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Research on Pattern Generation and Innovative Design of Chinese Mongolian Embroidery based on AIGC Technology

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Abstract:- This study aims to investigate the potential of generative artificial intelligence (AI) technology in the generation and innovation of Mongolian embroidery patterns. It seeks to address the limitations of traditional embroidery pattern design, which is often time-consuming and inefficient, and to enhance the market competitiveness of Mongolian embroidery products. A substantial corpus of Mongolian embroidery patterns has been assembled, and image processing software has been employed to enhance the processing. A generative adversarial network (GAN) and a variational self-encoder model are constructed to learn and train Mongolian embroidery patterns, with the objective of generating new patterns that exhibit a combination of traditional style and modern design concepts. The experimental results demonstrate that the Mongolian embroidery patterns generated by AIGC technology retain the defining characteristics of traditional patterns in terms of form, while also exhibiting a greater degree of diversification in design style through the creative generation of the model.

Keywords:- *Generative Artificial Intelligence; Mongolian Embroidery; Pattern Generation; Innovative Design.*

I. INTRODUCTION

In recent years, Artificial Intelligence Generated Content (AIGC) technology has shown great potential in the field of cultural and creative design, especially in the innovative design of pattern generation.AIGC technology can automatically generate high-quality artworks by utilizing deep learning models such as Generative Adversarial Networks (GANs) and Variable Auto-Encoders (VAE). The application of this technology not only improves the efficiency of art creation, but also broadens the creative boundaries of designers, enabling the deep integration of traditional culture and modern technology. As an important part of Mongolian culture, Mongolian embroidery is famous for its unique pattern design and rich cultural connotation. With the progress of modernization, Mongolian embroidery is facing multiple challenges such as the reduction of inheritors and the decrease of market demand, etc. The introduction of AIGC technology brings new possibilities for the generation and innovation of Mongolian embroidery patterns, which is of great cultural and economic significance to realize the digital protection and modernization application of traditional patterns through intelligent means.

The core purpose of this study is to explore the application of AIGC technology in Mongolian embroidery pattern generation and innovation, aiming to realize the creative transformation and innovative development of traditional culture through intelligent means. Specifically, this study aims to:

- Efficient generation of Mongolian embroidery patterns using AIGC technology to solve the time-consuming and inefficient problems of traditional embroidery pattern design. The systematic protection and inheritance of Mongolian embroidery patterns through digitization ensures that this precious cultural heritage can be completely recorded and widely disseminated.
- Applying AIGC technology to modernize the design and commercialization of Mongolian embroidery products to enhance their market competitiveness and economic benefits, and to attract more young people to participate in the inheritance and innovation of Mongolian embroidery. This study will not only help to enhance the artistic and cultural value of Mongolian embroidery, but also provide a useful reference for the protection and innovation of other traditional cultures.

➢ *In Order to Achieve the Above Research Objectives, the Following Methods and Steps were Used in this Study:*

- Data Acquisition: A large amount of high-quality image data is collected through all-round and multi-angle shooting of Mongolian embroidery works by high-definition camera equipment. Then, image processing software is used to optimize the acquired images, including steps such as removing noise, adjusting color balance, and correcting image distortion, in order to obtain clear and accurate digital images.
- Model training: based on data collection and processing, the generative adversarial networks (GANs) model is constructed, and the variational autoencoder (VAE) is utilized for auxiliary training. By learning and training a large number of Mongolian embroidery patterns, the model is able to generate new patterns with traditional styles. This process not only includes the restoration of existing patterns, but also involves innovative design, so that the generated patterns retain traditional elements and incorporate modern design concepts.

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- Design experiments: after the model training is completed, a series of design experiments are carried out to verify the generation effect and practical application value of the model. These experiments include generating different styles of embroidery patterns and applying them to the design of various cultural and creative products, such as apparel and home furnishings, etc., to evaluate their market response and economic benefits.
- Analysis and discussion of results: the experimental results are analyzed in detail to assess the actual effect of AIGC technology in Mongolian embroidery pattern generation and innovation, summarize its advantages and shortcomings, and put forward suggestions for improvement. At the same time, the application prospect of AIGC technology in traditional culture protection and innovation is discussed in the light of existing literature and research results.

