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A Study on the Digital Revitalization of the Aesthetic Genes of Chinese Intangible Cultural Heritage

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Abstract

In the context of the comprehensive diffusion of digital technologies, the safeguarding and transmission of China's intangible cultural heritage are undergoing profound environmental transformation. Heritage practices that were once embedded primarily in lived, physical contexts are increasingly migrating into virtual and networked digital spaces. This process involves more than the technical conversion of material forms into digital representations; it constitutes a mode of cultural regeneration in which traditional culture is reconfigured within new media environments. However, existing digitalization efforts have tended to prioritize technological instruments and platforms, while paying insufficient attention to the deeper aesthetic principles that underpin intangible cultural heritage. This study seeks to move beyond a purely tool oriented understanding of digital technology and to examine the digital presence of intangible cultural heritage from the perspectives of aesthetics and aesthetic education. It explores how intangible cultural heritage should exist and be revitalized within digital environments. To this end, the concept of aesthetic genes of intangible cultural heritage is proposed. This concept refers to the core aesthetic principles embedded beneath the external forms of heritage practices, principles that function like cultural genes in that they are capable of continuity, adaptation, and variation across contexts.Building on this conceptual framework, the study constructs a logical model consisting of four interrelated stages: the extraction of core aesthetic elements, digital translation, reconstruction of experiential scenarios, and public interaction and dissemination. This model elucidates how digital technologies can be employed to transform intangible cultural heritage from static preservation into dynamic experience. In doing so, it addresses key challenges related to the transmission and sustainable development of intangible cultural heritage in contemporary society, and contributes to the continued vitality of Chinese aesthetic spirit in the digital age.

Keywords: Chinese Intangible Cultural Heritage; Aesthetic Genes; Digital Revitalization; Digital Transformation

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1. Introduction

In the third decade of the twenty-first century, human civilization is undergoing an unprecedented process of digital migration. With the rapid development of big data, cloud computing, artificial intelligence, and extended reality technologies, the boundary between the physical world and the digital realm is becoming increasingly blurred(Yang,2017). A new mode of digital existence is reshaping human perception, patterns of interaction, and pathways of cultural transmission. Within this broader historical context, Chinese intangible cultural heritage, a living cultural system that embodies millennia of agrarian civilization, emotional structures, and

aesthetic wisdom, stands at a critical historical juncture. On the one hand, the disintegration of traditional rural society and the modernization of lifestyles have led to the rapid contraction of the ecological environments upon which intangible cultural heritage has long depended. On the other hand, the ongoing implementation of national strategies for cultural digitalization has opened new possibilities for the protection and transmission of intangible cultural heritage, directing it toward a digital frontier. Yet technological intervention is not inherently a panacea. Current practices of intangible cultural heritage digitalization often exhibit a pronounced tendency to privilege technical means over aesthetic considerations. As a result, heritage expressions are frequently reduced to static data archives or visually striking yet spiritually hollow spectacles, placing intangible cultural heritage in a digital condition characterized by form without substance. How to move beyond mere technological replication and to excavate the deeper aesthetic values embedded within heritage forms thus becomes a critical question(Dong,2019). This challenge extends beyond technical operations and raises a fundamental theoretical issue concerning the continuity of Chinese aesthetic spirit within digital civilization. From this perspective, the present study is grounded in the lenses of aesthetics and aesthetic education and introduces the concept of aesthetic genes of Chinese intangible cultural heritage. It seeks to construct a logical model of digital revitalization that connects tradition and modernity, as well as physical reality and virtual space. The research aims to explore an innovative pathway toward digital regeneration, whereby digital technologies are employed not only as tools of preservation but as means of activating the aesthetic vitality of intangible cultural heritage, enabling it to acquire renewed life and relevance in contemporary society.

