

Research on AIGC-Driven Cross-Media Narrative Design and Cultural Communication: A Case Study of Dunhuang "Digital Scripture Cave"

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ABSTRACT

This paper takes the Dunhuang "Digital Scripture Cave" project as the research object, focusing on the visual communication practice and path of AI-driven cross-media narrative in global cultural communication. By using the case analysis method and literature research method, it sorts out the evolution of AI technology in the field of cultural communication, cross-media narrative theory and related theories of global cultural communication, analyzes the application of AI technology and visual communication design practice in the "Digital Scripture Cave" project, discusses the multi-media visual collaborative narrative, the narrative transformation strategy from "one-way output" to "two-way interaction", and the visual adaptation strategy to cope with cross-cultural differences, and evaluates the communication effect of the project. The purpose of this study is to summarize the successful experience of the project, provide reference for the global communication of other cultural projects, and enrich the theoretical research on the application of AI technology in the field of design.

KEYWORDS

AI; Cross-media narrative; Global cultural communication; Dunhuang "digital scripture cave"; Visual communication

1 Introduction

In 1900, the Scripture Cave of Mogao Grottoes in Dunhuang was discovered. More than 50,000 documents, paintings and other cultural relics preserved in the cave cover the history, religion, art and other fields from the 4th to the 11th century AD, which are important treasures for studying ancient civilizations in China and even the world. However, for a long time, due to the erosion of the natural environment, man-made damage and the limitation of display conditions, the cultural relics in the Scripture Cave are facing severe protection pressure, and their cultural value is also difficult to be widely recognized globally. With the advent of the digital age, new technologies represented by AI have provided an opportunity to solve these problems ^[1].

Against this background, the "Digital Scripture Cave" project came into being. The project aims to realize the digital protection, cross-media display and global communication of the cultural relics in the Scripture Cave through advanced technologies such as AI. The traditional ways of Dunhuang cultural communication, such as physical exhibitions and book publishing, have problems such as limited communication scope, poor interactivity, and difficulty in meeting the needs of audiences with different cultural backgrounds. The integration of AI technology can break the constraints of time and space, innovate the form of communication, and improve the effect of communication.

This study takes the "Digital Scripture Cave" project as the core case, uses the case analysis method to deeply analyze the specific practice of AI-driven cross-media narrative in visual communication in the project; at the same time, uses the literature research method to sort out the relevant theoretical achievements at home and abroad, providing a solid theoretical support for the research. Through the research, it aims to explore the visual communication practice path of AI-driven cross-media narrative in global cultural communication, which not only provides reference for the digital communication of other cultural heritages, but also adds new content to the research on the application of AI technology in the field of design. The innovation of this study lies in the close combination of AI technology, cross-media narrative and the global communication of Dunhuang culture, focusing on the key link of visual communication, and revealing its internal laws and effective paths from the practical level.

2 Theoretical foundation: the theoretical origin of AI-driven cross-media narrative and global cultural communication

2.1 The evolution of AI technology in the field of cultural communication

The development of AI technology began in the 1950s, and it has experienced many waves from the initial symbolic AI to today's deep learning. In the field of cultural communication, its application can be divided into three stages. In the early stage (1980s - early 21st century), its application in the field of cultural communication was relatively limited and basic, mainly used for the digital processing of cultural data. For example, in the construction of digital libraries, AI was used for automatic classification and retrieval of documents. During this period, the Dunhuang Academy also began to

carry out digital scanning of murals, laying a foundation for subsequent research and communication. In the middle stage (early 21st century - 2010), AI emerged in content creation, such as AI generating simple music fragments, paintings, news writing, etc., and began to assume part of the role of content production in cultural communication. In recent years (2010 to present), AI technology has achieved leapfrog development and made remarkable achievements in personalized recommendation, intelligent interaction, virtual generation and other aspects. For example, the precise push of cultural content based on user portraits, the use of AI to generate virtual anchors for cultural explanation, etc. In the communication of Dunhuang culture, AI has been able to achieve complex tasks such as intelligent restoration of murals and virtual restoration of cave scenes ^[2].

2.2 The connotation and development of cross-media narrative theory

The cross-media narrative theory was proposed by Henry Jenkins. Its core is to present a story through different media platforms, and each medium has its unique narrative function, jointly constructing a complete narrative universe. This theory emphasizes the "cross-media nature" and "synergy" of narrative. Different media are not isolated, but interrelated and complementary to each other.

