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Research on IP Image Design of Pumi Clothing Patterns Using AIGC Technology

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Abstract. In this study, through Artificial Intelligence Generated Content (AIGC) for the local ethnic minority Pumi people's dress patterns of China's local culture as a carrier, we mainly extract the dress patterns characterized by the Lonicera pattern, combining AIGC technology and the Lonicera pattern to further generate the IP image with national characteristics. Using the stable diffusion model, based on the dataset of a complete Lonicera pattern, the LoRA (Low Rank Adaptation) model is trained for the Pumi dress pattern, and an IP series of image designs based on the Chinese Pumi ethnic group is innovatively designed. This ultimately achieves the purpose of integrating traditional culture and technology, publicizing the local characteristics of the dresses, and passing down the excellent traditional dress patterns of this ethnic group. This research provides reference value for the integration of the Pumi ethnic minority and promotes the digital transformation and innovative development of national culture.

Keywords: AIGC, Pumi Costume, honeysuckle patterns

1. Introduction

In recent years, the Ministry of Culture and Tourism, in the Five-Year Plan for the Protection of Intangible Cultural Heritage, has clearly put forward the strategic requirement of adhering to creative transformation and innovative development, which points out the direction for the protection and inheritance of traditional culture [1]. As an ethnic minority in China's Yunnan Province, the Pumi people's national costume carries localized characteristics and intangible cultural heritage techniques. As one of the carriers of Pumi culture, the Lonicera pattern, which originated from the worship of nature and the life force of the Pumi people, is facing the crisis of being lost due to the development of science and technology and the impact of the fast fashion era. As early as the Sui and Tang dynasties, Lonicera patterns were widely used in clothing and other accessories, and a large number of Lonicera patterns have been found in the incense of the Mogao Caves, which are of various kinds and show a variety of Lonicera patterns that are usually based on the honeysuckle flower, which is regarded as a symbol of the vitality and perseverance of the Pumi people for its blossoming in the severe winter.

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2. Related work

2.1. Historical distribution

The Pumi, an ethnic minority in China, originated from an ancient nomadic Qiang group known as the Xifan, who then migrated to present-day Yunnan and Tibet, becoming one of the major ethnic groups in the Xichang area. The ethnic origin of the Pumi can be confirmed by historical documents, national legends, and ethnographic data, such as the “White Wolf” Qiang, which is one of the Qiang who migrated to the south, and the ancestors of the Pumi gathered in tribal form on the Tibetan Plateau, where the Lonicera flower was used as one of the dress patterns of the ethnic group because of its resistance to the cold and its growth in the plateau area. Especially in the field of dress design, the Lonicera flower pattern represents toughness and holiness, signifying a sacred and beautiful symbol, which is especially prominent in the craft of dress.

The Song History recorded that people “such as Xifan to seek good horses to the city,” representing the original tribes that, due to wars, continued to migrate to the Southwest region and gradually formed their own unique culture [2]. Thus, the Pumi people are nomadic, with farming and handicrafts that are very well developed. They make good use of nature and take and make things, including the processing of agricultural and sideline products, with textile, leather, iron manufacture, brewing, oil extraction, bamboo weaving, and so on.

2.2. Location analysis

The evolution of the Pumi ethnic group's clothing is closely related to their historical migrations and social transformations. Their ancestors settled in the southwestern part of Sichuan (such as Yuexi, Mianning, Jiulong, and Shimian) and the northwestern part of Yunnan (such as Lijiang) around the 7th century. Early clothing was characterized by linen fabric and sheep horn patterns. After the transition to settled farming in the 13th century, bamboo weaving techniques were incorporated into the decorative system. During the Yuan Dynasty, some of the Xifan people who followed the army to the south settled in Yunnan and formed the main body of the Pumi people. Their clothing was influenced by Mongolian fashion, featuring bright colors and heavy decoration, especially the hat ornaments in red, green, and blue symbolizing good fortune. Under the chieftain system of the Ming Dynasty, cultural exchanges with Han, Yi, Bai, and other ethnic groups led to the stabilization of the clothing system and the emergence of age and gender distinctions: minors of both genders mostly wore linen, women wore pleated skirts, and adult women wore "Duba" headdresses adorned with agate and glass beads, highlighting religious beliefs and color aesthetics. Since modern times, the name "Pumi" has been officially established. However, the process of globalization and digitalization has led to the decline of traditional craftsmanship, and traditional patterns such as the honeysuckle flower are on the verge of extinction, urgently requiring the use of AIGC technology for dynamic inheritance and digital regeneration.

