Research on Generative Design of Chinese “Dunhuang Zaojing” Patterns Based on AIGC

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Abstract. With the rapid development and increasing maturity of AI technology, AIGC is being applied and continuously developing in an increasing number of fields. Secondly, the inheritance and redesign of traditional Chinese patterns, particularly “Dunhuang Zaojing” patterns, in the new era has become a new direction for the renewal of traditional patterns. Currently, the use of AIGC technology to modernize traditional patterns has become a new approach to achieving design diversification. Therefore, this study aims to explore the inheritance and innovative design paths of“Dunhuang Zaojing" patterns based on AIGC (Midjourney). First, a “Dunhuang Zaojing” pattern data set was constructed based on literature, four generation methods were designed, and an evaluation system consisting of four dimensions and eight indicators was constructed. Second, "Dunhuang Zaojing" patterns were generated using Midjourney using the four methods, while the generation time was recorded. Finally, the generation time and evaluation results were analyzed. The generated results achieve innovations in detail and composition, offering new avenues for the digital display and modern design transformation of traditional "Dunhuang Zaojing” patterns. They lower the creative barrier while preserving the core structure and contemporary color characteristics. They also clarify the advantages and optimization directions of AIGC in traditional pattern generation, providing a reference experimental framework and evaluation approach for subsequent intelligent design research on similar intangible cultural heritage elements.

Keywords: AI-Generated Content, Midjourney, “Dunhuang Zaojing” pattern, Generative Design.

1. Introduction

AIGC (AI-Generated Content) is an emerging branch technology in the field of artificial intelligence. Its core is to rely on advanced technologies such as deep learning, natural language processing (NLP), and large language models (LLM) to achieve automatic generation of various types of content [1]. AIGC technology can cover common multimedia formats such as text, images, audio, and video, and can also be expanded to specialized content creation areas such as code writing and 3D asset construction. AIGC content generation models can be divided into two types: unimodal input, where the input and output maintain the same modal properties; and cross-modal input, where the input and output exhibit different modal properties [2].

Currently, AIGC is being applied and developed in various fields. For example, in the healthcare sector, Wang et al. analyzed publications and keywords, summarized the hot topics as the impact of medical applications, and proposed that future regulation should focus on this [3]. Chen et al. proposed a mobile AIGC-driven human digital twin (HDT) architecture, and the results showed that it can balance user experience and network overhead [4]. Liu, Wang et al. constructed a comparison dataset between consultants and ChatGPT 3.5 and 4.0, and found that ChatGPT was close to human experts on macro topics [5]. Li, Wang and others reviewed the research and pointed out that AI depression diagnosis has entered the third generation of fusion methods, which has potential but is limited by ethics and sample size [6]. In the field of autonomous driving, Zhang, Wei and others proposed a cloud-edge-end collaborative architecture and designed a resource allocation solution to verify that it meets low latency and personalization requirements [7]. In facial forgery defense, Dai, Fei, and others proposed the Face Omron Ring (FOR) method, which introduced an identity regression module and a pre-trained model to achieve 100% protection for 5,000 identities [8]. In urban planning, Zou et al. combined geographic information with neural networks and genetic algorithms to build a model that outperformed traditional methods in indicators such as land use and traffic congestion [9].

AIGC's powerful capabilities have led to significant research and development in the design field. For example, in brand visual communication, Chen et al., through case studies, found that it can improve the efficiency of advertising creatives and enable personalized push notifications [10]. Zhang et al. extracted a brand product family DNA training model based on the SD platform, proving its advantages in design element expression and cross-category inheritance [11]. In the product design direction, Kwong et al. proposed an AI method that integrates emotion, engineering, and marketing, and used electric irons as an example to verify its effectiveness in the early design stage [12]. In tourism IP design, Fan Wu et al. used the spotted seal IP as a case study and used a multimodal generative model to conduct a phased study. The results showed that the method was efficient and had significant relevance [13]. In terms of animation creation, Shen et al. optimized the style model of "Arknights" based on SD to improve the consistency of image style and detail expression [14]. In clothing design, Liu et al. used Attribute-GAN and large-scale datasets to automatically generate clothing combinations, which outperformed mainstream models in terms of authenticity and matching [15]. In interface design, Huang et al. proposed a "demand mapping-conflict resolution" model, combined with the Midjourney generation solution. Evaluation showed that the optimized interface significantly improved efficiency, attractiveness, and satisfaction [16]. In interaction design, Schmidt et al. introduced large language models into the human-centered design process to improve efficiency and user representation, and emphasized transparency to avoid bias [17]. In furniture design, Wang et al. explored the path of new Chinese furniture based on the Midjourney and 7R principles. The results showed that it cannot only reproduce the Ming-style aesthetic, but also surpass traditional methods in terms of materials and production efficiency [18]. In 3D interior design, Gallega, Sumi, and others integrated DALLE-2 and ChatGPT to develop a prototype, which was verified by user studies to assist in texture generation and material selection. Although it is effective, it still requires fine-tuning with domain data [19].

