

The Impact of Artificial Intelligence on the Digital Application Path of Intangible Cultural Heritage: A Case Study of Shadow Puppetry

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Abstract

With the continuous advancement of technology, artificial intelligence (AI) has been widely applied to the digital protection and innovative development of intangible cultural heritage, gradually becoming an important force in promoting the systematic construction of intangible cultural heritage. As the core of the new generation of information technology, AI, with its efficient data processing, precise decision support, and continuous learning capabilities, is profoundly influencing the survival and development models of intangible cultural heritage. This paper systematically explores the role and mechanism of AI in the protection, inheritance, and dissemination of intangible cultural heritage from four dimensions: digitization, informatization, intelligentization, and automation. Taking Chinese shadow puppetry as an example, this paper focuses on analyzing the practice of AI in digital acquisition, content generation, and immersive experience, promoting the transformation of intangible cultural heritage protection methods from "static recording" to "living inheritance," expanding the expressive forms of traditional art, and enhancing audience participation and interactive experience.

Keywords

Artificial Intelligence; Intangible Cultural Heritage; Shadow Puppetry; Digital Preservation.

1. Introduction

All In recent years, artificial intelligence has developed rapidly and deeply integrated with technologies such as big data, 5G communication, and 8K ultra-high-definition display. Significant achievements have been made in the recording, restoration, and cultural and creative design of cultural heritage, promoting the effective transformation of cultural resources into cultural productivity. However, in the field of intangible cultural heritage, especially in digital preservation and innovative design, the application of artificial intelligence remains insufficient. Intangible cultural heritage has distinct regional and temporal characteristics. Its transmission relies heavily on oral and hands-on instruction, a single method, and the aging of inheritors poses a serious challenge. General Secretary Xi jin ping pointed out: "We must be adept at organically unifying the promotion of excellent traditional culture with the development of contemporary culture."^[1] Against this backdrop, artificial intelligence provides a new technological path for the efficient collection, systematic recording, intelligent analysis, and long-term preservation of intangible cultural heritage, helping to promote the digital and intelligent transformation of intangible cultural heritage protection. Several Paths for Artificial Intelligence to Empower the Digital Protection, Dissemination and Inheritance of Intangible Cultural Heritage.

2. AI-Based Approaches to the Protection, Dissemination, and Inheritance of Intangible Cultural Heritage

2.1. Using Artificial Intelligence Technology to Protect Intangible Cultural Heritage

Intangible Cultural Heritage (ICH) includes the practices, representations, expressions, knowledge and skills that communities, groups and individuals regard as cultural heritage, as well as related tools, objects, handicrafts and cultural spaces. These cultural contents are passed down from generation to generation, reflecting the essence of human cultural diversity and creativity[2]. At present, the research and practice of digitalizing intangible cultural heritage is still at the stage of data collection and organization. Based on the early digitalization of intangible cultural heritage, artificial intelligence can start intelligent optimization in the later stage, thereby greatly improving the speed of image classification and collection. In this step, it is necessary to collect a sufficient number of fixed-size, classified digital images of intangible cultural heritage projects. After processing the suitable intangible cultural heritage projects into images and videos, AI image processing technology is used to retrieve effective features for similar images, which facilitates the digital preservation and management of intangible cultural heritage projects. At the same time, it also prepares for the establishment of intangible cultural heritage knowledge graphs. In specific projects, based on ontology analysis of intangible cultural heritage images, the latest machine learning technology is introduced to analyze the elements and features of images, forming an automated mode for material data capture and clustering. This provides a precise data foundation for further applications such as automatic image clustering analysis and similarity matching. Compared with manual operation, it greatly improves the speed of collection and organization [3]. For example, high-precision scanning is used to digitally input shadow puppets, and then 3D digital modeling is performed to transform the shadow puppet image into a digital model that can move freely.

