dunhuang” archive presents mural details with high-resolution and large-scale digital results, offering

researchers and the general public access to comprehensive and high-quality cultural heritage data (Fig. 1). The high-resolution digital fresco archive is set at a resolution of 300 DPI with 50% overlap between adjacent images, a correctional image positioner to within 2 millimeters, a display resolution over 4,000 x 4,000 pixels, and a research resolution of over 8,000 x 8,000 pixels (Fig. 2).

During the scanning process, a full-coverage method was used to maintain consistent scan distance between the digital camera and the wall face to ensure the accuracy of image data. Scans were continually shot and moved at a front-facing angle to achieve balanced lighting and reduce warping. Point cloud image positioning is used to correct image stitching to an accuracy of millimeters and control the error value. Finally, the synthesized fresco data was arranged using a method known as "cross-stitching", wherein only the central part of the image–having the highest resolution and least distortion was selected for digital archive and display (Du and Zhang, 2023).

The resulting data volume for each digitized wall is enormous. For example, the west wall of Cave 61 at the Mogao Caves was captured at a resolution of 210,270 x 91,273 pixels — exceeding 44.2 billion pixels in total — and takes up more than 60 GB of storage. Meanwhile, the use of the LOD model has significantly improved rendering efficiency, reduced computational load, and optimized the user experience, all while accurately and faithfully exhibiting digital artworks (Yu and Wu et al., 2020).

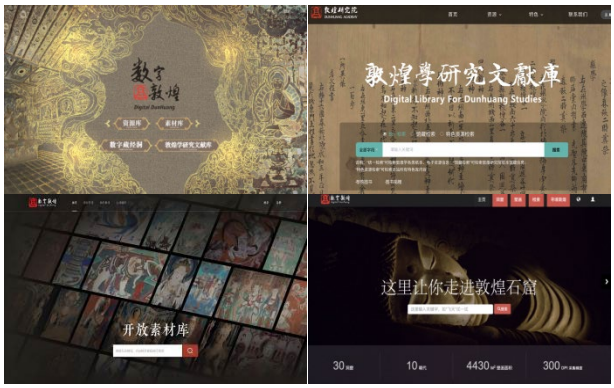


Figure 1. Digital Dunhuang

Figure 2. High-fidelity digitized relic images
Cave 57 of Mogao Caves Guanyin Bodhisattva's Sermon

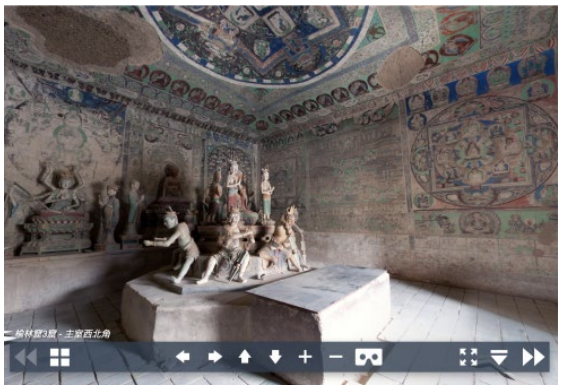

Figure 3. Yulin Cave 003 VR Panorama Tour

The promulgation and reuse of digitized assets plus the increased involvement of the public in the digital cultural heritage domain have redefined the cognitive boundaries of cultural heritage under the core values of openness and collaboration, and expanded the scope of public values and understanding into the domain of cultural heritage. Therefore, the first task during the cultural heritage digitization process is to ensure that image collection accurately reproduces the morphological patterns of the work at a technical level while also building a metadata system that allows for highly descriptive, standardized and multilingual text support to guarantee the integrity and sustainability of data.

As a form of systemizing quality standards using social norms, the core of quality culture lies in the internalization of ideologies regarding quality systems and workflows (Baštová et al., 2004; Rozsnyai, 2003). Through their research into digitization of cultural heritage, Bachi and Fresa et al. (2014) argue that popular culture is quality culture. When cultural heritage is promoted to the masses through digitization, scientific and standardized digital processing not only preserves the metaphysical properties of a cultural relic, but also delivers the added cultural and academic value of in-depth contextual descriptions.

