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The Application of Generative AI in the Design of Guizhou Batik Patterns

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Abstract

Guizhou batik is a typical representative of textile dyeing intangible cultural heritage. This paper explores the feasibility of integrating generative AI with Guizhou batik by examining the current state of both fields. It proposes how generative AI can address existing challenges in Guizhou batik, such as the uneven distribution of inheritors and the outdated pattern symbols and design language. Furthermore, it discusses how traditional handicrafts can coexist with digital intelligence in the modern era. The study also demonstrates that the introduction of generative AI not only enables efficient design and enhances artistic expression but also preserves the traditional characteristics of batik craftsmanship, providing insights into the digital-intelligent integration of Guizhou batik art.

Keywords: generative AI, Guizhou Batik, pattern design, Cultural Heritage Preservation

1. Introduction

Guizhou, as a province rich in ethnic minority cultures, boasts a vast array of intangible cultural heritage, with batik being an indispensable part. The value of Guizhou batik lies not only in its deep cultural significance but also in its unique aesthetic craftsmanship. However, traditional batik techniques face challenges such as complex processes, time-consuming production, limited color variations, and weak dye fastness, making them less compatible with the fast-paced modern era. The advancement of artificial intelligence, particularly generative technologies, has expanded the possibilities of design applications, bringing new vitality to the field.

2. Overview of Guizhou Batik Culture and Generative AI Technology

2.1 Overview of Guizhou Batik Culture

As a representative textile dyeing technique in Guizhou Province, batik is closely linked to the region's karst landforms and humid climate, which foster the growth of unique natural dye sources such as beeswax and indigo. This distinctive and complex geographical advantage directly influences the craftsmanship of batik.

The traditional batik-making process is intricate and varies across different regions, but it can generally be summarized into four key steps: pre-wax treatment, wax application, dyeing, and wax removal [1]. During the wax application process, the temperature of the molten beeswax must be controlled between 60°C and 70°C to maintain its β-crystal structure [1]. In the indigo reduction bath, microbial fermentation must be carefully regulated within a temperature range of 10°C to 35°C to achieve optimal dyeing results. Additionally, during the wax removal stage, the temperature must be precisely maintained at 96°C to ensure complete wax dissolution without damaging the fabric. These meticulously crafted techniques make the entire batik process time-consuming and labor-intensive, leading to inefficiencies and a slow response to market demands.

Beyond its complex craftsmanship, Guizhou batik boasts a diverse pattern system that reflects indigenous beliefs, ethnic history, worldviews, and cosmology, forming a unique cultural totem. Common motifs include dragons,

phoenixes, birds, fish, flowers, spirals, thunder patterns, and cloud patterns—symbolizing ancestral heritage, mathematical reasoning, and spiritual faith. These motifs serve as abstract expressions of storytelling and cultural transmission. However, despite its rich cultural depth, traditional batik techniques face multiple challenges in the era of artificial intelligence. The complexity of the craft limits innovation, the shortage of skilled inheritors results in a lack of novel pattern designs, and the relatively uniform traditional batik styles hinder penetration into the international market. These challenges necessitate urgent attention and solutions.

2.2 Overview of Generative AI Technology

Generative Artificial Intelligence (Generative AI) is a significant branch of AI, with its technical workflow generally divided into three stages: the learning and training phase, the generation and adjustment phase, and the generation optimization phase. Its core capability lies in enabling machines to perform deep learning based on given instructions, allowing them to identify patterns, imitate learned rules, and generate creative outputs that align with user requirements. These outputs can include text, images, audio, code, and more, making generative AI a transformative technology.

The rise of large-scale models has been a pivotal factor in the rapid advancement of AI. As technological barriers lower, the combined forces of data availability, computational power, algorithms, and policy frameworks have led to an exponential increase in the development of generative AI platforms across various industries. Today, numerous AI platforms have emerged, each excelling in different areas. Examples include DeepSeek, ChatGPT, Stable Diffusion, Midjourney, Adobe Firefly, and JiMeng AI, among others. Some specialize in text generation, while others focus on creative image production, animation, or video generation [2]. Common applications of generative AI include content creation, where platforms such as DeepSeek and ChatGPT assist in generating advertising copy, answering queries, and aiding in programming. Others, like Midjourney and Adobe Firefly, allow users to generate images or videos simply by entering prompts. These diverse platforms cater to different application scenarios, significantly improving efficiency, enhancing creativity, and—most importantly—enabling personalized content generation. This versatility gives generative AI a distinct advantage in modern digital workflows.