II. CHARACTERISTICS AND CLASSIFICATION OF MONGOLIAN EMBROIDERY PATTERNS

The motifs of Mongolian embroidery have distinctive national characteristics and artistic values, and usually include animal and plant patterns, geometric shapes, and religious and daily life elements. These motifs, as shown in Figure 1, are not only visually appealing, but also carry rich cultural and historical information.

A. Pattern Characteristics

Mongolian embroidery patterns are especially rich and colorful in animal and plant motifs. For example, animal motifs such as butterfly, curly grass and lotus are commonly seen in Mongolian embroidery works, symbolizing the harmonious coexistence of Mongolian people and nature[1] . These patterns show the unique beauty and cultural connotation of Mongolian embroidery through fine stitching and use of colors. The animal and plant motifs not only show the beauty of nature, but also reflect the Mongolian people's reverence and dependence on animals, which played an important role in their nomadic life.

Geometric patterns also occupy an important place in Mongolian embroidery patterns. Geometric patterns such as diamonds, triangles, and waves not only increase the decorative and aesthetic appeal of embroidery works, but also have symbolic meanings. For example, the diamond pattern usually symbolizes prosperity and good luck, while the wavy pattern represents water and life. Geometric shapes are often used in embroidery to form complex patterns and motifs that are not only beautiful, but also contain deep symbolic meanings, demonstrating the Mongolian people's pursuit of order and symmetrical beauty.

Religious elements are also reflected in Mongolian embroidery patterns. Religious elements such as Baoxiang flower pattern, Pushe pattern, Lansa pattern and so on reflect the religious beliefs and spiritual pursuits of the Mongolian people. These patterns are preserved on clothes, tapestries and other daily items through embroidery, which is both practical and has the function of cultural inheritance. Religious motifs are often combined with other elements to form a unique artistic style that expresses the rich spiritual life of the Mongols and their devotion to religion.

Fig 1: Display of Patterns

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A. Classification of Mongolian Embroidery

Mongolian embroidery can be categorized into various types according to its application fields and craft characteristics, mainly including dress embroidery, household goods embroidery and religious goods embroidery, as shown in Figure 2.

Costume embroidery is the most common type of Mongolian embroidery and is widely used on traditional costumes such as Mongolian robes, belts and hats[2] . This kind of embroidery usually uses bright colors and fine stitches to highlight the identity and status of the wearer. Mongolian embroidery is not only decorative and beautiful, but also a symbol of identity and social status. For example, clothes with complicated patterns and expensive silk threads usually belong to nobles or members of high social status.

Household goods embroidery includes all kinds of fabrics for decorating the home, such as tablecloths, pillowcases, tapestries and so on. This kind of embroidery not only has practical functions, but also reflects the wisdom of Mongolian people's life and aesthetic interests through rich pattern designs. The patterns of household goods embroidery are often full of symbolism, such as flowers, animals and other patterns symbolizing happiness, health and prosperity.

Religious goods embroidery is mainly used in religious ceremonies and rituals, such as Buddha cloaks and sutra streamers. With its solemn patterns and rigorous craftsmanship, this type of embroidery conveys the Mongolian people's reverence and faith in religion. Religious embroidery works often use intricate patterns and high-quality materials to ensure their solemnity and sacredness in religious ceremonies.