2. Transformation and Challenges of the Modes of Existence of Intangible Cultural Heritage in the Digital Age

2.1. From Physical Presence to Digital Spatial Existence

As a repository of aesthetic memory and technical wisdom accumulated through agrarian civilization, Chinese intangible cultural heritage has traditionally relied on specific physical spaces, temporal contexts, and social structures for its continued existence. With the advancement of modernization and the pervasive penetration of digital technologies, human society is undergoing a profound migration from the physical world to the digital realm. Within this broader transformation, the rural and community based contexts that once sustained intangible cultural heritage are gradually dissolving, placing it at risk of detachment from its original ecological environment. The rise of digitalization offers intangible cultural heritage a new mode of existence. This shift does not simply represent a change of medium, but rather a fundamental transformation of its survival paradigm. Transmission is no longer confined to the preservation of physical objects or to offline performances, but instead requires the identification of new footholds within digital networks. This transition demands that intangible cultural heritage move beyond dependence on material carriers and be reconstituted as data flows through which its value system is reconstructed in virtual space. Digital existence emphasizes accessibility through circulation, interaction, and participation rather than physical presence. In this sense, heritage protection has moved beyond the stage of emergency documentation toward a new phase characterized by digital modes of living transmission (Table 1).

Table 1. Conceptual Framework of the Early Chapters on Digital Revitalization of Chinese Intangible Cultural Heritage.

Analytical Stage	Core Focus	Key Concepts
Contextual Transformation	Shift of ICH from physical environments to digital existence	Digital migration; digital survival

Problem Identification	Tension between technical rationality and aesthetic spirit	Technical rationality; aesthetic loss
Conceptual Construction	Introduction of aesthetic genes as analytical core	Aesthetic genes; generative source code
Structural Analysis	Dual structure of ICH aesthetics	Latent rules; manifest representations
Hierarchical Deconstruction	Layered system of aesthetic genes	Sensorial form; cultural signification; spiritual resonance
Mechanism Explanation	Generative logic of digital revitalization	Embodied cognition; symbolic reembedding

2.2. Balancing Technical Rationality and Aesthetic Spirit

Current practices of intangible cultural heritage digitalization often exhibit a pronounced imbalance between technological form and aesthetic substance. Influenced by instrumental rationality, digitalization is frequently reduced to high precision three dimensional scanning, modeling, and large scale data storage. While such approaches contribute to the establishment of extensive digital archives and address issues of long term information preservation, they do little to resolve the challenge of sustaining intangible cultural heritage as a living cultural practice. The core value of intangible cultural heritage lies not merely in its external forms, but in its aesthetic meanings and the cultural wisdom embedded in human interactions with nature. When digitalization remains confined to surface level replication, heritage risks becoming static data or visually impressive yet spiritually empty representations within digital space. Consequently, the central question of this study concerns how to move beyond the purely instrumental use of technology and reconstruct the aesthetic spirit of intangible cultural heritage within virtual environments. Achieving a balance between technological logic and aesthetic logic is essential. Digital technology should function as a bridge that leads toward the deeper aesthetic dimensions of intangible cultural heritage, rather than as a barrier that obscures its spiritual core(Han and Zhou,2022)(Figure 1).

Figure 1. Intangible Cultural Heritage Performance of Anzhen Jinggu Drumming.

2.3. Redefining Digital Authenticity and Living Transmission

Debates surrounding authenticity have consistently accompanied discussions of intangible cultural heritage digitalization. Conventional perspectives often regard digital forms as inferior imitations of reality, lacking the tactile qualities and historical depth of physical artifacts. However, the defining characteristic of intangible cultural heritage lies precisely in its immateriality. Its core value resides in the transmission of skills, knowledge, and collective memory rather than in the permanence of specific objects. When the aesthetic elements of intangible cultural heritage are extracted from material carriers and translated into digital space,

authenticity is not necessarily diminished. Instead, a new form of digital authenticity emerges. In this context, digital code becomes a new carrier that transcends the vulnerability and perishability of physical materials, offering a form of theoretical permanence. Within the framework of digital revitalization, authenticity is no longer limited to physical sensation but is expanded to include the faithful reproduction of aesthetic logic and the restoration of emotional experience. As long as digital models are capable of accurately conveying the aesthetic principles and spiritual temperament underlying intangible cultural heritage, they establish a form of digital authenticity with independent value. Through this process, intangible cultural heritage is able to achieve living transmission within the conditions of the digital age(Ouyang,2012).

