



Research on Digital Protection and Innovative Communication of Digital Humanities Resources from the Perspective of Cross-Media Convergence

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Abstract. Recent advances in digital technologies have significantly transformed the preservation and communication of cultural heritage in the field of digital humanities. However, existing studies often focus on individual technologies and lack systematic integration from a cross-media perspective. This study explores how cross-media convergence can support both digital protection and innovative communication of digital humanities resources. Using a literature analysis method, 21 representative studies were reviewed to identify key technologies, application scenarios, and existing research gaps. The results indicate that technologies such as VR, AR, XR, artificial intelligence, and holographic visualization play important roles in digital preservation, immersive experiences, and multi-platform communication. Based on these findings, this study proposes an integrated cross-media framework that links digital resource construction, technology integration, user interaction, communication dissemination, and evaluation mechanisms. The framework provides a systematic perspective for understanding the role of digital technologies in cultural heritage preservation and offers insights for the sustainable development of digital humanities.

Keywords: Cross-Media Convergence, Digital Humanities Resources, Digital Protection, Innovative Communication

1 Introduction

In the digital era, the preservation and dissemination of digital humanities resources (DHR) have undergone significant transformation. These resources include both tangible cultural heritage, such as historic architecture, and intangible cultural heritage (ICH), including traditional crafts and folk arts [1], [8]. Traditional preservation methods often rely on static documentation or single-media presentation, making it difficult to convey the dynamic and culturally embedded nature of heritage resources. As a result, public engagement with cultural heritage remains limited.

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Cross-media convergence integrates multiple forms of media, including text, images, audio, video, virtual reality (VR), augmented reality (AR), extended reality (XR), and interactive systems, offering new possibilities for digital heritage preservation and communication [12], [16]. By combining diverse digital technologies, cross-media environments can improve both the accuracy of heritage documentation and the effectiveness of cultural dissemination. Technologies such as 3D reconstruction, heritage building information modeling (HBIM), holographic visualization, and artificial intelligence are increasingly applied in the digitization and presentation of cultural heritage resources [1], [10].

Despite these advances, existing research often focuses on individual technologies or specific application scenarios, while systematic integration of digital protection and cross-media communication remains limited. To address this gap, this study reviews 21 representative English-language studies to examine how cross-media convergence supports both the preservation and innovative communication of DHR. The study summarizes key technologies, analyzes application scenarios, identifies research gaps, and proposes an integrated framework for digital humanities resource protection and communication.

2 Literature Review

Existing studies on DHR mainly focus on three aspects: digital preservation, immersive cross-media experiences, and innovative communication strategies. The key technologies, application scenarios, and representative studies are summarized in Table 1. In addition, several bibliometric and scientometric studies have analyzed the development trends and research hotspots of digital cultural heritage and digital humanities, providing a broader perspective on the evolution of this field [2], [3], [4].

In digital preservation research, scholars have explored various technologies for both architectural heritage and ICH. VR, AR, mixed reality (MR), and HBIM have been widely applied to digital archiving, restoration, and management of architectural heritage [1]. VR-based architectural heritage preservation has also been explored in recent studies [7]. Similar approaches have been applied to the protection of traditional Chinese paper-cutting, where 3D modeling and interactive simulation support cultural knowledge transmission [8]. In addition, high-precision technologies such as laser scanning, UAV-based photogrammetry, and point-cloud processing ensure the authenticity and integrity of digital heritage assets [1], [5]. Several studies also emphasize the role of digital archives and knowledge databases in the long-term preservation and management of ICH [6], [19].

Immersive cross-media experience has become a key feature of contemporary heritage communication. AI-driven interactive learning systems for ICH can significantly enhance user engagement and learning outcomes[11],[12]. Research combining UTAUT2 and immersion theory further shows that perceived immersion, hedonic motivation, and social influence influence users' adoption of digital heritage platforms [16]. Technologies such as holographic multimedia systems and extended reality (XR)

environments also enable multi-sensory interaction, allowing audiences to actively explore heritage content rather than passively receive information [9], [10],[11].

Research on innovative communication has expanded in recent years, focusing on digital platforms, dissemination mechanisms, and evaluation frameworks. Studies indicate that AR/VR storytelling, artificial intelligence narratives, and social media platforms can significantly enhance the accessibility and dissemination of cultural heritage resources [14], [15]. In addition, evaluation systems have been proposed to assess digital heritage communication through indicators such as user engagement, cultural influence, and dissemination performance [17], [18]. Some studies have also explored digital cultural heritage dissemination platforms and deep learning - based content analysis methods for cultural communication [13].

Despite these advances, most studies still focus on individual technologies or isolated application cases. Comprehensive integration of digital preservation technologies and cross-media communication strategies remains limited. Issues such as user experience, cultural authenticity, and ethical considerations also require further investigation.

Overall, existing studies highlight both technological progress and research gaps in digital heritage preservation and communication. These insights provide the basis for developing an integrated framework for cross-media DHR. Recent studies also emphasize the importance of digital modeling and cultural experience research for supporting heritage preservation and audience engagement [20], [21].

