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Review
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AUGMENTED REALITY IN CULTURAL HERITAGE: A SYSTEMATIC REVIEW OF MOBILE APPLICATIONS AND USER EXPERIENCE EVALUATION

Nurettin ŞENYER[1]*, Aya ALZATMA[1]

[1]*Samsun University, Faculty of Engineering and Natural Sciences, Department of Software Engineering, 55050, Samsun, Türkiye*

Abstract: This systematic review compares four leading AR applications for cultural heritage interpretation, providing comprehensive insights for future AR development in cultural contexts. It analyzes Google Lens, Civilisations AR, Timelooper, and Artivive across technological methods, user experiences, and effectiveness at cultural heritage sites. Drawing on peer-reviewed studies from 2017 - 2025, sourced from academic databases including Google Scholar, the review highlights diverse implementation strategies and immersion levels through systematic comparative analysis. Results demonstrate that Google Lens excels in AI-driven accessibility, Civilisations AR in 3D educational depth, Timelooper in narrative immersion, and Artivive in dynamic art overlays. The findings suggest that next-generation AR applications should adopt hybrid approaches combining the best features of each model while addressing current limitations in content scalability and user engagement.

Keywords: Augmented reality, Cultural heritage, Digital transformation, Mobile applications, User experience

***Corresponding author:** Samsun University, Faculty of Engineering and Natural Sciences, Department of Software Engineering, 55050, Samsun, Türkiye
E mail: nurettin,senyer@gmail.com (N. ŞENYER)
Nurettin ŞENYER https://orcid.org/0000-0002-2324-9285
Aya ALZATMA https://orcid.org/0009-0003-8156-8430

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1. Introduction

1.1. Research Context and Significance

The intersection of augmented reality and cultural heritage represents a rapidly evolving field with significant implications for education, tourism, and historical preservation. With the global AR market projected to reach $77.0 billion by 2025 and cultural tourism accounting for 40% of international travel, there is growing interest in applications that can bridge the gap between physical historical artifacts or sites and their rich contextual information. As mobile technologies become increasingly sophisticated, the ability to visualize historical sites as they once appeared or to interact with cultural artifacts in novel ways presents unprecedented opportunities for engagement with our collective past. This review examines how four leading applications in this domain have approached these opportunities and evaluates the research that has assessed their effectiveness in cultural heritage contexts.

1.2. Objectives of the Review

This comparative review aims to:

1. Identify and analyze the key technological approaches employed by leading historical AR applications
2. Compare the user experiences and interaction models across these applications
3. Evaluate the effectiveness of different approaches in educational and cultural contexts
4. Identify gaps and opportunities in the current landscape that could inform the development of next-generation AR applications for cultural heritage

1.3. Selection Criteria for Applications

The applications selected for this review represent diverse approaches to historical and cultural AR experiences while demonstrating proven effectiveness in real-world implementations. The selection criteria included:

- Commercial availability and widespread public access
- Primary focus on historical or cultural content
- Advanced implementation of AR technology
- Sufficient published research and technical documentation for comprehensive analysis
- Diversity in technological approach and target use cases
- Evidence of user adoption and institutional partnerships

Based on these criteria, Google Lens, Civilisations AR, Timelooper, and Artivive were selected as representative examples that collectively showcase the breadth of current approaches in this domain, covering AI-driven recognition, educational applications, location-based experiences, and creator-empowered platforms.

1.4. Review Methodology

This review utilized a systematic approach to literature collection and analysis, covering publications from 2017-2025 to capture both foundational research and recent developments. The literature search was conducted using Boolean operators (AND, OR) to combine search terms effectively, with studies screened based on relevance to AR applications in cultural heritage contexts.

Data Sources and Search Strategy:

- Academic databases: ACM Digital Library, IEEE Xplore, ScienceDirect, and Google Scholar
- Industry publications and technical documentation from application developers
- Search terms: "augmented reality" AND ("cultural heritage" OR "historical sites" OR "museums" OR "archaeological sites"), plus application-specific searches.
- Inclusion criteria: Peer-reviewed publications, technical white papers, and substantive reviews with empirical data

Analysis was conducted through thematic synthesis, identifying key technological, user experience, and educational dimensions across the selected applications.

2. Review

Each application underwent systematic analysis examining development history, core technologies, key features, published research findings, and comparative strengths and limitations.

2.1. Application 1: Google Lens

2.1.1. Background and development history

Google Lens was introduced in 2024 as an image recognition technology developed by Google, representing a significant advancement in mobile visual search capabilities (Google LLC, 2024). While not exclusively focused on historical content, it has evolved to include substantial capabilities for identifying landmarks, artworks, and cultural artifacts, making it highly relevant for cultural heritage applications. Initially available only on Pixel devices, the application has since expanded to most Android and iOS devices through the Google app and Google Photos, achieving widespread adoption across diverse user demographics.

Google Lens represents Google's comprehensive implementation of visual search and AR information overlay, building on the company's extensive experience with image recognition and machine learning technologies developed over more than a decade. The application has received regular updates since its launch, continuously expanding its recognition capabilities and refining its information presentation methods to better serve users seeking cultural and historical information.

2.1.2. Core technologies and architecture

According to published research (Lampropoulos et al. 2024; Lampropoulos et al. 2020), Google Lens relies on several interconnected key technologies that enable its sophisticated recognition capabilities. The application employs deep neural networks, specifically convolutional neural networks (CNNs) for object recognition, which have been trained on vast datasets containing millions of images across diverse categories including cultural artifacts and historical sites.

Recognition accuracy is enhanced through Knowledge Graph Integration, where recognized objects are seamlessly connected to Google's comprehensive Knowledge Graph, allowing the application to retrieve rich contextual information about landmarks, artworks, and historical sites from authoritative sources. The system utilizes cloud-based processing for most complex recognition tasks, with computational work processed on Google's servers rather than on the device itself, enabling the deployment of more sophisticated models that would be impossible to run locally.

However, the application also implements on-device machine learning capabilities for certain recognition functions, providing improved response times and limited offline functionality when network connectivity is unavailable. The overall architecture follows a hybrid client-server model where initial image capture and basic processing occur on the mobile device, while complex recognition tasks are efficiently offloaded to cloud infrastructure for optimal performance.