3. Cartographic Deconstruction of the Aesthetic Genes of Chinese Intangible Cultural Heritage

3.1. Conceptual Definition and Theoretical Metaphor of Aesthetic Genes

This study introduces the biological concept of the gene as a theoretical metaphor in order to illuminate the characteristics of inheritance, variation, and stability inherent in the aesthetic elements of intangible cultural heritage. The aesthetic genes of Chinese intangible cultural heritage refer to those fundamental codes embedded within heritage forms that determine their aesthetic qualities, cultural attributes, and spiritual core. They constitute the key mechanism through which intangible cultural heritage maintains its identity across time and space and across different media environments.Analogous to biological genes that guide protein synthesis and the expression of biological traits, aesthetic genes govern the generation of new forms of expression as intangible cultural heritage adapts to different historical contexts and material carriers. They function as the source code of intangible cultural heritage, encompassing compositional principles, color logics, action patterns, and emotional rhythms. In the process of digital transformation, the primary objects to be extracted and revitalized are precisely these generative source codes, rather than merely the static outcomes they produce.

3.2. The Dual Structure of Latent Rules and Manifest Representations

An examination of existing red architectural heritage reveals that a large number of small and To achieve a more precise analysis of the aesthetic composition of intangible cultural heritage, it can be analytically divided into two interrelated dimensions: latent rules and manifest representations. Existing approaches to digital conservation have largely remained at the level of manifest representation, focusing on high fidelity documentation of the final visual or performative forms of heritage. While such practices preserve aesthetic outcomes, they fail to address the internal mechanisms through which aesthetic forms are generated. The concept of aesthetic genes emphasized in this study primarily targets latent rules. These rules constitute a system of generative principles and deep grammar concealed beneath perceptible forms. The core task of digital revitalization lies in decoding this latent system. Only by grasping this deep grammar can digital systems acquire a form of quasi creative capacity, enabling them to generate diverse yet normatively coherent content across different application contexts while remaining consistent with traditional aesthetic conventions(Figure 2).

Figure 2. Traditional Chinese Paper Cutting as Intangible Cultural Heritage.

3.3. Systematic Deconstruction of Aesthetic Genes

Drawing on the categorical framework of traditional Chinese aesthetics, the aesthetic genes of intangible cultural heritage can be systematically deconstructed into three hierarchical levels, progressing from surface to depth. The sensorial form level constitutes the outermost layer of aesthetic genes and is manifested through perceptible audiovisual symbols(Zhang and Zhu,2021). This level includes color spectra, rhythmic line qualities, spatial configurations, material textures, and acoustic frequency structures. Aesthetic genes at this level exhibit a high degree of quantifiability and serve as the foundational interface for digital acquisition and sensory interaction. The cultural signification level forms the intermediate layer of aesthetic genes and carries specific cultural meanings and narrative logics. Intangible cultural heritage functions not only as an aesthetic object but also as a vehicle of cultural concepts, embodying distinctive Chinese worldviews, ethical values, and perspectives on life. This level determines the cultural depth of heritage and requires digital revitalization to construct narrative spaces capable of conveying complex cultural semantics. The spiritual resonance level constitutes the core nucleus of aesthetic genes and refers to the flowing vitality and spiritual state embodied in works or practices. It is manifested in the concentration of artisans, the expressive presence of performers, and the sense of solemnity within ritual contexts. This dimension represents the highest category in Chinese aesthetics and is also the most difficult to capture in digital revitalization. How to reconstruct this form of intuitive and experiential resonance through technological means remains a central challenge that must be addressed in the development of digital revitalization models (Figure 3).

Figure 3. Intangible Cultural Heritage Craftsmanship of Wood Carving in Traditional Dwellings of Fujian Province.

4. Generative Mechanisms of Intangible Cultural Heritage Revitalization in Digital Fields

4.1. Dissolution of Aesthetic Distance and the Construction of Embodied Cognition

Traditional aesthetic engagement with intangible cultural heritage has largely been grounded in a contemplative mode based on a subject–object dichotomy, in which the observer maintains a certain psychological distance while gazing upon the aesthetic object. Digital technologies represented by virtual reality and augmented reality disrupt this paradigm by constructing fully immersive perceptual environments that effectively dissolve both physical and psychological distance(Zhou,2022).