The digitization of cultural heritage is a composite process involving technology and values interpretation; this forms a theoretical dialog with the preservation of authenticity emphasized in the Aura Theory (Bachi and Fresa et al., 2014). Conventional wisdom holds that technical specifications can diminish a relic's aura, therefore causing "disenchantment". However, when digitization strictly adheres to international standards and integrates cultural interpretation into the technical process, these not only impact reproduction and preservation but can also create a dynamic balance between human and technological values which makes digitized assets an important medium for preserving the intrinsic "here and now" qualities of cultural heritage. Ultimately, this kind of digital product based on quality culture is neither a mechanical reproduction of an original nor a simulacrum produced in a postmodern context; rather, through the self-discipline of technological rationalism it becomes a retranslation of aura preserved in the digital domain.

### 4.2 Gaze Generation: Twin Dimensions of authenticity

In *On Some Motifs in Baudelaire*, Benjamin defines aura as the experience of the returned gaze, i.e. "To capture the aura of a phenomenon is to endow it with the ability to return the gaze" (Vassilev, 2023; Benjamin, 2000, p. 212). This concept

suggests a unique way of viewing that allows the observer to take in the work from an all-new perspective, as if the target itself is also conscious and able to respond to the human gaze. What is special about viewing in this way is that the observer retains a sense of distance while remaining aware of their own behavior, such that the observer experiences a version of themselves beyond this gaze at a cognitive level. In fact, this is another reinterpretation of the sense of distance, emphasizing that despite the seeming disappearance of physical space an object still retains an "insurmountable" sense of existence (Vassilev, 2023). Holtorf (2013) argues that authenticity is a quality of cultural heritage and not just an objective attribute but a reconstructed perception of pastness in a current context. Meanwhile, this kind of quality can be reproduced in the present, and the authenticity of a historical object does not rely purely on that physical entity but instead depends on how a subject perceives and interprets the passage of time by that entity (Holtorf, 2013).

The collaborative perception and technical dimensions involved in 2020's release of "Dunhuang E-tour Animated Drama" promote authenticity and gaze generation of aura during the creative practice (Figure 4).


Figure 4. Dunhuang E-tour Animated Drama

First of all on a perception level, the Dunhuang E-tour Animated Drama strictly adheres to the principle of digital retranslation based on the ontological properties of the cultural relic while striving for the creative ideal of minimal intervention. During the digitization process, the team spurned artistic reconstruction methods commonly seen in traditional animation and chose to instead use the Mogao frescoes as the only source material, utilizing high-resolution digital scanning technology to directly acquire image data so as to minimize any secondary painting or further artistic rendering. Meanwhile, the animation retains material historical markings found on the original walls such as minute fresco cracks or the peeling off of mineral pigment which builds up this recognizable sense of the layering of history (Fig. 5). Moreover, by restoring the soundscape of ancient Dunhuang music, an audio-visual connection is created that elevates the authenticity of the relic beyond the visual domain.

Figure 5. Dunhuang E-tour Animated Drama — "Who's Taking Center Stage?"

On a technological level, this animated series uses a restrictive dynamic narrative strategy as much as possible to maintain the mural visual integrity as a static work of art, simulating the gaze of an observer before the wall. Meanwhile, camera movement is tightly restricted, single-shot durations are extended, and the range of dynamic elements is reduced. This restrictive dynamic narrative style stabilizes the fresco's flattened composition internally while recreating the visual gaze pattern from the physical world into the digital medium by restricting movement of the visual focus.