Mr. Li Zhengdao advocated the integration of science and art and added that “science and art are like two sides of a coin that do not meet each other but are inseparably fused together [3]. In this study, the main color tones of the Pumi ethnic group were integrated into the AIGC design, and the colors of the Lonicera pattern were extracted in the preliminary stage of the design. The stable diffusion model was first used to input a specific text-image model (such as the CLIP model) to guide the image generation process, so as to make the generated image match the given text description [4]. This ensures the accuracy of the ethnic costume, which further better conveys the ethnic group's sensitivity to color.

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2.3. Patterns

This design extracts six types of Lonicera patterns as the perceptual machine of the neural network model. It then employs a Convolutional Neural Network to process these six distinct patterns, resulting in specialized images [5]. Simultaneously, the internal neural network generates six different visual images as the internal dataset, ensuringthe complete realization of the Lonicera pattern in the output image. This approach enhances the IP image design, specializing in the processing of image and video data(Table 1). By utilizing convolutional layers to refine image features, it is widely applied in computer vision tasks.

Table 1. Lonicera pattern pattern type list

Form	Name	Legend (of a map, etc)	Pattern extraction	Morphological	Meaning of words
Category I	Continuous Undulation			Twisted Branches Shape single leaf	Wave Curve
				Branches, bilobed	Bipartite Directionality
Category II	Toroidal			Inset and surround symmetry	Ring Display Symmetrical distribution
Category III	Hawksbill Turtle shape			Turtle-shaped convoluted pattern	Auspicious Symbolism
Category IV	Fenugreek Bead pattern			Vine-basedSymmetrically arranged from the top and bottom of the interior	Symmetry Continuity Orderliness
Category V	Triangular Symmetrical			Group two honeysuckles symmetrically Stacked in Sequence	Various Forms According To the Number of leaves
Category VI	A twisted Branch			Undulate Undulating	Molding

3. Method

3.1. Realization of AIGC technology principles

This study fully utilizes the expression of combining AIGC technology and design to explore the technical and practical means in Agent AI in which AIGC understands multiple modalities (e.g., Lonicera pattern tattoos and inputs from the underlying linguistic architecture) and generates meaningful actions in the physical and virtual world. This design process includes the steps of data collection, pre-training, fine-tuning, inference iteration, generating results, and user feedback, which summarizes certain practical experiences and opens up new design paths for further work in the field of large-scale language models generating traditional culture-based AI images and non-heritage traditional creative design.

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In the traceability stage, we explore the cultural connotation and contemporary value of the Pumi people, investigating the relevance of the Lonicera pattern to their dress design. The types and colors of the Lonicera are then input into the AIGC processor. The final realization stage consists of four steps: data collection, model selection and framework design, an iterative training process, and image generation (Figure 1).

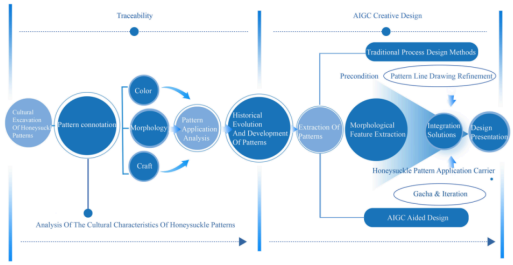

Figure 1. Research path of Lonicera dress pattern in AIGC creative design

Firstly, in the data collection stage, a total of six different forms and types of Lonicera patterns were collected as input sample graphics: continuous undulating type, ring shape, tortoiseshell type, gourd-type beading, triangular symmetrical beading, and stranded type, which represent the diversity of data Especially, the cultural semantic angle of the Lonicera pattern is mined to give the cultural meaning and connotation in the IP image design. In the training and iteration process, through the continuous input and optimization of the language architecture and the continuous improvement of the image quality, the LORA model is trained iteratively based on the relationship between the generator and the discriminator. Furthermore, in the iterative process, the new image generated by the generator is determined by the discriminator, and then the generator adjusts the weights according to the feedback from the discriminator. The generator then adjusts the weights according to the feedback from the discriminator and eventually generates more accurate and high-quality images, improving its own discriminative ability to gradually generate clearer and more realistic images. The empowerment of AIGC technology in the design field is not only an increase in work efficiency but also a change in the traditional design process.