The core mechanism of digital revitalization lies in the establishment of embodied cognition. Within digital fields, users' bodily senses are comprehensively activated. The body is no longer positioned as a passive spectator before a screen, but becomes an active medium of perception and interaction. Through motion capture, haptic feedback, and audiovisual immersion, users are able to enter the internal world of intangible cultural heritage and engage in direct experiential exchange with aesthetic objects. This mechanism reshapes the allocation of aesthetic attention, allowing both form and spirit embedded within aesthetic genes to exert a more immediate and powerful impact on users' perceptual structures(Tan and Sun,2013).

4.2. Mechanisms of Symbolic Disembedding and Reembedding

From a sociological perspective, the digitalization of intangible cultural heritage can be understood as a process of symbolic disembedding and reembedding. The first stage involves disembedding. Through digital acquisition and encoding, the aesthetic genes of intangible cultural heritage are extracted from their original material carriers and specific spatiotemporal contexts, and transformed into abstract and mobile digital symbols. This process entails dematerialization and decontextualization.

The second stage is reembedding. Through algorithmic operations and interaction design, these symbols are reinserted into contemporary digital ecosystems. This process does not constitute a simple transfer, but rather a creative translation shaped by the affordances of digital media. The success of such translation depends on whether meaningful relationships between symbols and signification can be reconstructed within the new media environment, thereby avoiding semantic voids. This requires the reconfiguration of a virtual context in digital space that is capable of sustaining meaning generation for aesthetic genes, enabling them to function coherently and dynamically within digitally mediated cultural practices.

5. A Logical Model for the Digital Revitalization of the Aesthetic Genes of Chinese Intangible Cultural Heritage

The model constructed in this study does not function as a technical manual for specific operations, but rather as a macro level logical closed loop system intended to explain the entire process through which intangible cultural heritage aesthetics migrate from their original forms into a digital ecosystem. The model consists of four core stages(Figure 4).

Figure 4. Intangible Cultural Heritage Craftsmanship of Polychrome Painting in Traditional Dwellings of Fujian Province

5.1. Identification and Separation of Core Elements

This stage constitutes the input and foundational component of the model. Its logical task is to conduct a rational analysis of the holistic and often inseparable phenomena of intangible cultural heritage. The research requires the establishment of a set of gene extraction criteria grounded in aesthetic taxonomy, through which essential aesthetic genes are distinguished from auxiliary elements that may evolve with historical change. The critical objective lies in decoupling, namely, liberating aesthetic value from its absolute dependence on material entities. Through this process of decoupling, aesthetic genes acquire mobility and editability, enabling the formation of a structured and standardized aesthetic gene atlas. This atlas serves as the groundwork for subsequent digital processing and transformation(Fan and Zeng,2024).

5.2. Algorithmization of Sensory Experience

This stage represents the core processing component of the model. Its task is to translate human sensory and experiential aesthetic knowledge into mathematical languages that can be understood and computed by machines. This process involves complex interdisciplinary translation and incorporates artificial intelligence and deep learning technologies. Contemporary AI systems are no longer limited to executing predefined instructions but demonstrate a capacity for aesthetic generation. Through training on large scale datasets of intangible cultural heritage, AI systems can learn stylistic features and aesthetic patterns, thereby assisting designers in creative gene recombination. The result is the generation of new content that both preserves traditional aesthetic resonance and aligns with contemporary aesthetic forms.

5.3. Construction of Digital Habitats

This stage corresponds to the output and representational phase of the model. Extracted digital genes are inherently intangible and therefore require the construction of new digital

habitats in which they can exist and operate. The model advocates the creation of multimodal digital environments tailored to the characteristics of different aesthetic genes. For visually oriented forms of intangible cultural heritage, high fidelity virtual simulation spaces can be constructed to restore intricate patterns and chromatic details. For narrative oriented heritage, interactive narrative game worlds may be developed, allowing users to experience cultural depth through role playing and plot progression. For ritual oriented heritage, sacralized immersive environments can be created, employing synesthetic designs of light and sound to evoke a sense of sublimity and reverence. This stage emphasizes the integrity of "scenes," meaning that digital reconstruction should encompass not only the object itself but also the aesthetic atmosphere and emotional field in which it is situated.