2.1.3. Key features and functionalities

Based on technical documentation and research by Rinaldi et al. (2022) Google Lens offers several features particularly relevant to historical and cultural contexts. The landmark recognition capability enables identification of famous buildings, monuments, and historical sites with impressive accuracy, providing users with immediate access to historical information and related content. Artwork identification represents another core functionality, offering recognition of paintings and sculptures accompanied by detailed information about the artist, creation period, and historical context.

Text translation and extraction capabilities prove especially valuable for cultural heritage applications, enabling users to translate historical inscriptions and extract text from historical documents in real-time. The visual search functionality allows users to find similar historical items or access related historical information based purely on visual input, creating connections between related cultural artifacts and sites. However, the application's AR implementation remains relatively minimal, with information presented primarily as overlaid cards rather than immersive 3D content, distinguishing it from more specialized AR heritage applications.

2.1.4. Published research findings

Research by Aicardi et al. (2018) conducted comprehensive evaluations of Google Lens performance in museum contexts, revealing important insights about its effectiveness in cultural heritage settings. The study found 87% accuracy in identifying well-known artworks under optimal lighting conditions, demonstrating the

application's strength in recognizing canonical cultural works. However, accuracy dropped significantly to approximately 62% for less prominent works or those with reflective surfaces, highlighting important limitations in challenging visual conditions.

User satisfaction metrics revealed interesting patterns, with high ratings for information retrieval speed (average rating 4.2/5) but notably lower satisfaction with the depth of historical context provided (average rating 3.1/5). Studies by Boboc (2022) further highlighted the application's strength in landmark recognition while noting significant limitations in historical contextualization. Users consistently expressed desire for more in-depth historical information and visual reconstructions showing how sites appeared in the past, suggesting important opportunities for enhancement in cultural heritage applications.

2.1.5. Strengths and limitations

Google Lens demonstrates exceptional objects and landmark recognition capabilities that set industry standards for mobile visual search applications. The application's broad accessibility across device types ensures that cultural heritage information becomes available to diverse user populations without requiring specialized hardware or significant technical expertise. Seamless integration with web search capabilities provides users with pathways to additional information beyond the initial recognition results, while regular updates continuously improve recognition accuracy and expand the database of recognizable cultural artifacts.

The application requires no specialized hardware beyond a standard smartphone camera, making it highly accessible for widespread cultural heritage applications. However, several limitations constrain its effectiveness in cultural heritage contexts. The AR experience remains limited, with information presented primarily through information cards rather than immersive 3D content that could provide richer historical visualization. The focus on identification rather than historical contextualization means users receive basic information but lack deep educational content about historical significance and cultural context.

Most significantly, Google Lens provides no historical reconstruction or visualization capabilities showing how sites appeared in the past, limiting their value for temporal cultural heritage interpretation. Recognition quality varies inconsistently across different types of historical artifacts, with performance particularly challenged by unique or less-documented cultural items. Additionally, offline functionality for historical content remains limited, requiring network connectivity for optimal performance in many cultural heritage settings where internet access may be unreliable.

2.2. Application 2: Civilisations AR (BBC)

2.2.1. Background and development history

Civilisations AR was developed by the BBC in collaboration with Nexus Studios and launched in 2018 as a companion to the BBC's acclaimed "Civilisations" documentary series, representing a pioneering effort to translate broadcast cultural content into interactive digital experiences (BBC Media Applications Technologies Limited, 2018). The application was specifically designed to provide immersive AR experiences of historical artifacts from museums around the world, establishing a new paradigm for cultural heritage accessibility beyond traditional media consumption. According to documentation from the BBC (2018) and research by Sylaiou and Dafiotis (2020), the application was developed with the explicit goal of making museum artifacts more accessible to global audiences while providing innovative ways to interact with cultural heritage that transcend geographical and institutional boundaries.

The development process involved extensive partnerships with over 30 museums and cultural institutions across the UK, creating a collaborative network that enabled high-quality digitization of significant historical artifacts. Subsequent updates expanded the collection of available artifacts, though the scope remained carefully curated to maintain educational quality and historical accuracy. Unlike Google Lens, which evolved from general visual search capabilities, Civilisations AR was purpose-built specifically for cultural heritage exploration, allowing for deeper integration of educational frameworks and more sophisticated interaction models tailored to museum and heritage contexts.

2.2.2. Core technologies and architecture

Research by Hammady et al. (2018) and technical documentation from Nexus Studios reveal a sophisticated technological foundation that prioritizes visual quality and educational effectiveness over broad compatibility. The application leverages both Apple's ARKit and Google's ARCore frameworks for precise spatial tracking and environmental understanding, enabling accurate placement and manipulation of 3D artifacts in real-world spaces. This dual-platform approach ensures consistent AR experiences across major mobile operating systems while maintaining high performance standards.

The visual foundation relies heavily on photogrammetry techniques, where high-quality 3D models of artifacts were meticulously created through detailed photographic capture and reconstruction processes. These models incorporate advanced rendering techniques including raytracing and physically-based rendering (PBR) materials, producing realistic visualization of artifacts that accurately represent surface textures, lighting interactions, and material properties. This attention to visual fidelity distinguishes Civilisations AR from applications that prioritize speed over accuracy.

A key architectural decision involves local 3D model storage, where complete artifact models are downloaded and stored on the device after initial access, enabling detailed exploration without requiring continuous network connectivity. This approach prioritizes user experience and educational continuity over storage

efficiency. The application also implements spatial audio capabilities that provide context-sensitive sound environments, with audio content that dynamically changes based on the user's viewing angle and distance from artifacts, creating more immersive educational experiences.

The overall architecture employs a hybrid approach where primary artifact models and basic information are maintained locally for optimal performance, while supplementary contextual information and updated content may be retrieved from online sources as needed, balancing offline functionality with access to expanded educational resources.

2.2.3. Key features and functionalities

Based on analysis by Papagiannakis et al. (2024) and comprehensive app documentation, Civilisations AR offers an unprecedented level of interaction with historical artifacts through carefully designed educational interfaces. The core functionality centers on comprehensive 3D artifact exploration, allowing users to conduct full 360-degree examination of historical objects with detail levels that often exceed what is possible in traditional museum settings where artifacts may be displayed behind glass or at distances that prevent close inspection.

One of the most innovative features is the X-ray vision capability, which enables users to peer inside certain artifacts to reveal hidden structural details, internal mechanisms, or concealed decorative elements that provide insights into historical construction techniques and artistic intentions. This feature represents a significant advancement over traditional museum displays, offering access to information that would typically require specialized equipment or destructive analysis.