### 4.3 *Digital Library Cave*—Dialectical Transformation of Modernity and Antiquity

The aura theory reveals the intimate connection between the uniqueness of an artwork and its historical presence, placing further emphasis that even the most faithful reproduction has no hope in recapturing the "here and now" of art — therefore diminishing the depth of its original historical context. On the surface, modernity and antiquity do indeed seem to stand diametrically opposed, i.e. "... the modern standing opposed to the antique, the new stands in opposition to the always-the-same." (Benjamin, 1985, p. 34). However, Adorno and Scholem (1994, p. 557) contend that "antiquity is revealed in modernity, and modernity in antiquity." This argument reveals the interdependence of time and space, suggesting that modernity and antiquity do not stand as binary opposites but rather are constantly reconstructing meaning in the shadow of the other. This kind of cognitive model that weaves spacetime together creates a potential resonance with the "unique here and now"-ness highlighted by the Aura Theory — when the observer gazes at an antique object, they not only perceive its solid form as a physical object but the constantly updating networks of meaning that shift throughout the sands of time.

The "Digital Library Cave" (see Fig. 6) is a time-travel-inspired participatory museum. In terms of visual presentation, integrates high-resolution digital scans with the physical rendering properties of game engines to restore the original appearance of cliff faces some 1.6 km away from the Mogao Caves. Meanwhile, the three-story building and Caves 16 and 17 at Mogao have been recreated to millimeter-level accuracy, vividly reproducing the Dunhuang Library Cave and the 60,000+ priceless scrolls stored therein for a century. Over

This contribution has been peer-reviewed. The double-blind peer-review was conducted on the basis of the full paper.
https://doi.org/10.5194/isprs-annals-X-M-2-2025-391-2025 | © Author(s) 2025. CC BY 4.0 License. 

30,000 massive images have been rendered to 4K resolution, and the final model contains over 200 million segments. The subtle features of the sculptures, the textured surface of their clothes, the coloring and line texture of the frescoes, the skin texture of damaged sections, and even the fine dust present on the sculptures and frescoes — every detail is clearly discernible. The use of global dynamic lighting technology not only recreates the effects of 10 a.m. sunlight but also adds a "flashlight" viewing mode inside the cave, allowing players change cave lighting as desired within the game engine — illuminating once-dim corridors, frescoes, and official appointment stele one-by-one to recreate a "yellow scrolls and dim light" effect of Buddhist asceticism within this virtual environment. For sound effects, an ancient Dunhuang melody is used as the main theme, drawing on natural sounds collected in the caves such as bells, the wind, and cavernous echoes. These have been arranged into a variety of songs suitable for different scenarios and historical dynasties.


Figure 6. Digital Library Cave

At the same time, gamification and interactive experiences provide a vital bridge between antiquity and modernity. The project used motion capture and AI-driven facial animations to produce 350 data-driven animated videos, which form the basis for six distinct role-play characters and seven NPCs. For example, players can take on the role of Master Hongbian, a monk from the late Tang dynasty, engaging directly in the historical narrative by completing quests such as sealing the Library Cave or overseeing the dispersal and eventual repatriation of cultural relics. Another interactive section, "Painting the Base Layer," has players collect mineral dyes such as turquoise and ocher to recreate the fresco-making process, offering an immersive experience that deepens understanding of ancient techniques.

Furthermore, the research team combined the Tibetan Empire document P.T.993 "Temple Map" with architectural imagery from frescoes to digitally reconstruct the long-lost Dunhuang Sanjie Temple, creating a virtual environment that reflects temple features from the Five Dynasties and Song periods. Grounded in academic hypotheses, this gamified restoration project expands the concept of antiquity beyond the archaeological framework into a "playable history" that fosters a more dynamic understanding of the past. This project enhances accessibility by using cloud gaming technology for server-side rendering and encoding, delivering 50 GB of content. Since all computations are handled in the cloud, users can access the full experience without needing high-performance devices. This breaks through the limitations of hardware, spacetime, and crowd control to recreate highly realistic scenes and highly immersive interactive experiences.

Historicity and modernity are not linear narratives; rather, the contradictions between them gradually dissolve into a dialectical relationship. The past and the future echo and interact with each other, with old and new waxing and waning in a mutually symbiotic relationship (Frisby, 1996). Through the process of digitizing cultural heritage, antiquity is not something that is sacrificed at the altar of modernity but rather becomes an important force that activates contemporary understanding. Modern technology can restore the material manifestation of antiquity, deepen the reconstructed perception, and transform observation into an actualized, ritualized gaze across spacetime. Modernity realizes a dialectical image in the cultural heritage domain through self-criticism (reflection on technological reproductions) and self-transcendence (reconstructing traditional narrative frameworks). The real picture of the past is fleeting, and is only captured at the moment of understanding (Benjamin, 2020).