Fig 2: Item Display

III. THE WORKING PRINCIPLE AND WORKING CHARACTERISTICS OF AIGC

A. Fundamentals of AIGC Technology

The fundamentals of Artificial Intelligence Generated Content (AIGC) technology stem from the development and evolution of Generative Adversarial Networks (GANs).GANs consist of two parts, the Generator and the Discriminator, a structure first proposed by Ian Goodfellow et al. in 2014. The Generator is responsible for generating realistic-looking images, while the Discriminator evaluates whether the image generated by the Generator is similar to the real image[3] . This competitive framework allows GANs to gradually improve the quality of the generated images during the training process until it is impossible to tell the difference between the generated and real images by the discriminator. During the training process of GANs, generators and discriminators collaborate and compete with each other through adversarial learning. The generator receives a random noise vector as input and tries to generate a realistic image to confuse the discriminator. The discriminator, in turn, receives inputs from both the generator and the real image and tries to distinguish between them. This adversarial training allows the generator to continuously optimize its ability to generate images, while the discriminator continuously improves its recognition ability, driving the entire system to a dynamic equilibrium.

B. Current Status of AIGC Image Generation Research

Artificial Intelligence Generated Content (AIGC) technology is well known for its wide range of applications in the field of image generation and design, demonstrating great potential not only in the technology industry, but also in artistic and cultural creations[4] . Before exploring the application of AIGC technology in Mongolian embroidery pattern generation and innovation, it is necessary to gain a deeper understanding of its application in the technological, market and generative fields and how these experiences can shed light on our research. Finally, with the help of AIGC technology for Mongolian embroidery pattern generation and innovative design, the overall framework of AIGC image generation is shown in Figure 3.

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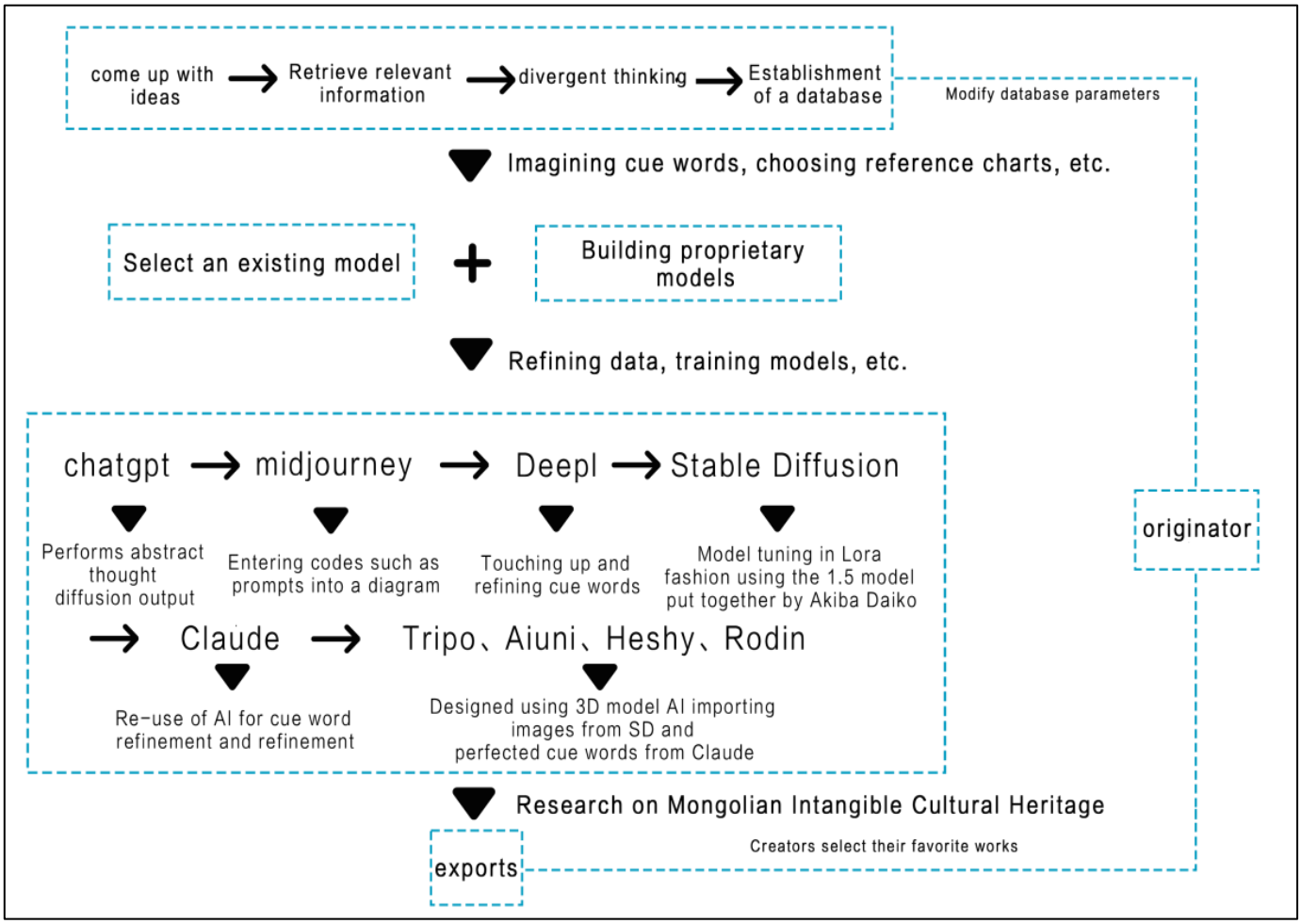