With the development of media technology, the form of cross-media narrative is also constantly enriched ^[3]. From the early linkage between books and movies to the current multi-media integration of social media, virtual reality, games, etc., the boundary of cross-media narrative is constantly expanding. In cultural communication, cross-media narrative can meet the media usage habits of different audiences and improve the communication efficiency and influence of cultural content. For example, for Dunhuang culture, books can be used to introduce its historical background in detail, movies can be used to show its artistic charm, AR/VR virtual reality technology can be used to allow audiences to experience the cave scenes in an immersive way, and games can be used to increase the audience's participation and interaction.

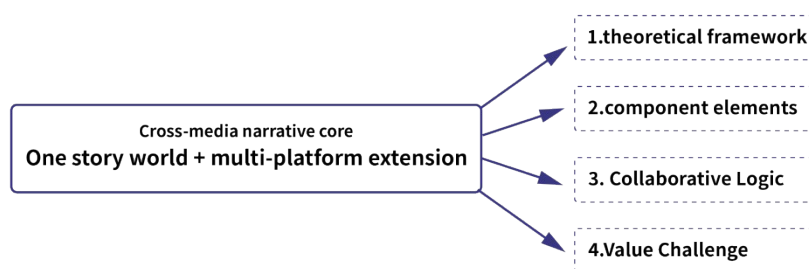


Figure 1 Logical analysis diagram of cross-media narrative

2.3 Theories and influencing factors of global cultural communication

Global cultural communication refers to the flow and interaction of culture on a global scale. Its theories mainly include cultural imperialism theory, cultural pluralism theory, "soft power" theory and so on. The cultural imperialism theory holds that developed countries in the West carry out cultural penetration and control over developing countries through the export of cultural products; the cultural pluralism theory emphasizes that different cultures should respect each other, communicate on an equal footing, and jointly form a colorful world culture; the "soft power" theory regards cultural communication as an important part of a country's comprehensive strength, and enhances the country's international influence through the attraction of culture ^[4]. There are many factors affecting global cultural communication. The attractiveness of culture itself is the foundation, such as the unique artistic value and historical heritage contained in Dunhuang culture; the development level of communication media determines the scope and efficiency of communication, and the communication capacity has been continuously improved from paper media to digital media; political and economic factors also play an important role, and a country's foreign policy and economic strength will affect the intensity and breadth of cultural communication; in addition, cultural differences are also an indispensable factor. Different values, ways of thinking and aesthetic habits will lead to the phenomenon of "cultural discount" in cultural communication.

3 AI technology and visual communication practice of dunhuang "digital scripture cave" project

The "Digital Scripture Cave" project was jointly initiated by the Dunhuang Academy and Tencent and other technology enterprises. Since its launch in 2019, after years of research and development and improvement, it has become a benchmark project for the digital communication of Dunhuang culture. With the Scripture Cave as the core, the project uses a variety of technologies such as AI, 3D modeling and cloud technology to build a digital platform integrating cultural relic display, historical reproduction and interactive experience.

In terms of the application of AI technology, the "Digital Scripture Cave" project has broken away from the "traditional" model of combining museums with digital technology. It is no longer limited to offline scene experience, but maximizes the use of technology support in the game field. In terms of high-precision digital twin and scene restoration, 3D laser scanning is used to obtain the point cloud data of the Scripture Cave, and then AI algorithms are used for data processing and model construction to realize the millimeter-level reproduction of the internal structure of the cave and the details of the murals. Moreover, AI can simulate the original appearance of the Scripture Cave in different historical periods according to historical documents and archaeological research results, allowing the audience to feel the changes of history. In terms of character shaping, AI facial animation generation technology is used to analyze and learn the character images in the murals, and generate virtual characters with a sense of reality. These virtual characters not only have a high degree of consistency with the mural characters in appearance, but also can make various vivid expressions and movements to tell the story of the Scripture Cave to the audience. In terms of interactive experience, cloud game technology is introduced, combined with the real-time response ability of AI, allowing users to roam the virtual Scripture Cave in an immersive way through mobile phones, computers and other devices. Users can move the perspective freely, interact with virtual characters, and even participate in the "re-enactment" of some historical scenes, which greatly enhances the sense of participation and experience.