2.2. Using Artificial Intelligence Technology to Realize the Digital Dissemination of Intangible Cultural Heritage

The dissemination of traditional handicraft intangible cultural heritage relies heavily on the "oral and physical teaching" of inheritors, resulting in a limited dissemination range and low efficiency, and is constrained by the life cycle and cognitive level of the inheritors. Artificial intelligence (AI), through natural language processing, machine learning, and deep synthesis technologies, can digitally record and model the knowledge, skills, and language style of inheritors, thereby generating "virtual inheritors" that can be disseminated across time and space. This is not only an upgrade of dissemination tools but also signifies a revolution in the subject of dissemination.

As a new subject of dissemination, AI can process large amounts of unstructured data such as video, audio, and text, and adjust the content presentation in real time according to audience needs, achieving the systematization, proceduralization, and efficiency of intangible cultural heritage knowledge systems, significantly alleviating the bottlenecks faced by traditional inheritance. For example, at the Shanghai International Tea Exhibition, the Tea Secret T-master Teapot, developed based on AI technology, is a typical example of the integration of traditional tea culture and intelligent technology. Using the tea-brewing techniques in the *Classic of Tea* as its core blueprint, it utilizes AI to achieve an innovative breakthrough in "datafication of skills-intelligentization of processes-efficient dissemination of culture."

2.3. Using AI Technology to Achieve Digital Inheritance of Intangible Cultural Heritage

The inheritance of intangible cultural heritage cannot be separated from systematic education, and enabling more people to participate in learning is key to the "living" of culture. With the help of the internet, an online and offline integrated teaching model can be constructed, making intangible cultural heritage learning more accessible and interactive. First, a comprehensive intangible cultural heritage database needs to be established based on the collected digital information. Currently, there are databases of intangible cultural heritage survey data, project resource databases, special resource databases, and digital protection and management systems for intangible cultural heritage, which lay the foundation for further intelligent inheritance. On this basis, intangible cultural heritage knowledge can be popularized to the public by using artificial intelligence-driven network intelligent question-and-answer systems. Such systems can identify knowledge elements such as entities, concepts, relationships, and events in user questions.^[4] And extract information from massive network data based on knowledge graphs, presenting intangible cultural heritage content in a more intuitive way, and improving the efficiency of the public in acquiring and understanding intangible cultural heritage knowledge.

3. The Role of AI Technology in the Digitalization Process of Intangible Cultural Heritage Shadow Puppetry

3.1. The Role of Artificial Intelligence Technology in the Appearance Design of Shadow Puppetry

Professor Ezomancini's "era of design for all" emphasizes the value of AI in lowering the design threshold and popularizing design capabilities[5]. The character design of traditional shadow puppetry relies on the experience and aesthetics of art masters, which is the core link affecting the performance effect. With the development of digital technology, AIGC (such as style transfer and diffusion models) provides a new way of generating character design. For example, inputting the phrase "design a gentle and beautiful shadow puppet of the White Snake Lady, retaining the traditional openwork craftsmanship," AI can quickly generate multiple design schemes, inspiring creators and making the shadow puppet designs more in line with contemporary aesthetic trends.

Designers can further develop their work based on AI sketches, significantly improving the iteration efficiency of new characters and cultural and creative products. Beyond visual design, AI also plays a crucial role in scriptwriting and music creation. By learning from numerous traditional scripts, AI can extract the narrative structure, dialogue style, and character traits of shadow puppetry. Simply inputting a theme (such as "war") can generate a plot outline or dialogue draft. Simultaneously, AI can learn the singing styles of different schools, generating background music for new productions and even simulating the timbre of deceased artists to achieve "singing style reproduction," promoting innovation and providing technical support for the preservation of endangered styles.

3.2. How Artificial Intelligence Can Help Preserve Shadow puppetry

Today, shadow puppetry does not appeal to young people. The problem lies in how shadow puppetry performances are limited to traditional theatre and puppetry styles not in sync with the media that matter today. AI could help fix this too-for preservation and promotion.