Fig 3: AIGC Technology Flow

(1) In terms of the technical field, the development of AIGC technology has benefited from the introduction and evolution of Generative Adversarial Networks (GANs) and Diffusion Models.GANs were proposed by Goodfellow et al. in 2014, and contain two parts, a generator and a discriminator.Through adversarial training, the generator gradually learns to generate lifelike images, whereas the discriminator continuously improves its discriminator ability. In recent years, GANs have been increasingly used in image generation, especially in the field of art creation and design. For example, a research team from Shanghai Jiao Tong University proposed Cultural Adversarial Networks (CANs), which can not only generate realistic images, but also generate images of different cultural styles based on input style labels. In this way, CANs are able to reproduce the style of traditional Chinese paintings while incorporating modern art elements to generate images with unique artistic value.

Diffusion Models (DDMs) is another important AIGC technique, and the DDPM model proposed by Ho et al. in 2020 gradually restores high-quality images by simulating the process of adding and removing noise on images[5] . The further improvement of this model, Latent Diffusion Models (LDMs), applies the diffusion process to the latent feature space after image coding, which not only improves the model performance, but also dramatically improves the effect of image generation. For example, a research team from Zhejiang University used LDMs to develop a new type of cultural relic restoration technology, which generates high-quality restored images by simulating the features and textures of historical relics, providing a new technical means for cultural heritage protection. The development of these technologies has laid a solid foundation for the application of AIGC in the field of image generation.The combination of GANs and diffusion models in the field of art creation and design not only promotes the advancement of image generation technology, but also provides a new method for the digital preservation and re-creation of traditional culture.

In recent years, the application of GANs and diffusion models in the field of AIGC has been expanding, not only achieving remarkable results in image generation, but also showing great potential in text generation, audio synthesis and video production. For example, a research team from Peking University has developed a novel poetry generation model using GANs, which is capable of generating poetic works that conform to rhymes and themes by learning a large amount of data from ancient poems. The successful application of this technology demonstrates the prospect of AIGC's wide application in different content generation fields.

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(2) From the perspective of market area, the industrial application of AIGC technology has attracted extensive attention from well-known companies at home and abroad. Huawei, Baidu, Tencent, and other companies have carried out a lot of R&D work in this field, which has promoted the rapid development and application of AIGC technology. For example, new-generation AI tools such as Dharma Academy and Tencent AI Lab are favored by designers, which are based on AIGC technology and can quickly generate high-quality images, greatly improving design efficiency. These tools are not only able to understand and reproduce complex artistic styles through deep learning algorithms, but also generate personalized artworks according to user needs, thus opening up new creative avenues in the design field.