In the whole workflow, input and output are two important links, including acquisition, model selection, model training, adjustment, and other phases. Taking Stable Diffusion as an example, in the model training phase, the attention mechanism, i.e., the three parts of the QKV, is used to analyze and solve the input problem and achieve the desired results (Figure 2).

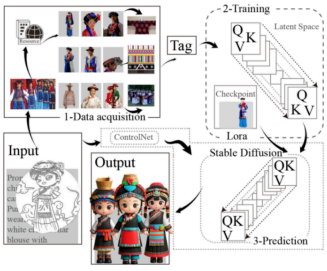

Figure 2. AIGC-assisted Pumi dress pattern design process

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In this research process, the different classifications of Lonicera patterns are excavated and applied to traditional clothing design, and the geographical distribution, cultural customs, traditional skills, and spiritual connotation of the Pumi culture as a minority are analyzed, which more accurately allows the AIGC generation technology to identify the charm of Chinese traditional culture and has more vitality and value in revitalizing the traditional culture of minority groups. This can help to enhance certain innovations in the design expression of contemporary designers. The designers' design expression has been enhanced with certain innovativeness.

3.2. AIGC innovation design process and methodology

This design mainly uses the Transformer architecture language model and the Stable Diffusion model as the text input and image output method, thus making the machine more stable to learn and understand the required base image. This is followed by the use of generated image data for iteration, the use of AIGC technology for color blending and graphic pattern optimization, and furthermore, a more accurate generated design image, which should not only conform to cultural heritage but also have visual aesthetic appeal. AI can generate designs that conform to both cultural connotations and market trends based on the combination of traditional colors of the Pumi people and modern aesthetics, realizing the dual value of AIGC and cultural creativity.The following is the overall model architecture for generating the design using the stable diffusion model (Figure3).

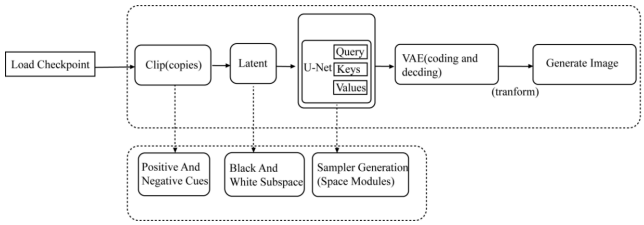

Figure 3. Stabilizing diffusion model architecture

This study employs Stable Diffusion's text-to-image and image-to-image methods with iterative optimization to generate Pumi IP imagery. Six Lonicera patterns are analyzed: continuous undulating (twisted wavy vines with three-flower-leaf arrangements), ring (circular base, symmetrical interior), tortoiseshell (tortoise-shaped base with curly grass, small florals, symmetrical leaves), gourd (horizontal vine base with symmetrical curly grass), triangle (variable leaf-count configurations), and twisted branch (complex leaves on irregular wavy vines). Deepseek's R1 model optimizes prompts; Midjourney creates 2D illustrations; Stable Diffusion produces 3D hand-held IP Blind Box models via image-to-image using control parameters and positive/negative prompts. Increased iterations ensure consistency. A three-stage optimization process—initial screening, manual adjustment, and evaluation—balances Pumi cultural semantics with modern IP innovation.

4. Analysis and result

4.1. Experimental design and quantitative assessment system

In the traditional Pumi dress pattern, it was found that the dress shape differs at different ages. In order to make the Lonicera pattern in the Pumi dress comprehensive, six different Lonicera patterns were used to generate images for different age groups, seasons, and genders in the IP series design. This was done to promote the traditional pattern and make the AIGC's ease of use and flexibility in the experiment more convincing. The following types of images were included: middle-aged

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women's Pumi IP images are mainly in the shape of gourds and triangles, representing symbols of good luck and well-being. The Pumi IP images of boys are mainly tortoiseshell-shaped and triangular; the Pumi IP images of girls are mainly undulating and triangular.