The “Dunhuang Zaojing” ceiling, a core decoration of caves such as the Mogao Grottoes, symbolizes the "heaven beyond heaven" of Buddhism, connecting architecture, murals, and statues, possessing both religious and aesthetic value. Its varieties include the Baoxiang flower, large lotus, grape-pomegranate, double-dragon lotus, and large flat-petal lotus, with designs gradually shifting from Buddhist themes to secular ones. The overall structure is a three-layered "square well"—border decoration—and drapery, with a rigorous layout. Colors continued the cool tones of the Sui Dynasty in the early Tang Dynasty, while the early Tang Dynasty employed a more intensive use of "overlapping shading" and gold foil, leading to a trend toward simplification in the later period. The forms are primarily composed of fine, rounded lines, drawing inspiration from the "fading shading" technique of brocade weaving, creating a fusion of painterly and textile textures. The development of “Dunhuang Zaojing” can be roughly divided into three stages: the early Tang Dynasty inherited the Sui Dynasty and ushered in a new era. Grape and pomegranate patterns replaced linked beads and lotus patterns, and the Baoxiang flower gradually took shape; it reached its peak in the middle period, and the Baoxiang flower became the mainstream. The shape turned to the "Huagai style" with gorgeous colors, showing the atmosphere of the prosperous Tang Dynasty; in the later period, affected by the "Anshi Rebellion", the Baoxiang flower became simpler and alienated into camellia patterns, large lotus and hundred flowers and grass patterns became popular, and the colors became lighter.

Currently, academic research has yet to explore the application of AIGC technology in the intelligent generation of “Dunhuang Zaojing” patterns. Therefore, this study, based on Midjourney and ChatGPT, explores innovative “Dunhuang Zaojing” pattern design. First, “Dunhuang Zaojing” images are collected and preprocessed to construct an experimental dataset. Then, using prompts generated by ChatGPT, intelligent generation of “Dunhuang Zaojing” patterns is achieved on the Midjourney platform. Comparative experiments are conducted with the results generated using manually written prompts and other methods, ultimately exploring the feasibility of AI technology in intelligent generation of “Dunhuang Zaojing” patterns. AIGC is used to generate “Dunhuang Zaojing” patterns, reducing creation costs and barriers to entry, and rapidly generating diverse solutions. The results preserve cultural DNA and aesthetic characteristics while innovating in formal details,

imbuing traditional patterns with new expressiveness. Through style transfer and optimization, they balance historical charm with modern aesthetics, expanding their value in digital display and dissemination.

This paper is organized as follows: Section 2 introduces the specific methods of this study, which mainly include four ways of generating "Dunhuang Zaojing" patterns, namely text-driven generation based on manually written prompt words, joint guided generation based on manual prompt words and reference images, text-driven generation based on ChatGPT prompt words, and joint guided generation based on ChatGPT prompt words and reference images. Section 3 provides a descriptive analysis of the generated results, systematically discussing image quality, generation time, and generated content characteristics. Section 4 concludes the paper, summarizing the research findings and highlighting the application value and potential significance of AIGC in the generation of traditional "Dunhuang Zaojing" patterns.

2. Methods

2.1. Design process framework

First, we collected images of "Dunhuang Zaojing" patterns, classified them, and preprocessed them to ensure the integrity and quality of the dataset. We then used ChatGPT to generate prompt words related to "Dunhuang Zaojing" patterns and performed intelligent pattern generation on the Midjourney platform. To further explore the effects of different generation methods, the experimental design included four generation methods: Comparative experiments were conducted to analyze the effects of different generation methods, including ① using ChatGPT to generate prompt words and combining them with traditional "Dunhuang Zaojing" patterns; ② manually composing prompt words and combining them with traditional "Dunhuang Zaojing" patterns; ③ using only ChatGPT to generate prompt words; and ④ using only manually composed prompt words. The generated patterns were evaluated using a five-point Likert scale. The evaluation not only compared the four generation methods with each other but also compared them with traditional "Dunhuang Zaojing" patterns, comprehensively examining the artistic quality, innovation, and similarities and differences with traditional patterns. (Fig 1)

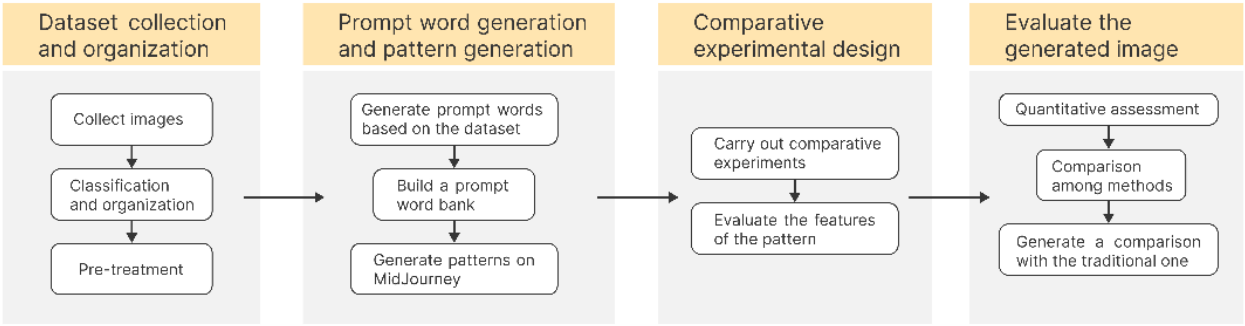

Figure 1. Design Flowchart

2.2. Midjourney Basics

Midjourney is mainly composed of modules such as text-image diffusion core, text understanding and encoding, image post-processing and optimization, training and iteration support, and decision support [20]. The core of the diffusion process consists of forward diffusion and backward denoising. Text understanding relies on the Transformer language model, and image post-processing focuses on improving visual quality and usability. Training and iteration support utilizes methods such as incremental fine-tuning, reinforcement learning (RLHF), and parameter pruning. The decision-making support module optimizes generation logic and improves the user experience by adjusting parameters such as the number of diffusion steps, sampler, and resolution. Currently, Midjourney has

been widely used in fields such as product design, animation, game art, and fashion, consistently producing high-quality and innovative results [21].