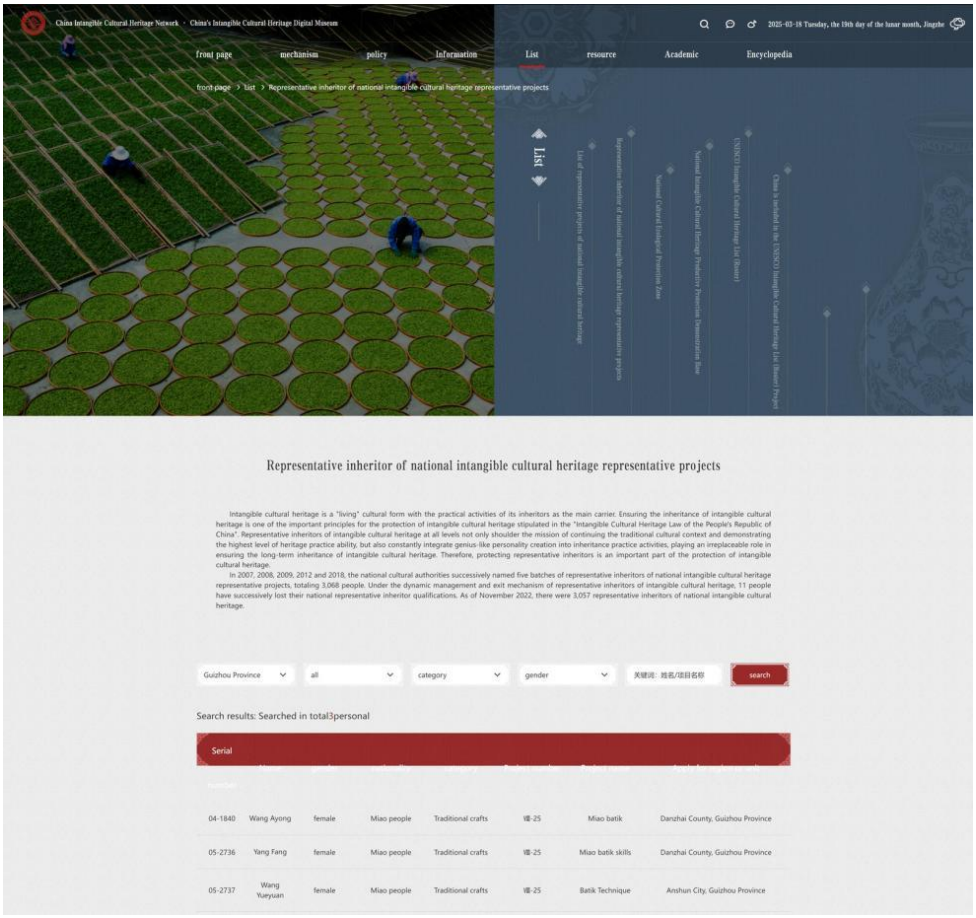

Figure 1. Registered Batik Inheritors Recorded by the National Intangible Cultural Heritage Protection Center

3. Analysis of the Current State of Guizhou Batik Pattern Design

3.1 Distribution of Inheritors

The inheritors of batik craftsmanship are the lifeblood of this intangible cultural heritage. The sustainability of this heritage depends on the collaboration of multiple stakeholders, including the government, the education system, and the market. According to data from the National Intangible Cultural Heritage Protection Center, there are only three officially registered national-level batik inheritors (as shown in Figure 1), with an average age of 67.3 years, all of whom are women. A significant portion of batik inheritors are over 60 years old, while younger inheritors under the age of 35 remain scarce. This severe aging trend among inheritors poses a serious challenge to the continuity of batik craftsmanship.Moreover, many younger inheritors lack a synchronized understanding of systematic craftsmanship and cultural knowledge, leading to gaps in their comprehension of traditional pattern genealogy. This disconnect makes it difficult to ensure cultural integrity in the process of innovation, further weakening the transmission chain.

Additionally, the gender imbalance among batik inheritors is another critical issue. Due to traditional customs and familial influences, the vast majority of inheritors are women. This disproportionate gender ratio can significantly impact the inheritance and evolution of batik. Men and women often approach the world and problem-solving differently—women tend to have a softer, more fluid artistic style, while men may exhibit a more structured, bold approach. The underrepresentation of male inheritors may result in a lack of diversity in design perspectives, ultimately affecting both the preservation and innovation of Guizhou batik.