Leading design firm Inspiration Technologies announced a multi-million dollar seed funding for its highly regarded AIGC product results. This financing not only demonstrates the market's confidence in AIGC technology, but also provides important support for further development and application of AIGC technology. By integrating advanced AIGC algorithms, Inspiration Technology's products are able to provide users with efficient and personalized design solutions, which significantly improves the efficiency and creativity of design work.2021 At the China International Art Fair, the AI painting "Landscape State of Mind" was sold at a high price, which marks the gradual increase of AIGC's recognition in the art market. This event not only demonstrated the great potential of AIGC technology in art creation, but also marked the market's recognition and acceptance of works created by artificial intelligence. Generated through AIGC technology, Landscape State of Mind combines the artistic style of traditional Chinese painting and the creativity of modern technology, achieving a perfect combination of tradition and modernity.2022, at the Beijing Art Festival, the painting "Digital Dreaming", a collaborative work between human and machine, won the Grand Prize in the category of digital art. This work, done by human artists in collaboration with AIGC technology, demonstrated the infinite possibilities of artificial intelligence in art creation through the fusion of traditional art styles and modern creative concepts. The success of "Digital Dream" not only demonstrates the innovative ability of AIGC technology in art creation, but also provides a new direction for future art creation.

(3) Generating the design field perspective, AIGC technology has brought new dynamics to design. The design process is complex, and the development of computer technology provides the possibility of a paradigm shift in design. Design is a complex solution process, the introduction of AIGC technology has led to a new "design turn"[6] . In the coloring of patterns task, the automatic coloring and style migration of dress patterns is achieved by Conditional GANs, which overcomes the problem of lack of fabric texture features in the traditional methods of color overflow and style migration.

For example, in the study of Fudan University, the research team used AIGC technology to digitize traditional blue and white porcelain patterns and generated new 3D porcelain designs based on them, which greatly improved design efficiency and innovation. At the level of academic research, scholars focus on the integration of traditional Chinese culture and AIGC technology, but the research on traditional Chinese large-format works is still insufficient. For example, a research team from Beijing Normal University digitally analyzed and generated large-format Chinese calligraphy works through AIGC technology, and although certain results were achieved, further optimization is still needed in the details of strokes and ink performance. This shows that there are still many technical difficulties to be solved in the process of applying AIGC technology to traditional culture. In the field of generative design, the multi-faceted application of AIGC technology has brought profound changes to the design process. First of all, the advancement of automatic coloring and style migration technology enables designers to handle complex patterns more efficiently.

In the study of Mongolian embroidery pattern generation and innovation, drawing on the successful experience of AIGC technology in the above fields can provide us with important insights. Through high-precision image acquisition, deep learning and generation of adversarial networks, AIGC technology can effectively solve the challenges in traditional embroidery pattern generation and realize efficient design innovation, as shown in Figure 4. For example, a research team from Inner Mongolia University generated new Mongolian embroidery patterns through AIGC technology, which not only retained the essence of traditional culture, but also combined with modern design concepts, and were widely acclaimed. Through digital preservation and dissemination technologies, this precious cultural heritage can be protected and passed on, and its sustainable development in modern society can be promoted.

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Fig 4: Demonstration of Image Generation

IV. AIGC MONGOLIAN EMBROIDERY REDESIGN IDEAS

This study intends to utilize AIGC technology to assist designers in the generation and innovative design of Mongolian embroidery patterns, specifically, to use the technology to design embroidery patterns with traditional Mongolian styles and apply them to cultural and creative products[7] . Currently, the AIGC model is mainly data-driven and the main learning object is modern design patterns, paying less attention to Mongolian traditional embroidery patterns. Similar to modern pattern design, Mongolian traditional embroidery patterns also have limited classic works, so the model needs to have certain image learning ability. Unlike modern pattern design, Mongolian traditional embroidery patterns have complex and diverse compositions and layouts, usually containing rich animal and plant patterns and geometric shapes.