This study enhances AIGC usability in traditional pattern design through comparative analysis of honeysuckle patterns (Figure 4), evaluating color variance, line curvature deviation, and unit repetition precision to reveal both capabilities and limitations. A radar chart derived from user questionnaires scored traditional embroidery at 95/100 for cultural semantics preservation, while AIGC achieved 85 in innovation and 95 in design efficiency; both attained 90 in color accuracy. These findings demonstrate AIGC's potential to meet designer expectations while highlighting areas for improvement.

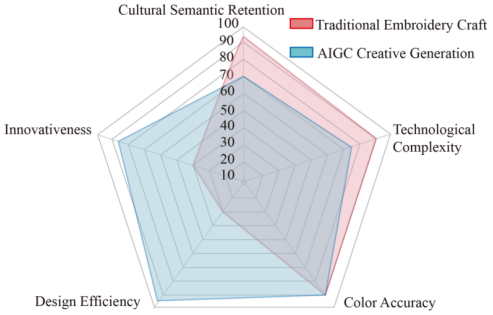

Figure 4. Comparison of efficiency between conventional process and AIGC idea generation design

4.2. Validation of validity and comparative mapping

Iterative training enhances model sensitivity to Pumi ethnic features. Variation across prompts necessitates deeper mining of clothing characteristics and cultural symbols to ensure ethnic fidelity. As Figure5 illustrates, iterations three and four yielded incomplete undulating pattern details; subsequent refinement achieved pattern accuracy and standard compliance. This underscores that grasping stylistic characteristics and cultural connotations is crucial for highlighting decorative patterns effectively(Figure5).

Figure 5. Comparison of iterative process of IP image generation

With the increase in the number of iterations, the model's feedback ability to the cue word is enhanced, and the characteristics of the IP image are accurately judged in terms of cultural semantics, which gradually converge to the ideal standard, such as the girl's IP image in the figure (Figure6) and the boy's IP image (Figure7).

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Figure 6. Three views of the blind box IP for a Pumi girl

Figure 7. Three views of the blind box IP for a Pumi boy

5. Discussion

Combining the process and research methodology of this research, the results of this design are evaluated and optimized using a combination of quantitative and qualitative forms, and the data formed by feedback in the form of online questionnaires is used to further analyze whether the series of Pumi IP images generated by AIGC technology this time has a sense of ethnic commonality, design innovation, and visual attractiveness.

This design combines mixed research methods, using a combination of quantitative and qualitative research, comprehensively analyzing the acceptance and emotional expression of the general consumer groups, experts and scholars, non-genetic inheritors, and core members of the Pumi ethnic group regarding the IP images generated by AIGC creativity, and extracting the core score values to statistically produce a bar chart for visual analysis, respectively.

After all tests are completed, the feedback from each group is comprehensively evaluated through a combination of quantitative and qualitative analysis. Quantitative data (e.g., ratings) can help us identify strengths and weaknesses in the design, while qualitative data (e.g., interview comments) can provide specific directions for design optimization. Ultimately, the analysis results are fed back into the AIGC design process to guide subsequent design iterations.

This study adopted a mixed-method approach, surveying 100 respondents online (including 10 general consumers and 5 experts) on their acceptance of traditional embroidery techniques and AIGC creative generation design (on a 1–10 scale). Quantitative results showed that general consumers rated AIGC at 8.5, far higher than the 4.5 for traditional embroidery, highlighting their preference for AI innovations and low engagement with intangible cultural heritage crafts; the experts maintained a cautiously neutral stance (7 and 6 respectively). Qualitative feedback revealed that scholars were concerned about the survival challenges of intangible cultural heritage due to

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young people leaving and experienced artisans being few and aging, believing that AI empowerment cannot achieve results overnight. This dual evaluation system not only identifies the strengths and weaknesses of the designs but also provides empirical evidence for iterative optimization, forming a closed-loop feedback mechanism(Figure8).