In terms of visual communication design, the project adheres to the concept of "technology + art" and has achieved innovations in many aspects. In terms of image quality and scene integration, 4K film-level rendering technology is adopted to perfectly present the colors and details of Dunhuang murals, breaking the limitation of physical space and allowing the audience to appreciate the details of the murals without leaving home. At the same time, a large number of traditional Chinese elements are integrated into the scene design, such as the style of ancient buildings and traditional decorative patterns, creating a strong Chinese-style art scene, allowing the audience to feel the unique charm of Dunhuang culture while appreciating. In terms of interactive mode design, attention is paid to the seamless connection between user participation and story experience. AI technology is used to analyze the user's behavior data, predict the user's needs and interest points, and guide the user to explore. For example, when the user's eyes stay on a certain mural, the system will automatically pop up relevant explanation information and interaction options, allowing the user to deeply understand the story behind the mural. In terms of information visualization design, the complex information in the cultural relics of the Scripture Cave, such as historical ages, religious schools, artistic styles, etc., is transformed into intuitive and easy-to-understand visual forms such as charts and animations. Through the data analysis and visualization processing of AI, the audience can quickly grasp the overall context and core content of Dunhuang culture.

4 AI-driven cross-media narrative: media integration practice strategy of visual communication

Combing the impact of AI on cross-media narrative visual communication from an academic perspective, it is not difficult to find that its core value lies in: based on Henry Jenkins' "convergence culture" theory, AI is used to break the barriers between different media, so that visual narrative shifts from "media characteristics" to "meeting user needs", and finally realizes the in-depth penetration of cultural communication and the value co-creation of creators and audiences. Taking the "Digital Scripture Cave" project as an example, we can carry out a more humanistic academic analysis from the two core dimensions of "multi-media visual collaboration" and "narrative model transformation", combined with theories such as media semiotics and user experience design.

4.1 Theoretical analysis of multi-media visual collaborative narrative

When disassembling the visual logic of cross-media narrative from the perspective of media semiotics, it will be found that the "shared symbol system" is the core link connecting different media, and AI just provides a more accurate and flexible implementation path for the construction and extension of this system. First of all, the process of AI constructing a unified visual symbol library is essentially the "extraction" and "re-application" of Dunhuang cultural symbols: through AI's image semantic analysis of Dunhuang murals — such as using edge detection technology to outline the outline of flying apsaras, using color clustering algorithms to restore the color of lotus flowers, and using feature extraction algorithms to capture the expression of Buddha statues — these symbols carrying cultural connotations are separated

from the original murals to form a standardized "symbol unit". This process exactly echoes Roland Barthes' theory of "arbitrariness of symbols". The characteristics of media will affect the presentation form of content, and AI allows symbols to not only maintain the unity of cultural core, but also give full play to the advantages of various media.

Secondly, the design of narrative nodes oriented by user journey reflects the practical combination of "audience-centered theory" and "narrative communication". AI will collect the user's behavior data, such as the user's stay time on different platforms, the type of clicked content, and the marked interest tags, and then build a "user cognitive map" based on these data, dividing the communication process of Dunhuang culture into three stages: "preliminary cognition, emotional resonance, and in-depth participation", and each stage corresponds to different media narrative nodes. The dynamic linkage of cross-media visual elements is actually the process by which AI makes the "narrative field" more integrated. In the traditional cross-media narrative, the visual content of different media is often isolated — the murals seen by users in VR may have no connection with the murals seen on posters. However, through integrating the data interfaces of different platforms, tracking the user's behavior trajectory, and intelligently pushing relevant content, AI enables visual symbols to "flow" between multiple media. This linkage breaks the boundaries of media and constructs a "super-media narrative field", which not only conforms to Jenkins' view in "convergence culture" that "cross-media narrative can promote the in-depth participation of the audience", but also allows users to contact the same cultural symbol through multiple touch points, deepening the memory of the symbol's meaning and enhancing the emotional stickiness to culture.

4.2 Transformation of visual narrative model: in-depth reform from "one-way indoctrination" to "two-way interaction"

AI promotes the transformation of the visual narrative model from "one-way output" to "two-way interaction", and its essence is the reconstruction of the "communication relationship" — changing the traditional linear communication of "communicator-led and audience passively receiving" into a network communication of "communicators and audiences participating together". This transformation can be analyzed more practically from the three levels of "content adaptation, scene participation, and feedback closed-loop", combined with academic theories.