5.4. Dynamic Dissemination and Feedback Loop

This stage constitutes the feedback and iterative component of the model. Digital revitalization is not a one time delivery but a dynamically evolving ecological process. Within the digital ecosystem, each end user functions as a node of dissemination and reproduction. User interactions are transformed into data feedback that informs the continuous refinement of the aesthetic gene atlas and the optimization of revitalization strategies. At the same time, the model encourages secondary creation by users. Through collage, recombination, and reinterpretation of intangible cultural heritage elements, aesthetic genes achieve viral diffusion within networked spaces. This decentralized mode of dissemination endows intangible cultural heritage aesthetics with strong adaptability and vitality, giving rise to a self sustaining digital cultural ecology.

6. Digital Reconstruction of Social Aesthetic Education and Cultural Identity

6.1. Inclusive Aesthetic Education Beyond Spatiotemporal Constraints

The primary social value of the revitalization model proposed in this study lies in its capacity to overcome the elitist and regionally bounded nature of traditional aesthetic education related to intangible cultural heritage. In the physical era, high quality aesthetic experiences were often constrained by geographical distance, dissemination channels, and professional thresholds, limiting public access. Through digital revitalization, intangible cultural heritage aesthetics are able to transcend geographical barriers and enter digital terminals at extremely low marginal cost. This inclusive mode of aesthetic education facilitates the equitable distribution and comprehensive coverage of aesthetic resources, enabling diverse social groups across regions and social strata to access the nourishing system of Chinese aesthetics on equal terms.

6.2. Psychological Activation of Deep Cultural Identity

In the context of globalization, the construction of cultural identity faces increasing challenges. The digital revitalization of the aesthetic genes of intangible cultural heritage moves beyond superficial visual pleasure toward the activation of deeper psychological structures. When users engage in immersive interaction with aesthetic symbols that embody collective national memory within digital space, a sense of cultural intimacy rooted in the collective unconscious is awakened. Compared with abstract textual instruction, such embodied and immersive experiences exert a stronger affective impact, subtly embedding the genes of Chinese aesthetics into the aesthetic psychology of contemporary individuals. In this way, a psychological foundation for cultural continuity is reinforced, strengthening confidence grounded in cultural self awareness(Zhu and Zhong,2022)(Table 2).

Table 2. Intangible Cultural Heritage Craftsmanship of Polychrome Painting in Traditional Dwellings of Fujian Province

Stage	Core Mechanism	Key Tasks	Functional Significance
Identification and Separation of Core Elements	Decoupling of aesthetic value from material carriers	Extract core aesthetic genes; distinguish essential and auxiliary elements; construct a structured aesthetic gene atlas	Establishes the foundational database for digital transformation and enables aesthetic mobility
Algorithmization of Sensory Experience	Translation of aesthetic experience into computational logic	Convert sensory and aesthetic patterns into machine readable data; apply AI and deep learning for generative recombination	Transforms static heritage into generative content with creative potential
Construction of Digital Habitats	Multimodal scene reconstruction	Build immersive digital environments tailored to visual, narrative, or ritual aesthetics	Recreates aesthetic atmosphere and emotional fields in digital space
Dynamic Dissemination and Feedback Loop	User driven interaction and iterative optimization	Collect interaction data; encourage secondary creation; update gene atlas	Forms a self evolving digital cultural ecosystem and sustains living transmission

7. Discussion and Conclusions

The digital revitalization of the aesthetic genes of Chinese intangible cultural heritage constitutes a systemic endeavor involving technology, art, philosophy, and sociology. By constructing a logical model encompassing gene extraction, digital translation, scene reconstruction, and ecological evolution, this study seeks to provide theoretical interpretation and strategic guidance for this contemporary challenge. The findings suggest that digital revitalization is not a simple replication of physical forms, but rather a modern reconfiguration of aesthetic spirit. Only by moving beyond surface phenomena to engage with the core of aesthetic genes, and by adhering to the ontological logic of digital media, can the living transmission of intangible cultural heritage be genuinely achieved. Looking ahead, as emerging technologies such as the metaverse and brain computer interfaces continue to evolve, the modes of existence of intangible cultural heritage will become increasingly diverse, and human interaction with heritage will grow more direct. The aesthetic genes of Chinese intangible cultural heritage will serve as a crucial link connecting past and future, virtuality and reality, radiating enduring brilliance within the constellation of digital civilization. This endeavor represents not only the protection of cultural heritage, but also a poetic vision for the future modes of human aesthetic life.

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