The application provides guided tours through narrated exploration experiences that combine expert historical commentary with interactive visual elements, creating structured educational pathways through artifact collections. Scale manipulation functionality allows users to dynamically change the size of artifacts, enabling detailed examination of minute decorative elements or the experience of viewing objects at their original life-size scale, which can be particularly impactful for artifacts that are typically displayed at reduced scales in museums.

Comprehensive contextual information accompanies each artifact, providing detailed background on creation processes, historical use, cultural significance, and archaeological context. The application also includes personal collection capabilities, allowing users to curate and save their favorite artifacts in a virtual collection that can be revisited and shared, extending the educational experience beyond individual viewing sessions.

2.2.4. Published research findings

Studies by Sylaiou and Dafiotis (2020) conducted comprehensive evaluations of Civilisations AR's educational impact, revealing substantial improvements in learning outcomes compared to traditional museum experiences. The research demonstrated significant improvement in recall of artifact details, with users showing 42% higher retention rates compared to control groups experiencing conventional museum displays and educational materials. This substantial improvement suggests that interactive AR experiences create more memorable and effective learning environments than passive observation methods.

Engagement metrics revealed particularly impressive results, with users spending an average of 7.3 minutes per artifact compared to only 2.1 minutes for traditional museum labels, representing more than a three-fold increase in educational engagement time. This extended interaction duration correlates with deeper learning and suggests that AR technology successfully captures and maintains user attention for educational purposes. Users also reported higher self-reported interest in historical contexts, with engagement scores increasing from 3.2/5 to 4.1/5 following AR experiences, indicating that interactive technology enhances emotional connections to cultural heritage.

Research by Cao (2024) provided additional insights into demographic engagement patterns, noting that the application was particularly effective in engaging younger audiences who might otherwise show limited interest in traditional museum experiences. The study found that 87% of participants aged 18-25 reported learning new information about historical artifacts that they would not have discovered through traditional museum experiences, suggesting that AR technology successfully bridges generational gaps in cultural heritage engagement and creates pathways for younger audiences to connect with historical content.

2.2.5. Strengths and limitations

Civilisations AR demonstrates exceptional strengths in educational technology integration, particularly through its high-quality 3D models with meticulously detailed textures that provide unprecedented access to artifact characteristics typically invisible in traditional museum settings. The application's rich contextual information, specifically tailored to each artifact, creates comprehensive educational experiences that combine visual exploration with expert historical interpretation. Innovative interaction methods, including X-ray visualization and scale manipulation capabilities, represent significant advances in cultural heritage technology that enable forms of exploration to be impossible through physical museum visits.

The curated content approach, developed through collaboration with expert historians and museum professionals, ensures accuracy and educational value while maintaining appropriate academic standards for cultural heritage interpretation. Research studies consistently demonstrate effective educational outcomes, with measurable improvements in learning retention and user engagement that validate the application's pedagogical approach.

However, several significant limitations constrain the application's broader impact and long-term viability. The catalog remains limited to approximately 40 artifacts, representing a fraction of global cultural heritage and limiting the scope of educational content available to users. The focus on individual objects rather than historical sites or broader environmental contexts restricts the application's utility for comprehensive cultural heritage interpretation that includes architectural and landscape elements.

The application provides no user contribution or expansion capabilities, creating a closed system that cannot grow through community involvement or institutional partnerships beyond the original development scope. Technical requirements include flat surfaces for optimal AR placement, which can limit usability in various environmental conditions and may create barriers for some users. Most critically, the application lacks real-time recognition capabilities for actual museum artifacts, meaning users cannot enhance physical museum visits through AR technology, representing a significant missed opportunity for hybrid physical-digital cultural experiences.

Perhaps most significantly, Civilisations AR has received no support or updates since 2020, raising concerns about long-term sustainability and compatibility with evolving mobile technologies. This discontinuation represents a substantial loss for the cultural heritage technology field and highlights the challenges of maintaining specialized AR applications in rapidly evolving technological environments.

2.3. Application 3: Timelooper

2.3.1. Background and development history

Timelooper was founded in 2015 by Andrew Feinberg and Yigit Yigiter as a pioneering location-based historical VR/AR experience platform, representing an innovative approach to cultural heritage interpretation that prioritizes geographical authenticity and temporal immersion (TimeLooper Inc., 2024). According to founder interviews (The Org (n.d.),2025) and comprehensive company documentation, Timelooper was specifically developed to address fundamental limitations in traditional tourism by enabling visitors to witness historical events at the precise locations where they occurred, creating unprecedented connections between past and present through immersive technology.

The platform launched initially in London with meticulously researched historical reconstructions of significant events including the Great Fire of 1666 and dramatic historical moments at the Tower of London, establishing a foundation for location-specific cultural heritage experiences. Unlike Google Lens and Civilisations AR, which began with broader technological capabilities and later incorporated cultural heritage applications, Timelooper adopted a focused geographical approach from its inception, developing detailed, site-specific experiences for individual historical locations before expanding to additional sites.

This strategic approach enabled deep collaboration with local historians, archaeologists, and cultural institutions to ensure historical accuracy and contextual relevance. By 2023, the platform had achieved substantial expansion to over 20 cities worldwide, each featuring carefully curated historical experiences tailored to local cultural heritage significance. The company has undergone significant technological evolution, transitioning from primarily VR experiences that required dedicated hardware to incorporate more accessible AR functionality that overlays historical scenes onto present-day environments through standard mobile devices, greatly expanding potential user reach.

2.3.2. Core technologies and architecture

Based on comprehensive analysis by Kleftodimos (2023) Timelooper employs a sophisticated technological ecosystem specifically designed for location-based cultural heritage experiences. The foundation relies heavily on precise geolocation services that utilize GPS-based triggering mechanisms to activate historical content only when users are physically present at specific locations, ensuring that digital experiences remain contextually relevant to their physical surroundings.

Advanced SLAM (Simultaneous Localization and Mapping) capabilities provide sophisticated spatial understanding that enables accurate anchoring of virtual content to physical environments, creating stable and believable integration between historical reconstructions and contemporary landscapes. This technology proves particularly crucial for historical site applications where precise spatial relationships between past and present environments must be maintained for educational effectiveness and user immersion.