The basic logic of Midjourney's operation in this study is shown in Figure 2. In the process of generating “Dunhuang Zaojing” patterns, Midjourney first undergoes forward diffusion training: by collecting images to construct a training set and setting a noise schedule, the original images are gradually converted into noisy images with blurred details. Subsequently, U-Net performs noise prediction on these noisy “Dunhuang Zaojing” paintings. Simultaneously, the input prompt text is semantically embedded via the CLIP text encoder and aligned with the image's visual features. Keyword weighting is then used to further highlight the “Dunhuang Zaojing” elements. In the reverse diffusion phase, the noisy image is gradually denoised through the collaborative efforts of the DDIM, PLMS scheduler, and U-Net, restoring the key structures and details of the “Dunhuang Zaojing” pattern. Finally, the VAE decoder maps the U-Net output features to pixel space, generating a complete “Dunhuang Zaojing-style” image. Throughout this process, the various functional modules collaborate, while the decision-making support module optimizes the generation results by adjusting parameters such as the number of diffusion steps and sampling strategy.

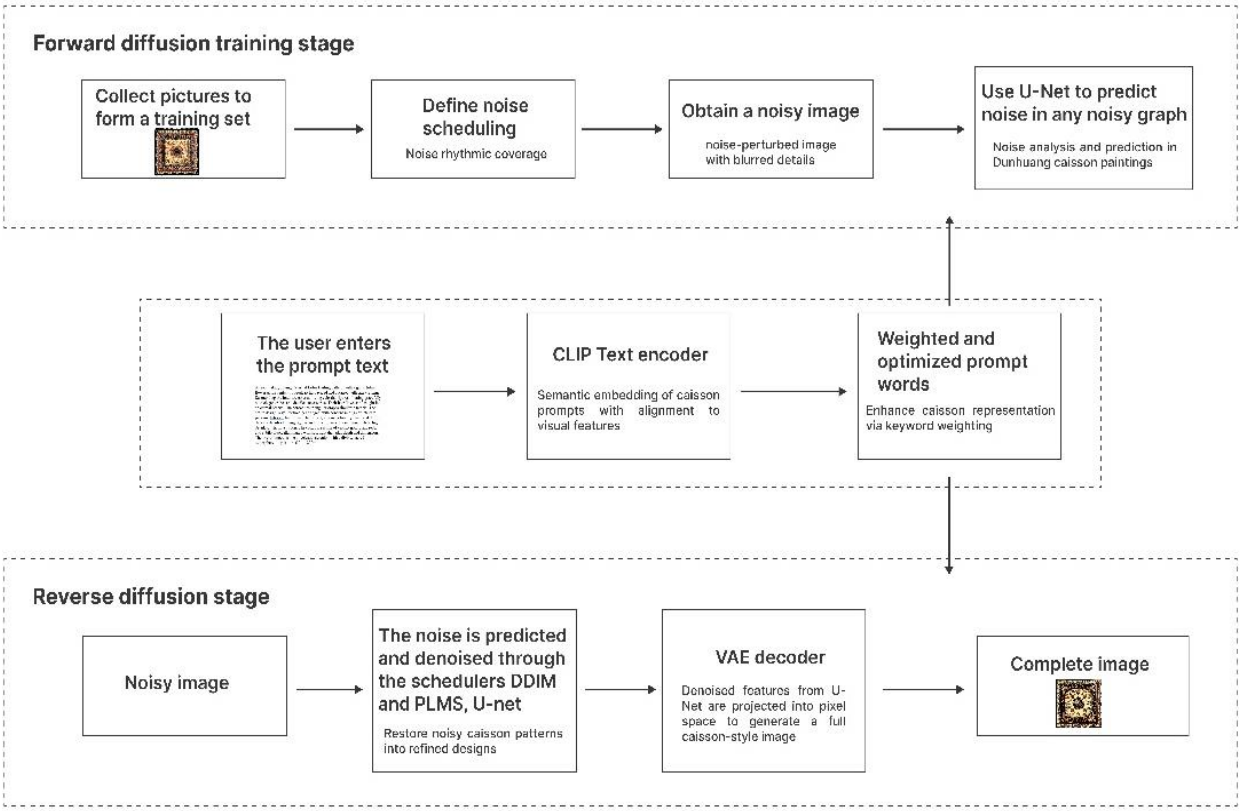

Figure 2. Midjourney operation flow chart

2.3. Experimental setup

2.3.1. Experimental data collection and preprocessing

The dataset for this article is drawn from the "Complete Collection of Dunhuang Grottoes - Patterns" (Part 1) and (Part 2), edited by Guan Youhui. Forty-five “Dunhuang Zaojing” patterns were extracted from this collection, encompassing six categories: lotus “Zaojing” patterns, flying lotus “Zaojing” patterns, lion-petal lotus “Zaojing” patterns, pomegranate “Zaojing” patterns, heart-petal lotus “Zaojing” patterns, and round flower “Zaojing” patterns. Ten experts in “Dunhuang Zaojing” pattern research were invited to rigorously screen the selected images. The experts generally agree that these images comprehensively reflect the main representative types and characteristics of “Dunhuang Zaojing” patterns, fully demonstrating the diversity and typicality of “Dunhuang Zaojing” art. (Fig 3)

(1) Collecting experimental data: According to the experimental requirements, each original image was adjusted to a bitmap of 512x512 px, with a size range of 200~500KB and a resolution of 300DPI.