### 4.4 Digital Rituals for Aura Reconstruction and Sacred Reproductions

Authenticity is a core theme running through the Aura Theory; however as a dynamic concept it has stimulated vigorous debate about its meaning and utility. One of the most important concepts here is: Authenticity is built through ritual and tradition, and is inextricably linked to aura (Rickly-Boyd, 2012). Loss of aura also cuts off the connection between art and ritual worship (Puppe, 1979).

Religion forms a vital component of Dunhuang culture. Throughout the digitization process, religious elements were manifested in various forms. Primarily, projection domes, VR, AR, and other technologies have been used to faithfully recreate the frescoes and painted sculptures within the Dunhuang Caves, allowing observers to immerse themselves in the religious atmosphere of a millennium ago. At the same time, a Digital Donors program was launched, inspired by the historical patrons of Dunhuang (Fig. 7). It aims to engage the public in the digital preservation of Dunhuang frescoes through creative digital channels such as crowdfunding, gaming, music, anime, and cultural innovation. The Digital Donors program uses flexible interpretation of Dunhuang IP to create a “digital blessing” mode that imbues a modern sense of ritual meaning through digital creativity. Users can interact with the Dunhuang E-tour mini program to obtain ritual items and receive a personalized blessing. Digital technology reconstructs ritual experiences across time and space. Through shifts in light and shadow and the reorganization of ancient melodies, it creates a ritualistic integrity that transcends physical remnants and evokes the sacred ambiance of being within a cave. This enables users to genuinely engage with the belief systems and ritual values embedded in Dunhuang culture.

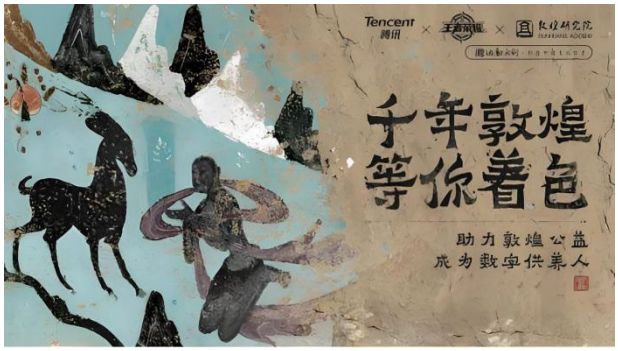


Figure 7. Digital Donors

Cultural heritage preservation systems are now expanding beyond the physical realm to encompass intangible elements—such as traditional knowledge and techniques passed down orally, including symbols, art, language, lifestyle, religious rituals, and value systems (Sotirova and Peneva et al., 2012). From frescoes to manuscripts, human beings have long transformed implicit knowledge into tangible cultural carriers through ritual and practice. While portions of this tacit experience are preserved through selective documentation, much of it remains obscured or is inevitably lost (Rosner & Roccetti et al., 2014).The introduction of digital technology transforms preservation itself into a creative process. The digitization and interactive re-creation of religious rituals not only transcend the physical boundaries of cultural heritage—they also hold the potential to rekindle aura through ritual replication. When someone uses digital technology to gaze into and interact with the gods and spirits of fresco, a ritualized dialog between digital interface and cultural heritage is formed. When users reimagine the past through such a lens, cultural memory ascends a dimension from a static archive into an embodied cognitive practice.

### 4.5 *Seeking Dunhuang*—Reshaping the "Sense of Distance"

Benjamin (1999) argues that the appearance of the distance is a key component of aura, and that modern society's obsession with proximity has contributed to its decline. Mechanical reproduction erodes this initial sense of distance by making copies easily accessible and bringing the artwork physically and psychologically closer to the viewer. Meanwhile, this manufactured intimacy not only diminishes the ritualistic and devotional value of art, but also undermines its historical testimony, authority, and authenticity. In the accelerated processes of reproduction and commercialization, physical and historical continuity are rendered irrelevant (Benjamin, 1999).