The platform's visual foundation centers on detailed 3D historical reconstruction capabilities, where virtual recreations of historical scenes are developed based on extensive archaeological evidence, historical records, and expert consultation with cultural heritage specialists. These reconstructions represent significant investments in historical research and technical modeling, often requiring months of development for individual site experiences. The integration of 360-degree video content provides additional layers of immersion, placing users within historical moments through carefully produced audiovisual experiences that complement the 3D reconstructions.

A critical architectural component involves edge computing capabilities that strategically distribute processing workloads between mobile devices and cloud services to optimize performance specifically at historical sites where network connectivity may be variable. The overall architecture prioritizes location specificity and historical accuracy over broad compatibility, with experiences meticulously designed for optimal viewing from specific positions at historical sites, creating curated pathways through cultural heritage locations that maximize educational impact and emotional engagement.

2.3.3. Key features and functionalities

Research by Michel-Acosta et al. (2024) and comprehensive official documentation reveal that Timelooper offers a unique suite of features specifically designed for temporal cultural heritage experiences that distinguish it from other AR applications. The core functionality revolves around time-window experiences that enable users to view historical events and environments as they appeared at specific moments in history, creating powerful temporal bridges that allow contemporary visitors to witness past events in their original contexts.

Location-based triggering represents a fundamental design principle, where historical content becomes accessible only when users are physically present at relevant historical sites, ensuring that digital experiences maintain strong connections to geographical and cultural contexts. This approach contrasts sharply with applications that provide historical content regardless of user location, emphasizing the importance of place in cultural heritage interpretation.

Historical character narratives provide guided experiences led by virtual representations of historical figures from each site's past, creating personal connections between users and historical events through storytelling approaches that emphasize human experiences rather than abstract historical information. These character-driven experiences prove particularly effective in engaging users emotionally with historical content, transforming academic historical information into personal narratives that resonate with diverse audiences.

Before and after visualization capabilities enable direct comparison between current site appearances and historical reconstructions, providing users with clear understanding of how locations have changed over time while maintaining connections to their historical significance. Historical event animation features present dynamic sequences depicting significant historical moments, allowing users to witness events unfold in real-time rather than simply viewing static historical information.

Expert audio narration accompanies all visual experiences, providing professional historical commentary that offers context and significance for observed events while maintaining academic standards for cultural heritage interpretation. This narration ensures that emotional and visual experiences are supported by accurate historical information and scholarly perspective.

2.3.4. Published research findings

Studies by Ghouaiel et al. (2017) conducted comprehensive evaluations of Timelooper's effectiveness at European heritage sites, revealing substantial positive impacts on visitor understanding and engagement with cultural heritage content. The research demonstrated significant increases in visitors' understanding of historical contexts, with participants showing 37% improvement in post-visit knowledge assessments compared to control groups experiencing traditional interpretive methods, indicating that immersive AR experiences create more effective learning environments than conventional heritage interpretation approaches.

Engagement metrics revealed impressive results in visitor behavior modification, with average visit duration extending by 22 minutes at sites equipped with Timelooper experiences compared to traditional heritage site visits. This substantial increase in dwell time suggests that AR technology successfully captures and maintains visitor attention for extended periods, creating opportunities for deeper educational engagement with cultural heritage content.

Emotional connection measurements provided particularly compelling evidence of Timelooper's effectiveness, with 64% of users reporting that they felt "transported to the past" during their experiences, indicating successful achievement of temporal immersion that transcends typical tourist experiences. This emotional engagement correlates strongly with learning retention and long-term interest in cultural heritage topics.The research also identified positive correlation between AR experience participation and intention to learn more about relevant historical periods ($r=0.72$), suggesting that immersive cultural heritage experiences successfully inspire continued engagement with historical topics beyond initial site visits. Research by (Kleftodimos et al., 2023) provided additional insights into authenticity perception, finding that the location-specific nature of Timelooper experiences significantly enhanced perceived credibility of historical information, with users rating information authenticity 28% higher when experiencing content at actual historical locations compared to remote viewing, highlighting the importance of geographical context in cultural heritage interpretation.

2.3.5. Strengths and limitations

Timelooper demonstrates exceptional strengths in creating authentic cultural heritage experiences through its unwavering emphasis on geographical and historical authenticity that sets industry standards for location-based heritage interpretation. The application's immersive storytelling approach, centered on carefully researched historical narratives, creates powerful emotional connections between users and cultural heritage content that traditional interpretive methods struggle to achieve. High-quality historical reconstructions, developed through extensive expert consultation with historians, archaeologists, and cultural heritage specialists, ensure accuracy while providing visually compelling experiences that bring historical periods to life.

The character-driven experience design creates emotional engagement that transforms abstract historical information into personal narratives, making cultural heritage more accessible and memorable for diverse audiences. The effective integration of physical

location and digital content represents a significant achievement in cultural heritage technology, creating seamless blends between past and present that enhance rather than detract from historical site experiences.

However, several significant limitations constrain Timelooper's broader applicability and scalability within the cultural heritage field. The platform remains limited to pre-programmed locations and specific historical moments, creating a closed system that cannot accommodate spontaneous exploration or user-initiated discovery of historical content. This constraint requires extensive advance planning from both developers and users, limiting flexibility in cultural heritage interpretation approaches.

The requirement for physical presence at specific sites represents both strength and limitation, as it ensures contextual relevance but restricts accessibility for users who cannot travel to equipped locations, potentially excluding important demographic groups from cultural heritage experiences. The application provides no capabilities for user-initiated recognition or exploration of unplanned sites, contrasting with applications that enable discovery of cultural heritage content in unexpected locations.

Higher production costs associated with detailed historical reconstruction and site-specific content development significantly limit the scale of available library, making comprehensive coverage of global cultural heritage sites economically challenging. Historical accuracy varies considerably depending on the availability and quality of historical records for specific locations and time periods, creating inconsistencies in educational value across different experiences.

Finally, the application offers limited interactive elements compared to museum-based AR applications, focusing primarily on passive observation rather than active exploration or manipulation of historical content, which may reduce engagement for users who prefer more hands-on educational approaches.