(2) Establishing the experimental data set: Based on the richness and typicality of pattern images, 45 “Dunhuang Zaojing” images were selected to form the experimental data set.

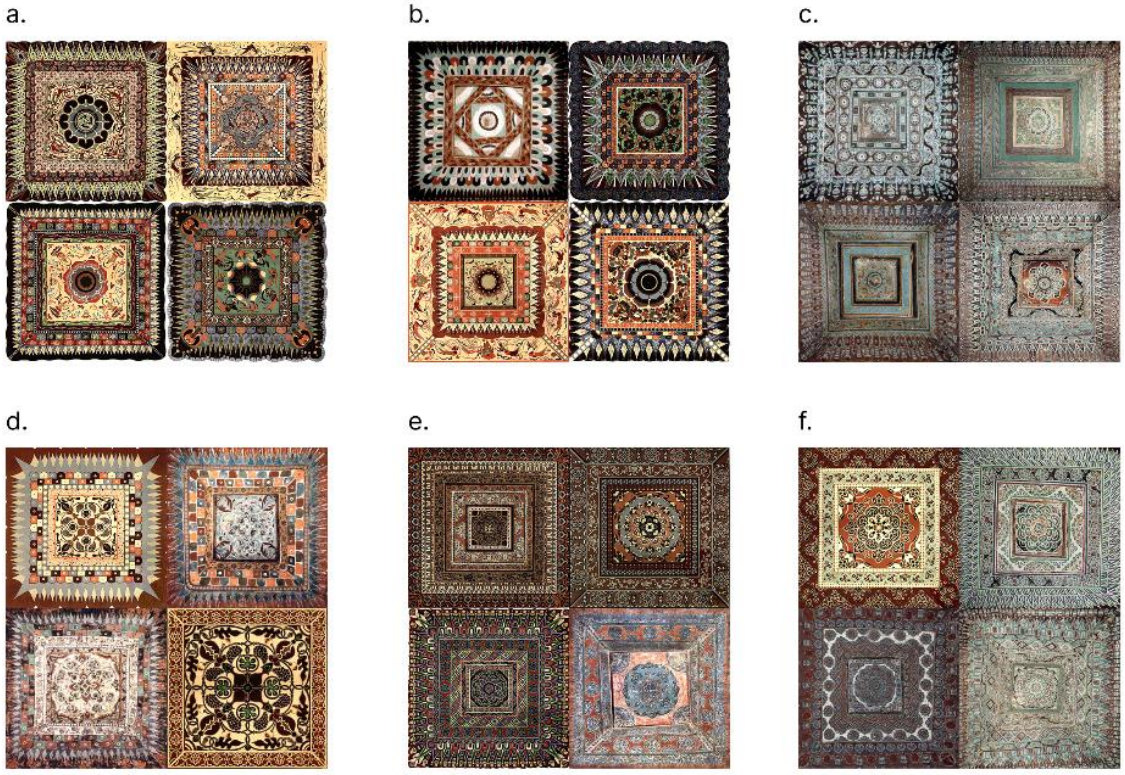

Figure 3. Schematic diagram of typical samples in the “Dunhuang Zaojing” pattern dataset. (a) Flying Lotus “Zaojing”, (b) Lotus “Zaojing”, (c) Lion-petal Lotus “Zaojing”, (d) Pomegranate “Zaojing”, (e) Peach Petal Lotus “Zaojing”, (f) Circular Flower “Zaojing”

2.3.2. Experimental environment

The Midjourney experiment was configured with a 12th Gen Intel(R) Core (TM) i7-12700H (2.30 GHz), a Windows 11 operating system, an NVIDIA GeForce RTX 3050 Laptop GPU, and 32GB of RAM. The ChatGPT website version was used in this experiment.

2.3.3. Introduction to raw image methods

This method uses a combination of manually written prompts and reference images to guide image generation: First, upload a reference image of the “Dunhuang Zaojing” pattern and copy the image link. Then, in the prompt box following the "/imagine" command, enter the “Dunhuang Zaojing” image link, a description, and parameters. The description defines the content, style, and other characteristics of the generated “Dunhuang Zaojing” image, while the parameters control the image properties. This method is referred to as MPI (Manual-Prompt + Image).

Using ChatGPT to generate prompts, combined with reference images, we generate images: The image upload process is the same as for "manual prompts and reference images combined with guidance." The main difference lies in the source of the prompts. First, you provide ChatGPT with information about the “Dunhuang Zaojing” patterns and the desired image. ChatGPT uses its language model to generate detailed prompts for the “Dunhuang Zaojing” patterns. Then, you enter the prompts in the prompt box to generate the image. This method is referred to as GPI (GPT-Prompt+Image).