The core function of technology in digital cultural heritage is to reduce the distance between the observer and the cultural relic—seemingly offering irrefutable evidence of aura’s decline. Yet, digitization is not merely a matter of collapsing distance; rather, it reshapes spatial and experiential relations into a new format. As the first in-depth interactive cultural project from Digital Dunhuang, *Seeking Dunhuang* revolves around Mogao Cave 285 and offers users interactive online explanations about the Dunhuang frescoes alongside an offline, in-depth VR experience (Shi, 2023) (Fig. 8). By balancing the "near" and "far" distances, the project restores part of the Mogao Caves' unique aura.

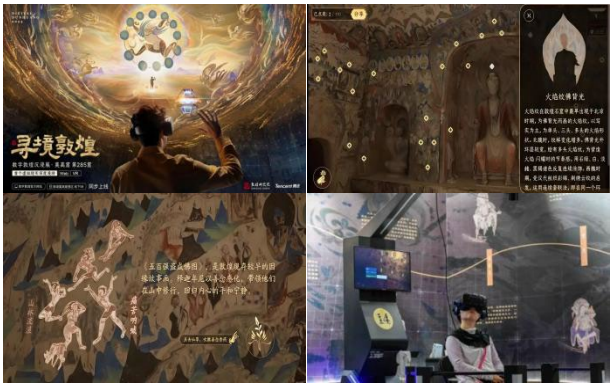


Figure 8. Seeking Dunhuang

In *Seeking Dunhuang*, users "enter" Mogao Cave 285 via an online platform or VR device. The production team highlights all the minute details and complexities of the cave system by using high-resolution digital scans and displays so that users get to sense how unique and inimitable cultural heritage is. Meanwhile, a mysterious, solemn atmosphere is created using special lighting and sound effects (such as lowlight environs or ancient music). Due to the sensitivity of frescoes to light exposure, visitors in real-life cave tours must rely on the flashlight being guided by the interpreter. *Seeking Dunhuang* faithfully replicates this experience of navigating a cave. Besides "Light mode", users can also switch to "Local light mode" to selectively illuminate specific areas, gradually revealing exquisite frescoes from the pitch-black cave (Fig. 9).

Figure 9. Local light mode and Light mode

The project’s background music also draws upon acoustic science to recreate ancient musical atmosphere of Dunhuang, inspired by the triadic religious traditions of Buddhism, Daoism, and Confucianism. Together, these elements construct a distinctive immersive atmosphere and cultivate an emotional distance that transcends physical damage, reinforcing a sense of ritual completeness.

Meanwhile, restrictive design (such as disabling magnification, rotation, or editing) limits the user's ability to interact, thereby preserving a sense of sanctity or inviolability in each cultural relic. When displaying digitized cultural heritage assets,

detailed accounts of historical background, cultural significance, and related stories are introduced, allowing the observer to truly feel the temporal and cultural distance between a cultural artifact and the present day. Additionally, time dilation (such as slow-mo replays) and spatial extension (such as zooming in on micro-details) enable users to feel within the relic a sense of the depth of time and breadth of space. By layering narratives—such as expert analysis, historical documents, and folk stories—the user gains a profound understanding of the complexity of cultural heritage and comes to feel a sense of "presence, yet untouchable" in relation to distance through this immersive experience.

Benjamin's thesis connecting aura to distance retains significant theoretical value in the digital age. However, methods of constructivism challenges the direct link between aura and authenticity, contending that aura is not some intrinsic property of objects but is rather shaped by social and cultural contexts (Cameron, 2007; Coleman, 2014; Jeffrey, 2015, 2018; Jones et al., 2017; MacIntyre et al., 2004). Instead of diminishing the aura, reproductions may in fact bolster uniqueness as the reproduction process is precisely what allows the original to retain its unique value (Latour & Lowe, 2011; MacCannell, 2013; Walsh, 2007). Therefore, during the process of building a digitized cultural heritage system, issues such as how to balance the differences between past and present, original and simulacrum, physics and metaphysics—while still preserving the authenticity and integrity of the legacy—have become a core problem. The aforementioned literature provides a critical reorientation: enhancing the *sense of distance* is more important than physical distance itself. The essence of digitization lies not in the mere replication of cultural heritage, but in constructing a system that continuously reminds the observer of their position and relationship to the cultural "entity."