Table 1. Key Technologies and Applications in Digital Humanities Resource Research

Category	Key Technologies / Approaches	Application Scenario	References
Digital Preservation	VR, AR, MR, HBIM	Digital archiving and restoration of architectural heritage	[1]
	3D scanning, UAV-based photogrammetry, point-cloud processing	High-precision documentation of cultural heritage	[1], [5]
	Digital archives and knowledge bases	Long-term preservation and cultural knowledge management	[6], [19]
Immersive Experience	XR environments	Multi-sensory interactive heritage exhibitions	[9]
	Holographic multimedia systems	Interactive heritage display and visualization	[10]
	AI-driven interactive learning	User engagement and digital heritage education	[12]
User Adoption	UTAUT2 + immersion theory	Adoption behavior of digital heritage platforms	[16]
Digital Communication	AR/VR storytelling, AI narratives	Cross-media heritage dissemination	[13], [14]
	Social media platforms	Cultural heritage communication and outreach	[15]
Dissemination Evaluation	Digital experience analysis	User experience and emotional engagement	[17]
	Evaluation indicator systems	Measuring communication effectiveness	[18]

3 Methodology (Literature Analysis Method)

This study employs a literature analysis approach to examine research on DHR within the context of cross-media convergence. A total of 21 English-language studies were selected, including systematic reviews, empirical studies, technical frameworks, and case analyses. These studies address topics such as digital preservation technologies, immersive media (VR/AR/XR), AI-driven interaction, holographic visualization, user experience, and digital heritage communication.

The selected literature was screened and classified into four thematic categories: (1) digital preservation technologies and HBIM-based heritage management, (2) immersive media technologies, (3) AI-driven interactive experiences, and (4) digital communication, user adoption, and platform-based dissemination.

A qualitative analysis combining thematic categorization and comparative review was conducted to synthesize the main contributions of the selected studies [1]. The results are summarized in Table 1, which presents key technologies and application scenarios reported in the literature. Based on these findings, this study proposes a conceptual framework for cross-media digital humanities resource protection and communication, illustrated in Figure. 1.

4 Cross-Media Digital Humanities Technologies and Applications

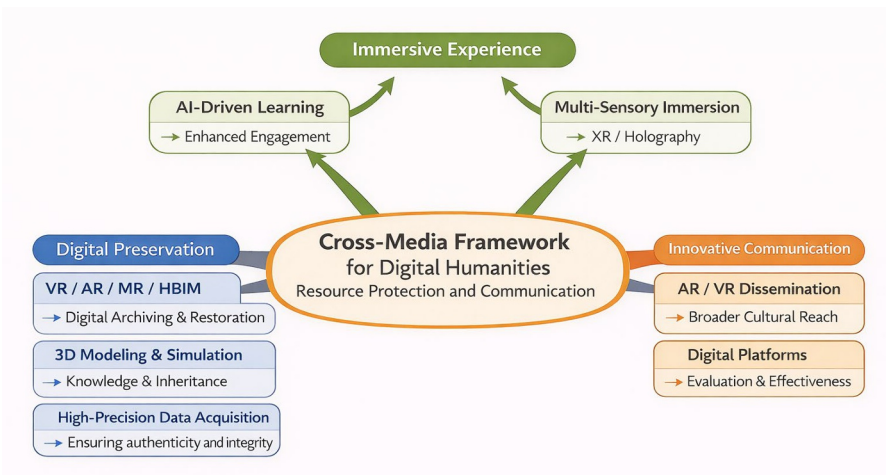


Fig. 1. Cross-Media Framework for Digital Humanities Resource Protection and Communication

Based on the literature summarized in Table 1 and the conceptual framework illustrated in Figure. 1, cross-media digital humanities form an integrated technological system that supports digital collection, preservation, presentation, and communication. Digital collection and modeling technologies, including 3D reconstruction, laser scanning,

UAV-based photogrammetry, and point-cloud processing, enable high-precision documentation of architectural and ICH [1]. HBIM further supports structured data management for heritage conservation, while texture restoration and virtual reconstruction improve authenticity and visual accuracy [8].

Immersive and interactive technologies further enhance digital heritage communication. VR, AR, and XR enable immersive simulations, on-site information overlays, and multi-sensory interaction [9]. Holographic multimedia systems provide three-dimensional visualization of heritage content [10], while artificial intelligence technologies such as gesture recognition and adaptive learning systems enable personalized cultural experiences [12]. These technologies support diverse applications including digital twins, virtual tours, craft simulation, digital museums, and cross-media dissemination through short-video platforms, live streaming, and immersive exhibitions [14], [15].

5 Research Gaps and Proposed Framework

Despite significant progress in digital heritage preservation and media technologies, several research gaps remain. Cross-media integration is still limited, as many studies focus on individual technologies rather than coordinated multi-media integration within a unified framework [9], [12], [14]. Practical applications of immersive heritage projects are also uneven, with most implementations remaining experimental or small-scale [10], [17]. In addition, research on user experience, cultural authenticity, and ethical considerations in digital heritage communication remains limited [16], [18].

To address these limitations, this study proposes an integrated framework for digital protection and innovative communication driven by cross-media convergence, as illustrated in Figure. 1. The framework includes five interconnected layers that support the preservation, presentation, and dissemination of DHR.

The Digital Resource Layer focuses on data collection and modeling. The Cross-Media Technology Layer integrates VR, AR, XR, artificial intelligence, and holographic technologies to enhance heritage presentation [9], [10], [12]. The Experience and Interaction Layer supports immersive and personalized engagement, while the Communication and Dissemination Layer enables multi-platform cultural communication [14], [15]. Finally, the Evaluation and Optimization Layer assesses communication effectiveness and sustainability through evaluation indicators and user feedback [17], [18].

6 Conclusion

This study reviewed 21 representative studies to examine how cross-media convergence supports the protection and communication of digital humanities resources. The analysis identifies several key technologies—including VR, AR, XR, artificial intelligence, and holographic visualization—that enhance the authenticity, interactivity, and accessibility of digital cultural heritage.

The results suggest that digital humanities technologies are gradually evolving toward integrated systems that combine digital preservation, immersive experiences, and multi-platform dissemination. To address current limitations, this study proposes a cross-media framework that links digital resource construction, technological integration, immersive interaction, communication dissemination, and evaluation mechanisms. The proposed framework offers a structured perspective for understanding and advancing digital heritage preservation and communication in future research.

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