Manually write prompts and use them with text from a reference image to drive the resulting image: This method eliminates the need to upload a reference image. Instead, simply enter the prompt for the “Dunhuang Zaojing” pattern into the prompt box following the "/imagine" command. The

prompts include key information about the setting of "Dunhuang Zaojing", artistic style, color scheme, and composition. This method is referred to as MP (Manual-Prompt).

Using reference images as a guide, ChatGPT then writes prompts to drive the image generation process. First, ChatGPT is told the specific requirements for generating a "Dunhuang Zaojing" ceiling image, which it then outputs. The prompts are then entered into a prompt box, and ChatGPT's generative language capabilities help Midjourney generate the image. This method is referred to as GP (GPT-Prompt).

2.4. Evaluation Setup

Combining the experience summaries of the previous 10 experts and consulting various relevant literature materials, a "Dunhuang Zaojing" Generation Evaluation Indicators (DCGEI) system was constructed. The AI-generated pattern results were then evaluated from four dimensions: structural integrity, pattern standardization, style coordination, and cultural connotation adaptability. Among them, structural integrity is divided into two specific criteria: the integrity of core components and the rationality of spatial layout. The integrity of core elements (CC) is mainly determined by whether the generated result contains "core + border + curtain". The rationality of spatial layout (SL) is determined by whether it conforms to the principle of symmetry, clear layers, and harmonious proportions. The standardization of patterns is divided into two specific standards: the adaptability of the theme pattern to the era, and the continuity and orderliness of the border pattern. The adaptability of the theme pattern to the era (TA) mainly depends on whether the pattern type matches the era, and the continuity and order of the border pattern (BO) mainly depends on whether the border pattern is continuous and echoes the well center. Style coordination is divided into two specific standards: the matching of color and era characteristics, and the compatibility of artistic style with the spirit of the times; the matching of color and era characteristics (CCO) mainly depends on whether the color tone matches the era, and the compatibility of artistic style with the spirit of the times (FS) mainly depends on whether the artistic style of the "Dunhuang Zaojing" is consistent with the spirit of the times; cultural connotation adaptability is divided into two specific standards: the unity of religious and secular connotations, and the conformity of cultural exchange characteristics to the times; the unity of religious and secular connotations (CU) mainly depends on whether it can embody Buddhist thoughts and reflect secular aesthetics, and the conformity of cultural exchange characteristics to the times (CE) mainly depends on whether the cultural exchange characteristics reflected by the "Dunhuang Zaojing" patterns are consistent with the characteristics of the times.

Furthermore, expert evaluation revealed that the integrity of core elements and the rationality of spatial layout were highly significant among the aforementioned indicators, thus accounting for a significant portion of the overall score. Therefore, the ratio of these indicators to each other was 2:2:1:1:1:1:1:1, with the scores for a, b, c, d, e, f, g, and h, respectively. This comprehensive evaluation utilizes a weighted average score, using the formula:

$$w = 0.2a + 0.2b + 0.1c + 0.1d + 0.1e + 0.1f + 0.1g + 0.1h. \quad (1)$$

3. Results

3.1. Generate descriptive analysis of results

Figure 4 shows the basic generation results of the four methods. In terms of generated image quality, the four methods produce clearer lines and a high degree of pattern element integrity, with no significant quality differences. In terms of generation time (Table 1), the GPI method is the fastest. This is because its prompt words are generated by ChatGPT and are highly structured. Combined with the reference image, the system can quickly locate image features, reduce additional parsing calculations and thus shorten generation time. The GP method is the slowest. This is because the prompts are lengthy and lack reference image constraints, requiring the system to parse and match within a larger semantic space, increasing the rendering burden. The MP and MPI methods fall in

between. This is because MP prompts are concise and relatively efficient to parse, but because it relies solely on text, the system still requires some computation to generate detailed information. While MPI uses reference images as an aid, it also adds the computational step of parsing and matching images with text, resulting in a slightly longer rendering time. In terms of generated content, the MPI and GPI methods are closer to traditional "Dunhuang Zaojing" patterns in composition and motifs. The central lotus, baoxianghua, and border elements are relatively regular, with a stable overall style and a high degree of preservation of cultural characteristics. In contrast, the patterns generated by the MP and GP methods are more abstract and diverse. While they show strong potential for formal innovation, they often lack controllability in detail and composition, and the reproduction of traditional features is relatively low.