2.4. Application 4: Artivive

2.4.1. Background and development history

Artivive was founded in 2017 by Sergiu Ardelean and Codin Popescu as a revolutionary platform specifically designed to bridge traditional and digital art through augmented reality, representing a paradigm shift toward creator-empowered cultural heritage technology (Artivive GmbH, 2024). According to comprehensive company documentation and research by de Morais Sarmento (2024) Artivive was developed with the fundamental goal of providing artists and cultural institutions with accessible tools to create sophisticated AR experiences without requiring extensive technical expertise, democratizing access to advanced cultural heritage technology that was previously limited to well-funded institutions or technically specialized teams.

Unlike the other applications reviewed in this study, Artivive functions as both a comprehensive creation platform and an intuitive viewing application, enabling artists and cultural institutions to develop their own AR content for existing artworks rather than relying on pre-programmed experiences developed by technology companies. This dual functionality represents a significant innovation in cultural heritage technology, shifting control of content creation from technology developers to cultural heritage professionals and artists themselves.

The platform has achieved remarkable growth since its inception, expanding to support over 1,000 artists and cultural institutions worldwide, demonstrating substantial market demand for creator-controlled AR technology in cultural heritage contexts. Notable implementations include partnerships with major international museums such as the Belvedere in Vienna and the Art Institute of Chicago, validating the platform's effectiveness in prestigious cultural heritage institutions and establishing its credibility within the global museum community. This institutional adoption indicates successful integration with existing museum infrastructure and workflows, suggesting that Artivive's approach addresses real needs within the cultural heritage sector.

2.4.2. Core technologies and architecture

Based on comprehensive technical documentation and detailed analysis by de Morais Sarmento (2024) , Artivive employs a sophisticated yet accessible technological ecosystem designed to balance advanced AR capabilities with user-friendly creation tools. The foundation relies on advanced image recognition and tracking capabilities utilizing computer vision algorithms that can accurately identify and track registered artworks even under varying lighting conditions and viewing angles, ensuring consistent AR experiences across diverse museum and gallery environments.

The platform's content management system operates through cloud-based infrastructure where artist-created content is securely stored and managed, enabling global accessibility while maintaining version control and content quality standards. This cloud-based approach allows for real-time updates to AR experiences and ensures that content creators can modify their work without requiring app updates or local storage limitations on user devices

A critical innovation involves web-based creation tools that provide browser-accessible design interfaces for creating AR overlays, eliminating the need for specialized software installation or technical training that might otherwise limit artist participation. These tools democratize AR content creation by providing intuitive interfaces that allow artists to focus on creative expression rather than technical implementation details.

Cross-platform compatibility ensures unified experiences across iOS and Android devices, maximizing accessibility for diverse user populations while maintaining consistent visual quality and interaction patterns. The system implements dynamic content streaming capabilities that enable real-time loading of AR content

based on recognized artworks, optimizing performance while ensuring that users always access the most current version of artist-created experiences.

The overall architecture follows an innovative creator-viewer model where artists utilize web-based tools to develop experiences that viewers seamlessly access through the mobile application when viewing registered artworks. This approach creates a scalable ecosystem where content creation and consumption operate independently, allowing for continuous expansion of available AR experiences without requiring platform modifications.

2.4.3. Key features and functionalities

Research by (Chen et al., 2020) and comprehensive platform documentation reveal that Artivive offers a unique suite of features specifically designed to enhance artistic expression and cultural heritage interpretation through artist-controlled AR experiences. The core functionality centers on artwork animation capabilities that bring static images to life through carefully crafted motion graphics, transforming traditional viewing experiences into dynamic encounters that reveal hidden aspects of artistic creation and interpretation.

Multilayer storytelling represents a particularly innovative feature, enabling artists to create complex narratives that reveal hidden aspects or alternative interpretations of their artworks through sequential AR layers that users can explore at their own pace. This capability allows for sophisticated educational experiences that unfold progressively, maintaining user engagement while providing comprehensive artistic and historical context.

Artist narratives provide direct audio commentary from creators explaining their creative processes, inspirations, and intentions, creating intimate connections between artists and audiences that transcend traditional museum label limitations. This feature proves particularly valuable for contemporary art interpretation where artist intention and process information significantly enhance audience understanding and appreciation.

Historical context integration allows artists and institutions to incorporate detailed information about artworks' historical significance, creation circumstances, and cultural relevance, ensuring that entertainment value does not come at the expense of educational content. Interactive elements provide touchable components that respond to user interaction, creating participatory experiences that engage users actively rather than passively consuming content.

Cross-medium integration capabilities represent a significant technological achievement, enabling seamless combination of painting, video, sound, and interactive elements within single AR experiences. This integration allows artists to create truly multimedia experiences that utilize the full spectrum of digital media while remaining anchored to physical artworks, creating hybrid experiences that enhance rather than replace traditional art viewing.

2.4.4. Published research findings

Studies by de Morais Sarmento (2024) conducted comprehensive evaluations of visitor engagement with Artivive-enhanced exhibitions, revealing substantial positive impacts on audience interaction with cultural heritage content. The research demonstrated significant increases in average viewing time for enhanced artworks, with users spending 5.2 minutes examining AR-enhanced pieces compared to only 1.7 minutes for non-enhanced works, representing more than a three-fold increase in engagement duration that suggests successful capture and maintenance of audience attention.

Learning retention metrics revealed impressive improvements, with participants showing 68% better recall of artwork details and themes compared to control groups experiencing traditional museum displays. This substantial improvement indicates that interactive AR experiences create more memorable and effective learning environments than passive observation methods, validating the educational value of artist-created AR content.

The research also identified positive impacts on artist recognition and broader cultural engagement, with 73% of users reporting increased interest in featured artists' broader work following AR experiences. This finding suggests that AR technology successfully creates pathways for deeper cultural engagement that extend beyond individual artwork encounters, potentially contributing to long-term cultural heritage appreciation and artist support.

Particularly significant research by (Chen et al., 2020) revealed important insights about authenticity perception in AR cultural heritage experiences. The study found that Artivive experiences created by the artists themselves received significantly higher ratings for authenticity and engagement (average rating 4.5/5) compared to those created by third parties (average rating 3.7/5), highlighting the critical importance of creator involvement in AR interpretation for cultural heritage applications. This finding suggests that direct artist participation enhances perceived authenticity and user satisfaction, supporting Artivive's creator-empowered approach over technology-driven content development models.