First of all, the AIGC adaptive push based on user behavior data is mainly to realize "precision communication" and "personalized narrative". In the traditional cross-media narrative, the visual content is often "one-size-fits-all" — whether it is ordinary tourists, historians or art practitioners, they all see the same sequence of high-definition mural images and the same length of cave roaming videos. This approach ignores the differences in users' cultural backgrounds, interest focuses and cognitive rhythms, resulting in low communication efficiency, and also exposes the limitation of Lasswell's "5W model" of "ignoring individual differences of the audience"^[5]. AIGC customizes exclusive visual narratives for different users. From the actual effect, this personalized strategy not only reduces the threshold for users with different cognitive levels to understand Dunhuang culture, but also makes the visual narrative more targeted, reduces the "loss" in the process of information communication, and improves the communication effect.

Secondly, the construction of participatory visual narrative scenes is the key to reconstructing the "narrative subject" — allowing users to change from "onlookers" to "participants". In the traditional visual narrative, users can often only "watch from a distance": the digital model of Dunhuang murals is pre-made, and the cave roaming video has a fixed length. Users cannot participate in the narrative process. However, AIGC breaks this situation of "passive reception" by constructing "participatory scenes". Taking the "damaged restoration" of Dunhuang murals, a core communication point, as an example, AI has built a "virtual restoration laboratory": users can use the AR mural restoration applet to try to fill in the damaged parts of the murals like cultural relic restorers — such as outlining the lines for the missing ribbons of flying apsaras and adjusting the color for the faded lotus flowers. In this process, users are no longer passively receiving the information that "murals need to be restored", but through practical operations, they deeply understand the detailed characteristics of the murals, the difficulty of restoration, and even can realize the significance of cultural relic protection work. More importantly, the user's restoration results will be integrated into the visual narrative of the "Digital Scripture Cave", enriching the communication content, forming a positive cycle of "communicators and audiences co-creating value", expanding the boundary of cross-media narrative, and turning the narrative from a "preset content" into a "dynamically generated process".

Thirdly, the visual presentation of cross-media interactive feedback is mainly to build a "communication closed-loop" — making the user's feedback a "new starting point" of the narrative^[6]. In the traditional cross-media narrative, the user's interactive feedback is often "hidden" and "fragmented", but AIGC converts it into intuitive visual elements by integrating the feedback data of multi-media platforms, making the feedback a part of the narrative. In this way, the user's interactive behavior is no longer the "end of communication", but the "new starting point of visual narrative". Therefore, the visual communication of the "Digital Scripture Cave" has gradually changed from "one-way output" to a "cultural community with universal participation", and finally realized the sustainable development and value-added of Dunhuang

cultural communication.

5 Communication path: global cultural communication strategy of dunhuang "digital scripture cave" project

The "Digital Scripture Cave" project promotes the global communication of Dunhuang culture through a variety of communication paths. In terms of multilingual support and international platform construction, the project has developed multiple language versions including Chinese, English, French, German, Japanese, Arabic, etc., to meet the needs of users in different countries and regions ^[7]. At the same time, it has established cooperative relations with well-known international cultural platforms, museums and academic institutions, and connected the project content to their digital platforms. For example, it has cooperated with the online platforms of world-renowned museums such as the British Museum and the Louvre to set up a "Digital Scripture Cave" section, and expanded the communication scope of the project with the help of the global influence of these platforms.

In terms of social media and online promotion, the project has adopted a variety of innovative methods. On international social media platforms such as Facebook, Twitter, Instagram and YouTube, it regularly releases short videos, pictures, articles and other content related to Dunhuang culture, including wonderful clips of virtual roaming, AI-generated art works, Dunhuang historical stories, etc. By creating popular topics such as "My Dunhuang Virtual Journey" and "Modern Interpretation of Dunhuang Symbols", it attracts users to participate in discussions and sharing. It also carries out online live broadcast activities, inviting experts from the Dunhuang Academy, AI technology R & D personnel, etc. to give explanations and interactions, answer users' questions, and enhance users' sense of participation and stickiness. In addition, it has carried out cross-border cooperation with some well-known international game and film IPs, integrating Dunhuang cultural elements into them, and communicating with the help of their large user base.