3.2 Current State of Pattern Symbol Design

Batik patterns are deeply rooted in ethnic cultural traditions, with each motif recording the historical evolution of the community. Symbols such as the "butterfly," "maple tree," "dragon pattern," "fish pattern," and "bird pattern" all carry profound cultural narratives. These symbolic storytelling methods contribute to the unique cultural identity of Guizhou batik.

(1) Systematic and Narrative Aspects of Symbol Design

The core of batik pattern design lies in symbolic representation. Designers classify and express symbols within different semantic categories, such as nature worship, ancestral worship, totemic symbolism, and geometric decoration (see Table 1) [3]. The structure of these symbols follows a hierarchical system: Core symbols are positioned at the center of the pattern, occupying the most prominent space with strict compositional rules.Auxiliary symbols are more flexible and serve to fill and decorate the design. Peripheral symbols, as the name suggests, are placed along the edges, playing a transitional and connective role.The most critical aspect of cultural symbol design is its cultural semantics—batik patterns should not only be aesthetically pleasing but also serve as carriers of ethnic history and cultural identity. For example, the "butterfly" pattern symbolizes the origin of life. According to Miao mythology, the Butterfly Mother was born from a maple tree and is revered as the mother of all beings. She fell in love with a water bubble and gave birth to twelve eggs, from which emerged legendary figures such as Jiang Yang (the ancestor of humanity), the Thunder God, the dragon, the ox, the tiger, the snake, and the centipede. After fulfilling her mission of creation, the Butterfly Mother became the guardian deity of the Miao people [4]. Thus, batik symbols are not merely decorative elements but visual carriers of ethnic history and cultural heritage.

Table 1. Classification of Batik Pattern Symbols

Pattern Category	*Typical Patterns*	*Symbolic Meaning*	*Pattern Examples*
Nature Worship	*Sun pattern, water wave pattern, cloud thunder pattern*	*Reverence for natural forces*	

Ancestral Worship	*Butterfly pattern, bronze drum pattern, spiral pattern*	*Related to the community's creation mythology or beliefs*	
Totem Symbolism	*Dragon pattern, fish and bird patterns*	*Ethnic identity recognition, spiritual beliefs of the community*	
Geometric Decoration	*Spiral pattern, floral and plant patterns*	*Decorative accents*	

(2) Continuity and Innovation in Design Language

The expression of batik patterns can be explored from three aspects: composition rules, shaping characteristics, and color systems. Traditional composition methods often follow principles such as "central symmetry," "continuous repetition," and "layered filling" [5]. Contemporary batik designers, while innovating, have incorporated some international design styles, such as the minimalist aesthetics of Nordic design. They simplify traditional symbols to cater to certain aesthetic preferences, but this may lead to a loss of cultural semantics.

Traditional shaping characteristics often feature abstract and geometric forms, focusing on the rhythm and fluidity of the composition. In terms of color systems, the primary palette involves indigo and white, which are used in the batik process to express layers and depth. With the introduction of digital design tools, the efficiency of pattern creation has significantly increased. However, this innovation sometimes results in reduced cultural distinctiveness and recognition, and in some cases, an overemphasis on innovation has caused a misalignment of symbolic meaning within the patterns.

(3) Traditional Craftsmanship vs. Digital and Intelligent Techniques

The traditional batik-making process centers around handmade craftsmanship, using indigo dye and natural beeswax as pigments, with copper knives as painting tools and cloth as the canvas. The wax-resist dyeing technique is employed to create the designs. These methods strictly adhere to the design rules passed down through generations, embodying the belief that "everything has a spirit, and everything can be painted."In contrast, digital intelligence (also known as "digital smart" technology) integrates digital media techniques into traditional processes, enabling faster and more efficient expression. The use of AIGC (Artificial Intelligence Generated Content) for decoding and encoding batik patterns allows for learning and simulating the traditional process through input instructions, ultimately generating results that resemble hand-crafted works. By adjusting and refining the design iteratively, digital methods can replicate the effects of plant dyes and copper knife artwork, changing the traditional characteristics of low production efficiency and high uniqueness.This deep integration of traditional craftsmanship and digital intelligence not only provides technological anchors for accurate cultural transmission but also fosters the emergence of a new paradigm for the "algorithm-driven traditional aesthetics" of intangible cultural heritage protection. Despite this, the practical application of AIGC in this field remains relatively rare and requires more guidance for positive development.