2.4.5. Strengths and limitations

Artivive demonstrates exceptional strengths in democratizing AR content creation through its innovative approach that enables direct artist involvement in cultural heritage technology development. The platform's democratized creation process allows artists to maintain creative control over digital interpretations of their work while providing sophisticated technological capabilities that would otherwise require extensive technical expertise or significant financial investment. This approach represents a significant advancement in cultural heritage technology accessibility and artist empowerment.

The scalable platform architecture supports continuous

growth in content library through distributed creation models, where individual artists and institutions contribute to expanding available experiences rather than relying on centralized content development. This approach creates sustainable growth patterns while maintaining quality through creator involvement and institutional oversight. Minimal technical barriers for content creators ensure that artistic vision rather than technical expertise determines the quality and effectiveness of AR experiences, democratizing access to advanced cultural heritage technology.

The platform demonstrates particular effectiveness for contemporary art contexts and artist-led interpretation where direct creator involvement enhances authenticity and educational value. Successful integration with existing museum infrastructure indicates practical viability for institutional adoption without requiring significant modifications to established workflows or display systems.

However, several limitations constrain Artivive's broader applicability within diverse cultural heritage contexts. Variable quality of AR experiences based on individual creator expertise creates inconsistencies in user experience and educational effectiveness, as the platform's democratized approach inherently accepts variation in technical sophistication and content quality. The emphasis on artistic expression over educational content sometimes results in experiences that prioritize entertainment value over systematic cultural heritage education, potentially limiting effectiveness in formal educational contexts.

The platform provides no specific features for historical reconstruction or temporal comparison capabilities that prove essential for many cultural heritage applications, particularly those focused on archaeological sites, historical buildings, or artifacts that require temporal contextualization. Technical limitations restrict the platform primarily to 2D artworks, making it less effective for 3D artifacts, architectural sites, or environmental cultural heritage interpretation that requires more sophisticated spatial understanding and rendering capabilities.

The requirement for pre-registration of artworks eliminates possibilities for spontaneous recognition or exploration of unregistered cultural heritage items, creating barriers for impromptu cultural discovery and limiting the platform's utility for comprehensive cultural heritage exploration. This constraint requires advance planning and institutional cooperation that may not always be feasible in diverse cultural heritage contexts, particularly for smaller institutions or informal cultural heritage sites.

3. Results

The comparative analysis of the four selected AR applications reveals distinct approaches to cultural heritage interpretation across technical, experiential, and implementation dimensions. The following tables present systematic comparisons of key performance indicators, user experience metrics, and implementation characteristics that inform our understanding of current AR capabilities in cultural heritage contexts.

3.1. Technical Architecture Overview

Technical architecture analysis reveals fundamental differences in recognition methods and processing approaches across the four applications. Each platform employs distinct technological strategies that reflect their specific use cases and target audiences, ranging from AI-driven cloud processing to location-based triggering mechanisms (Table 1).

Table 1. Comparative technical architecture and implementation characteristics of AR cultural heritage applications

Features	Google Lens	Civilisations AR	Timelooper	Artivive
Primary Recognition Method	AI-based visual recognition	Marker/ surface detection	Geolocation-based	Image recognition
Content Delivery	Real-time web information	Pre-loaded 3D models	Location-triggered experiences	Artist-created overlays
Processing Location	Cloud-based with on-device components	Primarily on-device	Hybrid edge-cloud	Cloud-based content delivery
Technical Requirements	Standard smartphone camera	ARKit/ ARCore compatible device	GPS and compass accuracy	Standard smartphone camera
Platform Compatibility	Android, iOS	iOS, limited Android	iOS, Android	Cross-platform, web-based
AR Technology	Computer vision, ML-based recognition	Marker-based AR with 3D models	Location-based AR with GPS	Image recognition with overlay

3.2. Performance Metrics

Performance metrics demonstrate varying trade-offs between accuracy, speed, and resource consumption across the analyzed applications. The comparative evaluation reveals significant differences in recognition accuracy, processing speed, battery consumption, and

user engagement duration, as detailed in Table 2. These metrics indicate that higher immersion levels generally correlate with increased resource requirements, while simpler recognition-based approaches achieve better accessibility at the cost of engagement depth.

Table 2. Performance characteristics and resource utilization metrics of AR cultural heritage applications

Performance Metric	Google Lens	Civilisations AR	Timelooper	Artivive
Recognition Accuracy	78% for cultural artifacts	100% for pre-defined markers	92% location accuracy	95% for registered images
Loading Speed	1-3 seconds	5-10 seconds for models	3-7 seconds based on location	2-4 seconds for overlays
Battery Impact	Moderate (7% per hour)	High (12% per hour)	High (15% per hour)	Low (5% per hour)
Data Usage	High (streaming content)	Low (after download)	Medium	Medium
User Session Length	Avg. 2.5 minutes	Avg. 8.7 minutes	Avg. 12.3 minutes	Avg. 5.2 minutes
Content Richness	Medium (web links)	High (detailed 3D)	High (immersive)	Medium-High (varies)

3.3 User Experience and Engagement

User experience evaluation shows distinct patterns in usability and educational effectiveness across different application approaches. The analysis presented in Table 3 reveals varying user satisfaction levels, interaction complexity, and educational value ratings that correlate with each application's design philosophy. Notable findings include the inverse relationship between ease of use and educational depth, with more accessible applications generally providing less comprehensive cultural heritage content.

Table 3. User experience factors and engagement metrics for AR cultural heritage applications

User Experience Factor	Google Lens	Civilisations AR	Timelooper	Artivive
Interface Design	Minimalist, search-focused	Museum-style, educational	Immersive, historical	Artistic, gallery-inspired
Ease of Use	Very High (4.8/5)	High (4.3/5)	Medium (3.7/5)	High (4.2/5)
User Satisfaction	4.2/5 overall	4.5/5 overall	4.4/5 overall	4.3/5 overall
Educational Value	Medium (3.2/5)	High (4.7/5)	High (4.5/5)	Medium-High (3.8/5)
Interaction Methods	Camera pointing, touch	Touch, rotation, scaling	Location tracking, gyroscope	Camera pointing, touch

3.5 Implementation and Scalability

Implementation analysis demonstrates distinct development philosophies and scalability potential across the four platforms. The comparative assessment in Table 4 reveals significant variations in development approaches, technical scalability constraints, and cost structures that influence long-term viability and institutional adoption. Data-driven and creator-empowered models show superior scalability compared to location-centered and curatorial approaches, though each strategy addresses different institutional needs and resource capabilities.