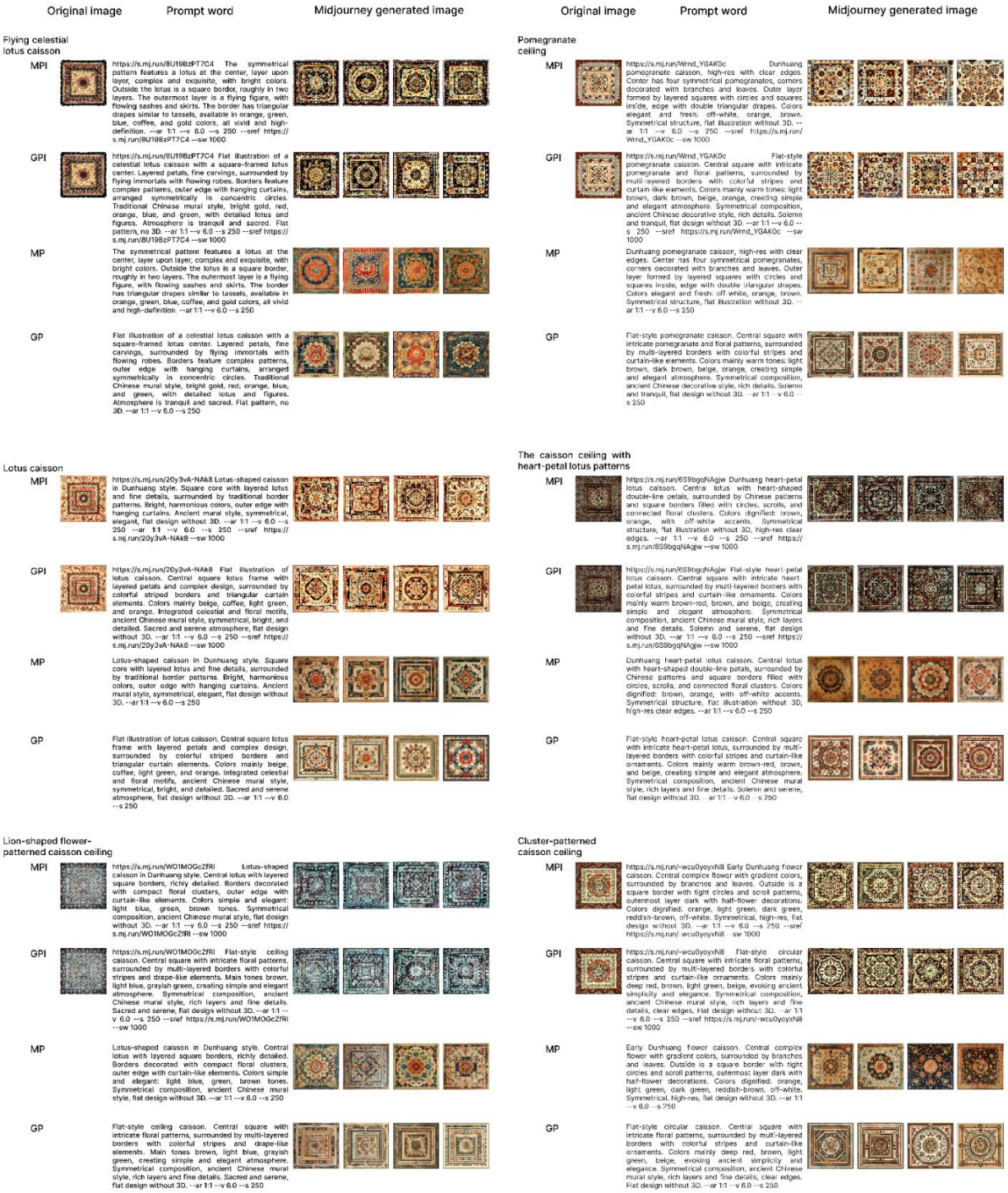

Figure 4. Four ways to generate different types of "Dunhuang Zaojing" patterns

Table 1. Comparison of the generation time of different "Dunhuang Zaojing" pattern generation methods

Generation method	Flying Lotus "Zaojing"	Lotus "Zaojing"	"Zaojing" with lion and lotus patterns	Pomegranate "Zaojing"	Heart-petal lotus-patterned "Zaojing"	"Zaojing"with round flower pattern
MP	56s	60s	61s	57s	60s	60s
GP	63s	60s	60s	63s	58s	59s
MPI	59s	57s	59s	59s	63s	60s
GPI	58s	59s	56s	58s	60s	62s

3.2. Evaluation and analysis of generated results

Table 2 presents the scoring results for different generation methods. For the Flying Lotus "Zaojing" pattern, GPI achieved the highest weighted average score of 4.3, indicating that the overall generated style most closely adheres to the artistic characteristics of the original Flying Lotus "Zaojing" pattern. Furthermore, MPI scored highly for the continuity and order of border patterns (4.97), MP for the rationality of spatial layout (4.28), and GP for the integrity of core elements (4.89). Therefore, GPI is the preferred method for generating the Flying Lotus "Zaojing" pattern. However, when evaluating specific stylistic criteria, MPI, MP, and GP can also be used as generation methods.

Regarding the lotus "Zaojing" pattern, GPI achieved the highest weighted average score of 4.435, indicating that the overall generated style most closely adheres to the artistic characteristics of the original lotus "Zaojing" pattern. Furthermore, MPI scored highly for artistic style and period fit (4.84), MP for the integrity of core elements (4.68), and GP for the matching of color with period characteristics (4.52). Therefore, GPI is the preferred method for generating lotus "Zaojing" patterns. When judging based on specific stylistic criteria, MPI, MP, and GP can also be selected as generation methods.

For the lion-petal lotus "Zaojing" pattern, the MPI achieved the highest weighted average score of 4.24, indicating that the overall generated style most closely adheres to the artistic characteristics of the original lion-petal lotus "Zaojing" pattern. Furthermore, GPI scored highly for the adaptability of the motif to the era (4.87), MP for rationality of spatial layout (4.73), and GP for continuity and orderliness of the border pattern (4.39). Therefore, MPI is the preferred method for generating the lion-petal lotus "Zaojing" pattern. If specific stylistic criteria are used, GPI, MP, or GP can also be used as generation methods.