### 4.6 Technological Uses of Non-linear Perspectives

In the digital age, it is essential not only to examine how technology alters the presentation of artworks, but also to explore how this impacts the cultural and historical context. The "deep time" concept enlightens us to view digital reproductions of cultural heritage within an expansive historical framework (Zielinski, 2008). Zielinski (2008) argues that the evolution of media technology throughout history has not advanced linearly, and technology has never progressed in one simple direction from the primitive to the complex; history is replete with innovations that have been abandoned by the mainstream narrative, as well as older technologies that are constantly being reinterpreted and reused.

Retrospective uses of technology frequently occur under specific conditions, and when outdated technologies come into contact with new social dynamics it can create unexpected results. This kind of retrospection is not merely an imitation of history, but rather an all-new interpretation and application of the past technologies inspired by present-day needs. Such technological retrospection is particularly striking in the context of the digitized preservation and promulgation of Dunhuang culture. Despite many technological innovations throughout history not continuing through to the present day, many of these when combined with modern tech end up creating surprising results in this new social context. For example, the digitization of Dunhuang frescoes relies not only on high-resolution scanning and AI restoration but also borrows from research into traditional painting techniques to extend forms of ancient art into a digital environment. Similarly, the application of spatial music tech during the immersive experience does not rely solely on modern synthetic acoustics but instead integrates ancient music research to recreate a rich and historically grounded soundscape within a digital environment. This kind of technological retrospection is not simply a simulacrum of history, but also a brand-new interpretation and reapplication of past technologies that reflects the complex and evolving relationship between history and technological innovation.

The process of technological retrospection involves not only the application of technological innovation but also cultural and social introspection into the nature of technology itself. Technology is not merely a tool that marks historical progress; it forms a part of that history itself within a complex, multi-layered system of evolution. It is therefore essential to approach the evolution of technology from a historical perspective and to recognize that technological development is not merely a response to contemporary needs but also a profound dialogue between the past and the future. The digitized exploration of Dunhuang exemplifies this concept. It not only preserves the ritual essence of this thousand-year-old culture through modern technological means but also gives new life to historical innovations by reinterpreting them within a contemporary framework.

## Conclusion

Ever since its publication, Benjamin's theory of aura has triggered broad debate across the research domains of art, media, and culture. While it is often assumed that mechanical reproduction diminishes–or even destroys–an artwork’s aura, the digital age has not witnessed the aura’s disappearance but rather its reinterpretation through a process of disenchantment and re-enchantment.

Although digital technology may have diminished the sacredness inherent in physical contact, a new "digital aura" has been reconstructed using high-resolution data scans and immersive, interactive design. This shift not only challenges the concept of uniqueness in traditional art, but also offers a new framework for understanding "authenticity" and "reproduction", allowing cultural heritage to be reinterpreted through the lens of technological mediation.

When observers gaze at cultural heritage through a 4K screen, they are not only viewing the revelation of history via technology but also engaging in the creation of future memories through interactive participation. This kind of experience transcends the traditional one–way model of viewing, allowing digital cultural heritage exhibitions to offer a multi-dimensional, immersive experience–one shaped by a “returned gaze”: the sensation that the object, in turn gazes back at its observer.

In conclusion, the aura in a digital age is neither simply diminished nor preserved unchanged–it undergoes a dynamic process of reconstruction and reenactment. This evolving process not only illustrates how technology mediates the preservation and dissemination of cultural heritage, but also prompts deeper reflection on the profound impact of digital media on society. Future research should continue to focus on how digital cultural assets shape new cultural values within the interplay of technological and social transformation, and how their socioeconomic potential can be fully realized without compromising historical authenticity.

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