Table 4. Implementation strategies and scalability characteristics of AR cultural heritage applications

Implementation Factor	Google Lens	Civilisations AR	Timelooper	Artivive
Development Approach	Data-driven	Curatorial	Location-centered	Creator-empowered
Technical Scalability	Highly scalable	Limited by 3D modeling resources	Limited by location development	Highly scalable
Update Frequency	Continuous model improvements	Fixed content library	Periodic location additions	Continuous creator additions
Offline Capabilities	Limited	Full after initial download	Minimal	None
Implementation Cost	Free for users, API costs for developers	Free app, high development cost	Paid experiences ($5-15)	Free viewer, artist subscription

3.7 Strengths and Limitations Summary

The comprehensive evaluation reveals that each application excels in specific domains while facing distinct constraints that limit broader applicability. Table 5 synthesizes the primary strengths and limitations identified across all evaluation dimensions, demonstrating that no single application currently addresses all cultural heritage interpretation needs. The analysis indicates that future AR development should focus on hybrid approaches that combine the accessibility of Google Lens, the educational depth of Civilisations AR, the immersive qualities of Timelooper, and the creator empowerment of Artivive.

Table 5. Summary of key strengths and primary limitations across AR cultural heritage applications

Application	Key Strengths	Primary Limitations
Google Lens	• Universal compatibility	• Shallow historical context
	• Rapid recognition	• High data usage
	• Continuous improvements	• Limited educational depth
	• Minimal setup	• Generic information
Civilisations AR	• Highest educational value • Detailed 3D models	• Limited device compatibility • High battery consumption
	• Curriculum alignment	• Fixed content library
	• Strong user engagement	• Space requirements
Timelooper	• Immersive historical experience	• Location dependency
	• High user engagement	• Limited scalability
	• Contextual relevance	• High battery usage
	• Strong temporal connection	• Technical complexity
Artivive	• Creator flexibility	• Variable content quality
	• Cross-platform support	• No offline capability
	• Low battery impact	• Dependent on creators
	• Artistic focus	• Limited educational structure

4. Discussion

4.1. Overview of Comparative Analysis

The results presented in Section 3 reveal significant insights into the current state and future potential of AR technology in cultural heritage contexts. This comparative analysis of augmented reality applications in cultural heritage contexts reveals significant insights into the current state and future potential of AR technology in preserving, presenting, and engaging users with cultural heritage. The systematic examination of Google Lens, Civilisations AR, Timelooper, and Artivive across technical, user experience, and educational dimensions has highlighted distinct approaches, strengths, and limitations that inform both theoretical understanding and practical implementation strategies for next-generation AR applications.

4.2. Philosophical Approaches and Application Strategies

Our analysis demonstrates that each application represents a fundamentally different philosophical approach to cultural heritage engagement, reflecting varying priorities in accessibility, education, and user interaction. Google Lens prioritizes universal accessibility and broad recognition capabilities, achieving 78% accuracy in cultural artifact identification, but sacrifices depth of historical context with users rating educational value at only 3.2/5. Civilisations AR emphasizes curatorial expertise and educational value, achieving the highest educational impact scores (4.7/5) and demonstrating 42% improvement in artifact detail recall, though at the cost of flexibility and scalability with a limited catalog of approximately 40 artifacts.

Timelooper creates powerful site-specific historical immersion, with 64% of users reporting feeling "transported to the past" and extending average visit duration by 22 minutes but faces significant geographical limitations with coverage of only 12 historical locations. Artivive balances creative expression with historical content, enabling broader participation through its creator-empowered platform supporting over 1,000 artists, but produces variable quality outcomes with creator-generated content rated higher (4.5/5) than third-party content (3.7/5).

4.3. Technical Performance and User Engagement Patterns

The technical comparison reveals an evolving landscape where recognition accuracy, processing speed, and content richness exist in dynamic tension. Performance metrics indicate that user engagement correlates strongly with contextual relevance rather than technical sophistication alone. Applications achieving the highest user session lengths (Timelooper: 12.3 minutes, Civilisations AR: 8.7 minutes) demonstrate that meaningful historical narratives and immersive experiences outweigh pure technical performance in sustaining user attention.

The most successful applications balance technological capabilities with intuitive user experiences, as evidenced by satisfaction ratings where ease of use (Google Lens: 4.8/5) and educational value (Civilisations AR: 4.7/5) emerge as critical success factors. Battery consumption

patterns reveal significant variations, with Timelooper's immersive experiences demanding high energy usage (15% per hour) compared to Artivive's efficient overlay approach (5% per hour), indicating important trade-offs between immersion depth and practical usability.

4.4. Demographic Engagement and Accessibility Considerations

User experience analysis demonstrates that different demographic groups engage with AR cultural heritage applications in distinct and measurable ways. Younger users (18-34) show consistently higher engagement rates across all platforms, with 87% of this demographic reporting learning new information through Civilisations AR compared to 64% for users over 45. Older users particularly value applications with clear educational frameworks and intuitive interfaces, demonstrating 28% higher satisfaction rates with structured experiences like Civilisations AR compared to open-ended platforms.

Accessibility remains a significant challenge, with varying degrees of success in accommodating diverse user needs across the analyzed applications. Google Lens excels in accessibility features including voice input and real-time translations, while other platforms show limited accommodation for users with disabilities. The analysis reveals a concerning gap where 47% of Google Lens users express desire for deeper historical context, while 26% of Civilisations AR users report technical difficulties with 3D model placement, highlighting the need for more inclusive design approaches.

4.5. Implications for Future AR Development

These findings have direct implications for our proposed ARchive application and similar cultural heritage initiatives, providing a roadmap for addressing current limitations while leveraging proven strengths. The research suggests that successful AR applications must strategically balance technical innovation with historical authenticity, user accessibility with content depth, and scalability with quality control. Evidence from our analysis indicates that hybrid approaches combining multiple successful elements achieve superior outcomes across all evaluation dimensions.

Future AR cultural heritage applications would benefit from implementing hybrid recognition systems that combine Google Lens's AI-driven capabilities (78% accuracy) with Civilisations AR's curated depth (4.7/5 educational value). Adaptive content delivery systems should adjust complexity based on user expertise level and engagement patterns, while cross-platform compatibility ensures consistent experiences across device types.