Offline activities and international cooperation also play an important role. The project has held offline exhibitions and experience activities in many cities around the world, such as setting up "Digital Scripture Cave" experience areas in cities such as New York, London and Paris, allowing local people to experience the charm of Dunhuang culture at close range. At the same time, it has carried out academic exchange activities with foreign universities and research institutions, held international seminars on Dunhuang culture, invited experts and scholars at home and abroad to discuss the protection and communication of Dunhuang culture, and enhanced the academic influence of the project. It has also cooperated with foreign cultural enterprises to develop digital products based on Dunhuang culture, such as digital art works and cultural and creative products, and expanded the communication of Dunhuang culture through commercial channels.

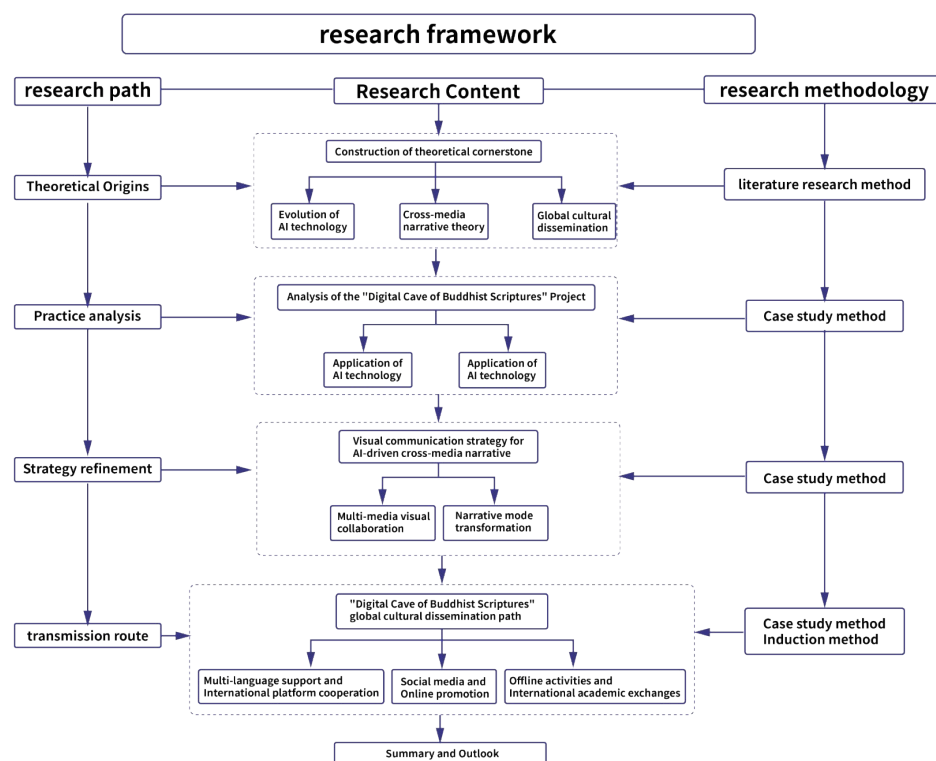


Figure 2 Research framework diagram

6 Conclusion and prospect

The practice of the Dunhuang "Digital Scripture Cave" project provides a valuable exploration sample for the digital protection and global communication of cultural heritage in the AIGC era. When AI technology breaks through media boundaries and deeply couples with cross-media narrative, it not only transforms Dunhuang culture from "static collection" to "dynamic narrative", but also builds a communication bridge across cultural differences through the innovative design of visual communication. Through the theoretical origin and practical analysis of this project, this study clearly sees the changes brought by AIGC-driven cross-media narrative, which transforms the audience from passive cultural receivers to active participants and co-creators; it expands the boundary of cultural communication, allowing niche cultural heritage to break through regional and language limitations and move towards a broader global perspective; it also opens up a new research direction for the field of design, that is, how to realize the integration of technology and art, so that cultural symbols can maintain the unity of core and adapt to the communication needs of different scenarios in multiple media. When more cultural heritages realize the innovation of cross-media narrative with the help of AIGC technology, and when technology truly serves the transmission of cultural values and the mutual learning of civilizations, excellent traditional culture will surely radiate stronger vitality in the digital age and inject deeper cultural strength into the construction of a community with a shared future for mankind.

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