The above analysis shows that AIGC's creative design empowering non-heritage skills is in line with the trend of contemporary design development, and the general consumer group has a strong interest in AIGC's creatively designed IP blind box hand puppets, while experts and scholars need to give a comprehensive assessment of the development trend of the times and support the development of AIGC.

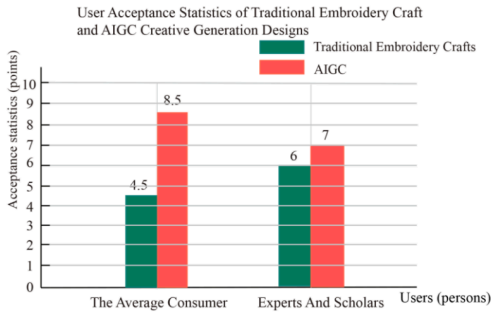

Figure 8. User acceptance statistics of traditional embroidery craft and AIGC creative generated designs

Comparative analysis (Figure 9) reveals divergent perspectives on AIGC generation between two Pumi stakeholder groups. Through online interviews using a 5-point Delphi method, 10 non-hereditary bearers scored traditional crafts 4.5/5, endorsing heritage preservation while criticizing AIGC's emotional deficit. Five Pumi community members, conversely, rated AIGC 4.5/5, favoring its innovative fusion with tradition as an AI-era adaptation. The findings collectively indicate that AIGC design must retain cultural semantics to achieve broad acceptance.

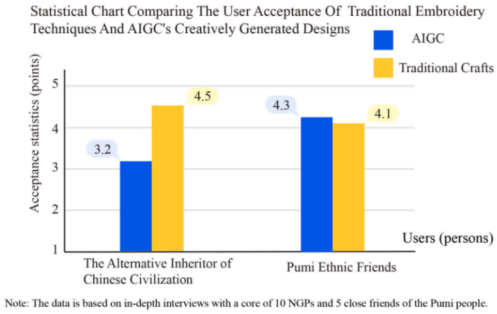

Figure 9. User acceptance statistics of traditional embroidery craft and AIGC creative generated designs

The synthesis of qualitative research methods, through online interviews with 10 non-genetic inheritors as well as members of the Pumi ethnic group, reveals that the development of traditional crafts requires the empowerment of AIGC tools, which not only facilitate the designers' design efficiency but also allow for a better expression of creativity.

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6. Conclusions

This study demonstrates AIGC's potential to pioneer innovation in Pumi ethnic pattern design across methodology, process visualization, and user testing validation. While facilitating cultural transmission and creative exploration, AIGC integration demands rigorous consideration of data quality, market viability, computational infrastructure, and substitutability. Deep excavation of formal and symbolic dimensions—particularly Lonicera patterns inherited since the Sui Dynasty—yields rich inspiration for contemporary design, catalyzing both preservation and innovation. Digital transformation fundamentally drives design renewal; AIGC-enabled revitalization of Pumi heritage not only enhances fashion and artistic value but also contributes to regional economic vitality and global cultural diversity.

References

[1] Kang, S., Bin Ibrahim, N. H., & Ab. Gani, M. A. A. (2023). Cultural Heritage Management: Innovative Design of Caisson Honeysuckle Pattern in the Middle Sui Dynasty in Mogao Grottoes. Frontiers in Artificial Intelligence and Applications

[2] Research on the Innovative Design of Digital IP Images Based on the Perspective of Traditional Chinese Medicine Culture. Yuqing Wang et al. [2024-01-01]

[3] Liu, J., & Jiang, S. (2024). Textile-based 3D printing and traditional Chinese geometric patterns for fashion textile development. Journal of the Textile Institute.

[4] Alfalasi, A., Khan, E., Alhashmi, M., Aldweik, R., & Svetinovic, D. (2024). SDXL Finetuned with LoRA for Coloring Therapy: Generating Graphic Templates Inspired by United Arab Emirates Culture. arXiv.

[5] Wang, F., Jiao, L., Zhu, K., Pu, L., & Zhang, L. (2025). Toward sustainable diffusion-based AIGC: Design and online orchestration in distributed edge networks. Computer Networks, 259.