For the pomegranate "Zaojing" pattern, GPI achieved the highest weighted average score of 4.24, indicating that the overall generated style most closely adheres to the artistic characteristics of the original pomegranate "Zaojing" pattern. Furthermore, MPI scored highly for matching color with period characteristics (4.96), MP for continuity and orderliness of border patterns (4.54), and GP for integrity of core elements (4.24). Therefore, GPI is the preferred method for generating pomegranate "Zaojing" patterns. When evaluating specific stylistic criteria, MPI, MP, and GP can also be selected as generation methods.

For the heart-petal lotus "Zaojing" pattern, MPI achieved the highest weighted average score, reaching 3.99, indicating that the overall generated style most closely adheres to the artistic characteristics of the original heart-petal lotus "Zaojing" pattern. Furthermore, GPI scored highly for the adaptability of the motif to the era (4.37), MP for the continuity and orderliness of the border pattern (3.86), and GP for the rationality of the spatial layout (4.81). Therefore, MPI is the preferred method for generating heart-petal lotus "Zaojing" patterns. When evaluating specific stylistic criteria, GPI, MP, and GP can also be used as generation methods.

In the case of "Zaojing" patterns with rounded flower patterns, GPI achieved the highest weighted average score of 3.93, indicating that the overall generated style most closely adheres to the artistic characteristics of the original "Zaojing" patterns. Furthermore, MPI scored highly for artistic style and contemporary fit (4.36), MP for the integrity of core elements (4.14), and GP for the continuity and orderliness of border patterns (4.12). Therefore, GPI is the preferred method for generating

"Zaojing" patterns with rounded flower patterns. When evaluating with specific stylistic criteria, MPI, MP, and GP can also be selected as generation methods.

As shown in Table 3, the statistical results show that, across the six evaluations, GPI achieved the highest score the most times (four times), MPI achieved the highest score twice, and neither MP nor GP achieved the highest score. This shows that GPI has a strong advantage in overall generation performance, while MPI demonstrates some competitiveness in some categories, while MP and GP have relatively limited performance in this dimension.

Table 2. Scoring table of the generation effects of different types of "Dunhuang Zaojing" patterns at different evaluation angles under different generation methods

Sample Category	Generation method	CC	SL	TA	BO	CCO	FS	CU	CE	w
Flying Lotus "Zaojing"	MPI	4.21	4.14	3.73	4.97	3.96	3.28	3.44	3.22	3.93
	GPI	4.94	4.35	4.21	4.91	4.12	4.67	3.17	3.34	4.30
	MP	3.19	4.28	2.45	3.89	3.24	2.47	2.11	2.09	3.12
	GP	4.89	3.13	3.27	4.58	3.17	3.12	3.08	2.57	3.58
Lotus "Zaojing"	MPI	4.26	4.13	3.56	4.47	4.16	4.84	3.93	3.18	4.09
	GPI	4.79	4.82	4.23	4.28	4.46	4.27	4.26	3.63	4.44
	MP	4.69	3.17	3.28	3.74	4.37	1.59	2.07	2.47	3.32
	GP	4.19	4.01	3.72	4.16	4.52	2.54	2.12	3.16	3.66
"Zaojing" with lion and lotus patterns	MPI	4.76	4.42	4.79	4.78	4.34	3.77	2.87	3.51	4.24
	GPI	4.47	4.54	4.87	4.26	3.82	4.13	3.02	3.59	4.17
	MP	3.14	4.73	3.26	4.53	3.13	1.57	2.72	1.82	3.28
	GP	4.11	3.32	4.05	4.39	2.18	2.46	3.17	2.54	3.37
Pomegranate "Zaojing"	MPI	4.28	4.16	4.03	4.65	4.96	4.14	2.08	2.92	3.97
	GPI	4.16	4.61	4.12	4.42	4.03	4.07	3.71	4.51	4.24
	MP	4.05	2.68	3.46	4.54	2.26	2.13	1.59	2.04	2.95
	GP	4.24	4.12	3.49	4.02	3.43	3.16	2.18	2.36	3.54
Heart-petal lotus-patterned "Zaojing"	MPI	4.29	5.42	3.15	3.19	4.68	3.08	3.67	2.73	3.99
	GPI	4.16	4.19	4.37	3.98	3.27	2.12	3.04	2.34	3.58
	MP	3.37	3.46	2.07	3.86	2.96	3.18	1.75	2.42	2.99
	GP	4.03	4.81	3.84	3.02	1.71	3.29	2.17	2.05	3.38
"Zaojing"with round flower	MPI	3.04	4.19	3.92	4.25	3.16	4.36	2.33	2.49	3.50
	GPI	4.57	4.26	4.21	3.53	4.03	3.27	3.46	3.13	3.929
	MP	4.14	3.12	3.09	2.17	2.04	1.59	2.67	1.89	2.797
	GP	3.16	4.06	3.43	4.12	2.18	2.02	2.43	2.16	3.078

Table 3. Statistics of the highest weighted average number of times of four generation methods in different categories of "Dunhuang Zaojing" patterns