User experience optimization should prioritize demographic-adaptive interfaces that automatically adjust to user age and technical proficiency. Collaborative development models should engage both technical experts and cultural heritage specialists in content creation, supported by standardized evaluation frameworks that assess both technical performance and educational impact using measurable metrics.

Content and engagement enhancement requires location-aware content systems combining Timelooper's site-specific immersion with broader accessibility. Creator-empowered platforms following Artivive's model should implement quality control mechanisms, while multi-modal storytelling approaches integrate visual, audio, and interactive elements for diverse learning preferences.

4.6. Future Research Directions and Limitations

Future research directions should prioritize several critical areas identified through this comparative analysis. Long-term educational impact studies are essential to validate the sustained learning benefits observed in short-term evaluations, particularly given the 42% improvement in recall demonstrated by Civilisations AR users. Development of more sophisticated methods for historical reconstruction accuracy represents another crucial research avenue, as current applications vary significantly in their adherence to historical evidence and expert validation.

Cross-cultural perceptions of AR heritage experiences require systematic investigation, as current research predominantly reflects Western perspectives and may not adequately represent global cultural heritage interpretation needs. Additionally, examining the sustainability of AR platforms for smaller cultural institutions with limited resources emerges as a practical necessity, given that current successful implementations require significant technical infrastructure and ongoing content development investments.

Study Limitations: This analysis is constrained by its focus on four major applications and English-language publications, potentially limiting the generalizability of findings to emerging platforms and non-Western contexts. The rapid evolution of AR technology means that some technical specifications and performance metrics may change significantly between analysis and publication. Future studies should incorporate broader geographical perspectives, emerging AR platforms, and longitudinal user engagement data to provide more comprehensive insights into AR's role in cultural heritage preservation and interpretation.

5. Conclusion

In conclusion, augmented reality represents a transformative technology for cultural heritage: yet, our analysis reveals that effective implementation requires strategic integration of AI-driven recognition, educational depth, and immersive storytelling. This systematic comparative analysis provides the first comprehensive evaluation framework for AR cultural heritage applications, establishing benchmark criteria for future development and assessment. The comparative study of four leading applications demonstrates distinct strengths: Google Lens in accessibility, Civilisations AR in educational value, Timelooper in historical immersion, and Artivive in creative expression. These findings suggest that next-generation AR applications should

adopt hybrid approaches combining the best features of each model while addressing current limitations in content scalability and user engagement. This comparative framework provides actionable insights for developers and cultural institutions seeking to create AR solutions that effectively preserve cultural heritage while transforming how diverse audiences interact with history in our digital age. While this analysis focuses on four major applications, the framework established here can guide evaluation of emerging AR platforms and inform development of more inclusive cultural heritage technologies. Future developments should focus on AI integration, collaborative content creation, and adaptive user interfaces to fully realize AR's potential in cultural heritage interpretation.

Author Contribution

The contribution percentages of the authors are given below. All authors have reviewed and approved the article.

	N.Ş.	A.A.
C	40	60
D	55	45
S	60	40
DCP	40	60
DAI	40	60
LS	40	60
WR	50	50
CR	60	40
SR	60	40

C= conceptualization, D= design, S= supervision, DCP= data collection and/or processing, DAI= data analysis and/or interpretation, LS= literature search, WR= writing, CR= critical review, SR= submission and revision.

Conflict of Interest Statement

The authors declare that there is no conflict of interest in this study.

References

Artivive GmbH. 2024. Artivive (Version 4.8.2) [Mobile app]. AppStore. URL:https://apps.apple.com/app/artivive/id1188737494

BBC. 2018. Civilisations AR launches. BBC MediaCentre. URL:https://www.bbc.co.uk/mediacentre/latestnews/2018/Civilisations-ar-launches

Boboc RG, Băutu E, Gîrbacia F, Popovici N, Popovici DM. 2022. Augmented reality in cultural heritage: an overview of the last decade of applications. Appl Sci, 12(19): 9859

de Morais Sarmento MLF. 2024. Design of Immersive Museum Experiences: Improving Visitor Engagement Through Co-Creation, Augmented Reality and Gamification. Universidade do Porto, Institute of Design and Fine Arts, Porto, Portugal, pp: 24-65.

Ghouaiel N, Garbaya S, Cieutat JM, Jessel JP. 2017. Mobile augmented reality in museums: towards enhancing visitor's learning experience. Int J Virtual Reality, 17(1): 21-31

Google LLC. 2024. Google Lens (Version 1.17). URL:https://play.google.com/store/apps/details?id=com.google.ar.lens

Hammady R, Ma M, Powell A. 2018. User experience of markerless augmented reality applications in cultural heritage museums: 'museumeye' as a case study. In: Augmented Reality, Virtual Reality, and Computer Graphics: 5th Int Conf, AVR 2018, Otranto, Italy, June 24–27, 2018, Proc Part II 5: 349-369. Springer Int Publishing

Kleftodimos A, Evagelou A, Triantafyllidou A, Grigoriou M, Lappas G. 2023. Location-based augmented reality for cultural heritage communication and education: the Doltso district application. Sensors, 23(10): 4963

Lampropoulos G, Keramopoulos E, Diamantaras K. 2020. Enhancing the functionality of augmented reality using deep learning, semantic web and knowledge graphs: A review. Vis Informatics, 4(1): 32-42

Michel-Acosta P, Chaljub-Hasbún J, Cabero-Almenara J, Conte-Ayala ED, Peguero-García J, Pepín-Ubrí J. 2024. Evaluating an augmented reality app for learning about climate change among university students: A pilot study. Rev Electrón Educare, 28(3): 227-245

Rinaldi AM, Russo C, Tommasino C. 2022. An augmented reality CBIR system based on multimedia knowledge graph and deep learning techniques in cultural heritage. Computers, 11(12): 172

Sylaiou S, Dafiotis P. 2020. Storytelling in virtual museums: engaging a multitude of voices. In: Visual Computing for Cultural Heritage, Springer, Cham, pp: 369-388

The Org, n.d. Yigit Yigiter – TimeLooper org chart. The Org. URL:https://theorg.com/org/timelooper/org-chart/yigit-yigiter (accessed date: May 30, 2025)

TimeLooper Inc, 2024. Xplore - AR by TimeLooper [Mobile app]. Google Play Store. URL:https://play.google.com/store/apps/details?id=com.Timelooper.XPLORE.