4. Application of Generative AI in Guizhou Batik Pattern Design

4.1 Symbolic Semantics Decoding and Batik Pattern Generation

Guizhou batik dates back to the Qin and Han dynasties and is primarily found in regions such as Danzhai County, Zhijin County, and Anshun City. Researchers such as He Ruyi [6], Wu Lili [7], Wang Tong [8], and Zhang Yu [9] have contributed to the study of batik traditions among the Miao people in Zhijin, Anshun, Huishui, and Liuzhi, shedding light on the different regional characteristics, folk customs, core patterns, color features, and pattern structures. These differences have led to the formation of various batik schools (see Table 2).Generative AI, through deep learning techniques, collects and learns related data, and builds corresponding databases by simulating, classifying, and summarizing information. This allows for the rapid and systematic decoding of the cultural symbolism and semantic logic of Guizhou batik patterns. By doing so, generative AI helps batik inheritors shorten the learning time, enabling them to grasp the core essence of batik pattern design more quickly.

Table 2. Analysis of Batik Schools

school	Core Patterns	Color Features	Pattern Structure
Danzhai Miao	Butterfly Mother, Water Patterns	Blue and white contrast	Symmetry with "vertical and horizontal" balance and scattered distribution
Zhijin Miao	Butterfly Mother, Yin Yang Fish, Miao Dragon, Golden Pheasant, Jiyu Bird, Bronze Drum, Swirl Patterns	Dark blue tones	Divergent, repetitive, positive and negative shapes, individual, continuous, appropriate, and combined forms
Anshun Miao	Horseshoe, Cockscomb Flower, Butterfly, Fish and Bird Patterns	Solid dark blue	"Full," "complete," "borrowed," and "combinational" layouts, with a multi-layered composition radiating from the center
Huishui Fengxiang Dyeing	Starry Sky, Butterfly, Square Grid, Spider Flower, Thorn Pear Flower	Cyan, blue, white tones	Symmetrical central motifs with suitable patterns on both sides
Liuzhi Long Horn Miao	Migration Symbols (straight lines, square patterns), Butterfly, Sand Tree Tip Symbols	Black and blue mixed dye	Geometric "point, line, surface" composition

Taking the batik patterns of the Danzhai Miao as an example, generative AI is used for pattern design. The author employs a combination of two platforms, DeepSeek (hereafter referred to as DS) and MidJourney (hereafter referred to as MJ), to generate new patterns. First, relevant historical and cultural data are input into DS, including information about the historical development of the ethnic group, core patterns, color features, and pattern structures, as well as the desired pattern outcomes. DS then learns from this information and generates prompt

words for MJ (as shown in Figure 1).Next, in MJ, the existing Danzhai Miao batik patterns are combined with the newly generated pattern prompts, producing new patterns that align with the semantic decoding and adapt to the development of the times (as shown in Figure 2). If the result is unsatisfactory, DS can be used to generate modification instructions, and adjustments can be made in MJ by refining the pattern iteratively until the most suitable version is achieved (as shown in Figure 3).

以下是为Midjourney设计的专业级提示词，严格遵循丹寨苗族蜡染的工艺特征与文化语义，同时融入现代设计创新：

Prompt:

Subject: A contemporary batik pattern design inspired by Danzhai Miao's Butterfly Mother motif, integrating sacred geometry and abstract symbolism
Style: Ethnic fusion + Neo-traditional + High-contrast graphic design
Key elements:

1. **Central motif:** Stylized Butterfly Mother with fractal wings containing 12 embedded egg symbols (representing Miao cosmogony)
2. **Structural logic:**
   - Strict bilateral symmetry (vertical/horizontal axes)
   - Radial scattering of 3D crystallized maple leaf patterns (symbolizing sacred tree origin)
   - Hidden fish-tail recursive patterns in negative space
3. **Color scheme:**
   - Primary: Indigo (#0D3B66) with 3-tier gradient depth
   - Secondary: Bleached white (#F4F4F4) for anti-dye effect
   - Accent: Metallic silver threads (0.5% density) mimicking wax cracks
4. **Cultural references:**
   - Wing veins shaped as ancient migration routes
   - Border patterns encoding Miao's twelve seasonal festivals
   - Sub-patterns of water bubbles and lightning bolts (symbolizing creation myth)
5. **Technical specs:**
   - Line width variation: 0.3-1.2mm (simulating copper knife limitations)
   - Pattern repeat unit: 30x30cm with 15° rotational symmetry
   - Digital texture overlay: Wax resist crackle effect (Scale: 8/10 Intensity)