	MPI	GPI	MP	GP
frequency	2	4	0	0

This study also analyzes the effectiveness of various AI-generated methods in generating "Dunhuang Zaojing" patterns. In terms of the integrity of core elements, all four methods effectively reproduce key elements such as the center, border, and drapery. These methods not only accurately reflect the morphological and functional characteristics of the center, border, and drapery in "Dunhuang Zaojing" patterns consistent with the period, but also achieve a degree of innovation that meets structural requirements. In terms of spatial layout rationality, all four methods perform relatively well overall. The generated results generally adhere to the principle of symmetry, with the use of pattern density and color gradation enhancing the sense of layering. The scale also aligns with the width proportions of square wells and borders from different periods, effectively showcasing the spatial order of "Dunhuang Zaojing" while also incorporating some innovative elements. Regarding the continuity and order of border patterns, all four methods effectively generate wavy, scattered, or

geometric borders, demonstrating outstanding repeatability and overall coherence. Furthermore, they innovate on this basis, ensuring that the generated patterns adhere to the characteristics of border continuity and coherence with the center. In terms of the adaptability of the theme patterns to the era, the four AI generation methods can highly generate and restore the adaptability of the theme patterns to the era (for example, honeysuckle patterns were common in the Sui Dynasty, and Baoxiang flowers were mostly used in the prosperous Tang Dynasty). They can not only fully reflect the characteristics of the details of the theme patterns of “Dunhuang Zaojing” patterns that are consistent with the characteristics of the evolution of the times, but also innovate based on this to conform to the characteristics of the theme patterns. In terms of matching colors with the characteristics of the times, the generated patterns can basically reproduce the color characteristics and techniques of different historical periods (such as the cool tones of the Sui Dynasty, the red, green and blue as the main colors of the prosperous Tang Dynasty, the overlapping techniques of the late Sui Dynasty and the incision and filling methods of the Tang Dynasty). They can not only better show the correlation between color and the style of the times, but also achieve certain innovations on this basis.

In terms of the compatibility between artistic style and the spirit of the times, the four generation methods performed generally well. While they were able to reflect the spirit of the times to a certain extent, they lacked distinct stylistic characteristics and spiritual connotations, resulting in a state of "fitting but not outstanding." This suggests that the current generation method based on Midjourney is still average in reproducing the unity of the artistic style of “Dunhuang Zaojing” and the spirit of the times, and there is room for improvement.

In terms of consistency between religious and secular connotations, the GPI generation effect is generally good (flying fairy “Zaojing” pattern 3.17, lotus “Zaojing” pattern 4.26, lion scroll lotus “Zaojing” pattern 3.02, pomegranate “Zaojing” pattern 3.71, peach heart lotus “Zaojing” pattern 3.04, round flower pattern “Zaojing” pattern 3.46), but the other three methods do not reflect the harmonious unity of Buddhist thought (such as the lotus symbolizing the Pure Land) and secular aesthetics (such as the grape pattern reflecting life). This result highlights the limitations of the four current Midjourney-based generation methods in accurately capturing the cultural identity of “Dunhuang Zaojing”. GPI generally performs well in terms of cultural exchange and time-appropriateness (Flying Apsaras “Zaojing” patterns, 3.34; Lotus “Zaojing” patterns, 3.63; Lion-petal Lotus “Zaojing” patterns, 3.59; Pomegranate “Zaojing” patterns, 4.51; Heart-petal Lotus “Zaojing” patterns, 2.34; Round Flower “Zaojing” patterns, 3.13). However, the other three methods fail to capture the cultural exchange of the eras (e.g., the integration of Hu and Han cultures in the Sui Dynasty, the integration of Chinese and Western cultures in the Early Tang Dynasty, and the dominance of the Central Plains during the High Tang Dynasty). This suggests that the four current Midjourney-based generation methods have limitations in capturing the cultural exchange of the eras embodied in “Dunhuang Zaojing”.

4. Conclusion

This paper first defines the goal of exploring the feasibility of intelligent generation of “Zaojing” patterns using Midjourney and ChatGPT. Based on a constructed dataset and four designed generation methods, this paper explains the technical principles and experimental environment of Midjourney, establishes a DCGEI evaluation system and defines a scoring formula, and analyzes the differences in image quality and generation time among the four generation methods. Combined with the DCGEI evaluation, this paper quantitatively compares their performance across six “Zaojing” types, concluding that GPI is the preferred generation method for most “Zaojing” and that MPI leads in specific categories. The paper also summarizes the application value of AIGC and identifies potential for improvement in the alignment of style with the spirit of the times, providing a reference for similar research. In subsequent similar studies, the selection of generative AI tools can be further optimized to improve the accuracy of various parameters and enrich the diversity of data sets, so as to generate innovative “Dunhuang Zaojing” patterns with more accurate composition, more fitting colors, higher

image quality, and richer cultural connotations. In the context of "Dunhuang Zaojing" patterns, an important traditional art form, this article introduces AIGC generation technology, which provides new possibilities for the design of traditional "Dunhuang Zaojing" patterns, verifies the effectiveness of AIGC in maintaining structural integrity and cultural genes, and demonstrates its potential in style transfer and detail innovation. The research not only provides a new path for the digital protection and artistic inheritance of "Dunhuang Zaojing" patterns, but also opens up space for their re-creation in visual communication, cultural and creative design, and cross-media applications, promoting the deep integration of traditional culture and intelligent generation technology.

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