In earlier periods of crafting and performing shadow puppetry, the skills were passed orally. The issue is that this was neither fast nor thorough enough and sometimes resulted in loss of the skills and pulling the audience level down. AI help is around the corner to fix that. Using computer vision tools, it can record the detailed actions interpreted to control each shadow

puppet, how the puppeteer's hand moves it and moves itself vis-a-vis the puppet, how fast it does so, how hard, the variation in characters, eg. how the heroines change motion from speed to sparring, versus how the warriors have different moves. All this can be put in a shadow puppetry movement library. And even use generative AI to make the shadow puppetry animation casts by itself. This can lower the barrier for small teams or individuals to create and distribute the shadow puppet amends and keep the art from extinction. The AI driven content recommending feature will also help share shadow puppetry with many more. Based on what you have liked and watched on TikTok, YouTube etc.

AI recommendation can serve up shadow puppetry content talking about trending topics or collabs with other popular games and animation. You won't have to go searching for shadow puppetry-the puppetry will find you! We already have AI combined with augmented reality (AR) for gamers to hang with the digital characters. We can also mix AI with AR and AI for cool interactive experience at museums etc. A dedicated AR area where visitors can don the glasses and be digital shadow puppeting! They could talk to the shadow puppet characters, making tradition fun and more human-friendly again. All plus AI translation tools to fit them with digital subs in different languages worldwide.

3.3. The Disruptive Transformation of Shadow Puppet Show Performance by Artificial Intelligence Technology

The impact of AI on shadow puppetry is not only reflected in design and dissemination, but also in its reshaping of the performance format. Traditional shadow puppetry relies on screens, lighting, and physical puppets, while AI expands its performance methods into the realm of the "digital universe." Through real-time rendering and digital animation technology, performers no longer control physical puppets, but rather digital models that can transform, split, and become particle-like, transcending the laws of physics. The background can also change in real time according to the plot.

This technological innovation has upgraded shadow puppetry from a "flat silhouette art" to an interactive and immersive dynamic stage. Digital shadow puppetry retains traditional aesthetics while significantly expanding expressive space, providing a more futuristic stage form for shadow puppetry and creating a new path for its modernization.

3.4. The Function of Artificial Intelligence Technology in the Shadow Puppetry Experience

The integration of AI with technologies such as VR/AR and voice recognition has completely broken through the traditional viewing mode of shadow puppetry, constructing new interactive experience scenarios. Users wearing VR devices can "step into" a digitally constructed ancient stage, obtaining an immersive experience far exceeding that of flat viewing. Through mobile phones or AR glasses, users can even "bring" digital shadow puppet characters into reality and control their movements in real time through gestures or voice commands (such as "make Piggy carry his wife"), transforming shadow puppetry from a stage art into a portable, instantly interactive "digital toy," significantly enhancing its appeal to younger audiences.

Furthermore, AI transforms traditional "one-way performance" into "interactive performance." Using cameras or sensors, AI can recognize audience expressions, sounds, or body movements and feed them back into the performance itself (e.g., audience sighs affect the plot, cheers enhance character power). This breakthrough has transformed shadow puppetry into an "interactive ritual" in which the audience participates and constructs together, greatly enhancing the sense of immersion and engagement.

4. Conclusion

Protecting, recording, and passing on intangible cultural heritage through artificial intelligence technology has an immeasurable role and value in protecting human culture. Shadow puppetry is profound and structural. The essence of this transformation is the innovation of the paradigm for the protection and dissemination of intangible cultural heritage. It transforms artificial intelligence from a "cultural specimen" to a "digital life form." In the process of combining AI with intangible cultural heritage, intangible cultural heritage is no longer a cold tool, but a catalyst for activating the inherent vitality of traditional culture. Artificial intelligence and the innovative design of intangible cultural heritage are constantly exploring and innovating in the context of the great integration of art and science. Ultimately, it is committed to building an open and inclusive intelligent traditional handicraft intangible cultural heritage dissemination ecosystem and realizing the diversified development of intangible cultural heritage dissemination formats. Artificial intelligence technology has expanded the possibilities for the protection and inheritance of intangible cultural heritage, while human wisdom and understanding of art need to ensure that its digital technology always develops along the path of respecting cultural heritage and nourishing art. Only in this way can we truly realize the "living inheritance" and "creative transformation" of intangible cultural heritage. At the same time, it also allows shadow puppetry and many other intangible cultural heritage projects to radiate new vitality under the perspective of new technologies, and to continue to participate in the process of human civilization.

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