Parameters:
--ar 1:1 --chaos 25 --stylize 850 --quality 2 --v 6.0

Figure 1. DS-generated Prompt for MJ

Figure 2. MJ-generated Patterns Based on the Prompt

Figure 3. Final Generated Suitable Pattern

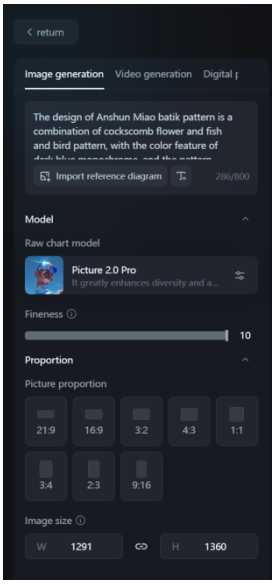

Figure 4 Jimeng AI Generation Interface

Figure 5 Jimeng AI Pattern Generated Based on Prompts

4.2 Design Language Innovation and Batik Pattern Generation

Although Guizhou batik can be divided into several major schools, the blending of ethnic groups has led to a fusion of their characteristics. Upon examining the design language, certain common features can be identified, such as "central symmetry," "continuous repetition," and "layered filling," which are frequently used techniques. In addition to MJ, there are many excellent AI platforms in China that can generate images, such as Jimeng AI. The author uses the Jimeng AI platform to innovate the design language and generate new batik patterns. Taking the Anshun Miao batik style as an example, the author inputs the following command in the image generation page of Jimeng AI: Anshun Miao batik pattern design, combining cockscomb flowers and fish-bird patterns, with a deep blue monochromatic color feature. The pattern structure is a full-layout design with a central-to-periphery, multi-layered composition. The model chosen is Image 2.0Pro, and the image size is W: 1291, H: 1360 (as shown in Figure 4). This allows Jimeng AI to generate the corresponding image (as shown in Figure 5). The author then selects the most appropriate design and iterates adjustments until the best result is achieved (as shown in Figure 6).

Figure 6. Final Optimized Pattern Generation

4.3 Intelligent Craftsmanship and the Revival of Batik Patterns

Traditional batik craftsmanship in Guizhou faces challenges related to the uneven distribution of inheritors. As a crucial link in the chain of cultural transmission, the craft is threatened by an aging practitioner demographic, a gender imbalance favoring women, low representation of urban inheritors, and a concentrated geographic spread. Additionally, the uniqueness of handmade production presents further challenges to the preservation of batik heritage.

(1) Building Human-Machine Collaboration to Overcome the Challenges of Traditional Craftsmanship

The inheritance of batik techniques is at risk due to the declining number of skilled artisans, compounded by the semantic loss in the transition from handcrafted to mechanized production. The advent of generative AI, alongside bionic control systems, intelligent fault-tolerance algorithms, and cross-media compilers, provides machines with intelligent "hands" capable of replicating traditional craftsmanship. Moreover, the synergy between high-precision nanotechnology and artisans' cultural intuition allows machines to precisely mimic the intricate characteristics of copper knife wax application, while artisans can compensate for the semantic gaps introduced by machine-based reproduction.

(2) Innovating Interaction Paradigms and Reducing Training Cycles

The essence of batik lies in the meticulous handwork of artisans, where every stroke—light or heavy—embodies years of experience. Advances in augmented reality (AR) now enable batik creation through AR gesture control systems, allowing for precise finger adjustments of density and wrist control of curvature. Additionally, sandbox modeling of craft parameters facilitates complex system simulations and the creation of novel patterns. This approach supports the nonlinear coupling of hundreds of process parameters, fostering new batik styles. Furthermore, the development of a digital DNA map for batik patterns can catalog unique features, procedural data, and heritage relationships, akin to biological DNA sequencing. Such a framework not only preserves the uniqueness of each craft but also reflects its evolution and lineage, significantly reducing the time required to train new artisans.

5. Conclusion

This study explores the current state of Guizhou batik and generative AI, analyzing their integration to decode the semantic logic of batik symbols and innovate design language. By leveraging multiple AI platforms, the research provides inspiration for creating novel batik patterns. Additionally, to address the uneven distribution of batik inheritors, this study proposes the construction of a human-machine collaborative framework to overcome challenges in traditional craftsmanship. With the aid of generative AI, intelligent machines can closely replicate handcrafted techniques, while artisans' cultural intuition helps mitigate semantic loss in machine-generated outputs. Moreover, the use of digital tools to create a DNA mapping system for batik patterns significantly shortens the training cycle for new artisans.However, there are still limitations in this research. For example, the challenge of reproducing the intricate "cracked ice" effect of traditional wax-resist dyeing through generative AI remains unresolved, which is a potential area for further investigation. It is hoped that these findings will provide valuable insights for future researchers working on the integration of generative AI and batik pattern design, contributing to the global promotion of China's intangible cultural heritage.

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