The current AIGC learning model can support a small number of images for learning, but the complexity and diversity of Mongolian embroidery patterns tend to make the model lose important style information and content information during the learning process, thus increasing the difficulty of model learning and making it difficult to realize an effective aesthetic model[8] . Based on this this study proposes to use the method of image saliency detection to process Mongolian embroidery patterns. Firstly, the significant regions in the original embroidery pattern are determined; then, the pixel points with different significance are binarized and rounded off with the help of optimization algorithm, and the pattern is cropped to get the trainable embroidery pattern subgraphs; finally, the Mongolian embroidery pattern model is trained with the help of the AIGC generation algorithm, and it is applied to the cultural and creative design, and the overall process is shown in Table 1 below.

Table 1: Description of the Design Process Framework

Module (in software)	Description of the Framework
Data Acquisition and Processing	A large amount of Mongolian embroidery pattern data was collected by high-definition camera equipment and optimized using image processing software, including steps such as removing noise, adjusting color balance, and correcting image distortion to ensure the clarity and accuracy of the data.
Model building and training	Generative Adversarial Networks (GANs) and Variational Auto-Encoder (VAE) models are constructed and optimized using image saliency detection methods. By learning and training a large number of Mongolian embroidery patterns, the models are able to generate new patterns with traditional styles while incorporating modern design concepts.
Diffusion model fine-tuning	Stable Diffusion 1.5 was used as the baseline model and fine-tuned using the Low-rank Adaptation of Large Language Models (Lora) method. The model was trained through a forward process (converting images to noise) and a backward process (reducing noise to images) to master image generation.
Keyword Extraction and Model Training	Keywords were extracted from the collected Mongolian embroidery patterns and combined with illustrations for large model training. The model is built and fine-tuned by safetensors files to ensure that the model can generate high quality Mongolian embroidery patterns.
Application of Generated Patterns	The generated embroidery patterns are utilized for the design of cultural and creative products, such as clothing, accessories and household goods. These products not only retain the unique style of traditional Mongolian culture, but also incorporate modern design concepts to enhance their market competitiveness and cultural dissemination effect. The controllability and quality of the generated patterns are improved through text-guided and image+text co-guided approaches.

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Design Practice and Experimentation	Various design practices are carried out to verify the application effect of the generated Mongolian embroidery patterns in different cultural creative products. The experimental results show that the patterns generated based on AIGC technology maintain the characteristics of traditional patterns in form, and show more diversified design styles through the creative generation of the model, with high visual appeal and market response.
Analysis and improvement of results	The experimental results are analyzed in detail to assess the actual effect of AIGC technology in Mongolian embroidery pattern generation and innovation, summarize its advantages and shortcomings, and put forward suggestions for improvement. At the same time, the application prospect of AIGC technology in traditional culture protection and innovation is discussed in the light of the existing literature and research results.

A. Detailed Program Analysis

In the process of generating Mongolian embroidery patterns using AIGC technology, the first thing that needs to be solved is how to make the model effectively learn and understand the unique style and elements of Mongolian embroidery. Mongolian embroidery is known for its rich animal and plant patterns, geometric shapes and religious motifs, and these elements are not only highly recognizable visually, but also carry deep cultural connotations. In order to achieve this goal, this study will use the method of image saliency detection to optimize the learning process of the model.

Image saliency detection is an image processing method based on the mechanism of visual attention to highlight important detail information by detecting the most visually appealing regions of an image. For Mongolian embroidery patterns, these salient regions usually contain the main pattern and color elements[10] . First, we will perform saliency detection on Mongolian embroidery patterns to identify the most important parts of the pattern. Next, the pixel points with different saliency are binarized using an optimization-seeking algorithm to determine which regions are cropable. By this method, we can effectively avoid losing key stylistic information during pattern cropping, thus preserving the overall beauty of the pattern.

After completing the model training, we apply the generated embroidery patterns in cultural creative design. The patterns generated by AIGC technology can be used to design various cultural creative products, such as clothing, jewelry, and home furnishings. These products can not only reflect the artistic value of traditional Mongolian embroidery, but also meet the modern consumers' demand for personalization and diversification. Through the application of digitizing technology, the traditional embroidery patterns are able to take on a new life in modern design, and the framework of the 2D image process is shown in Figure 5.

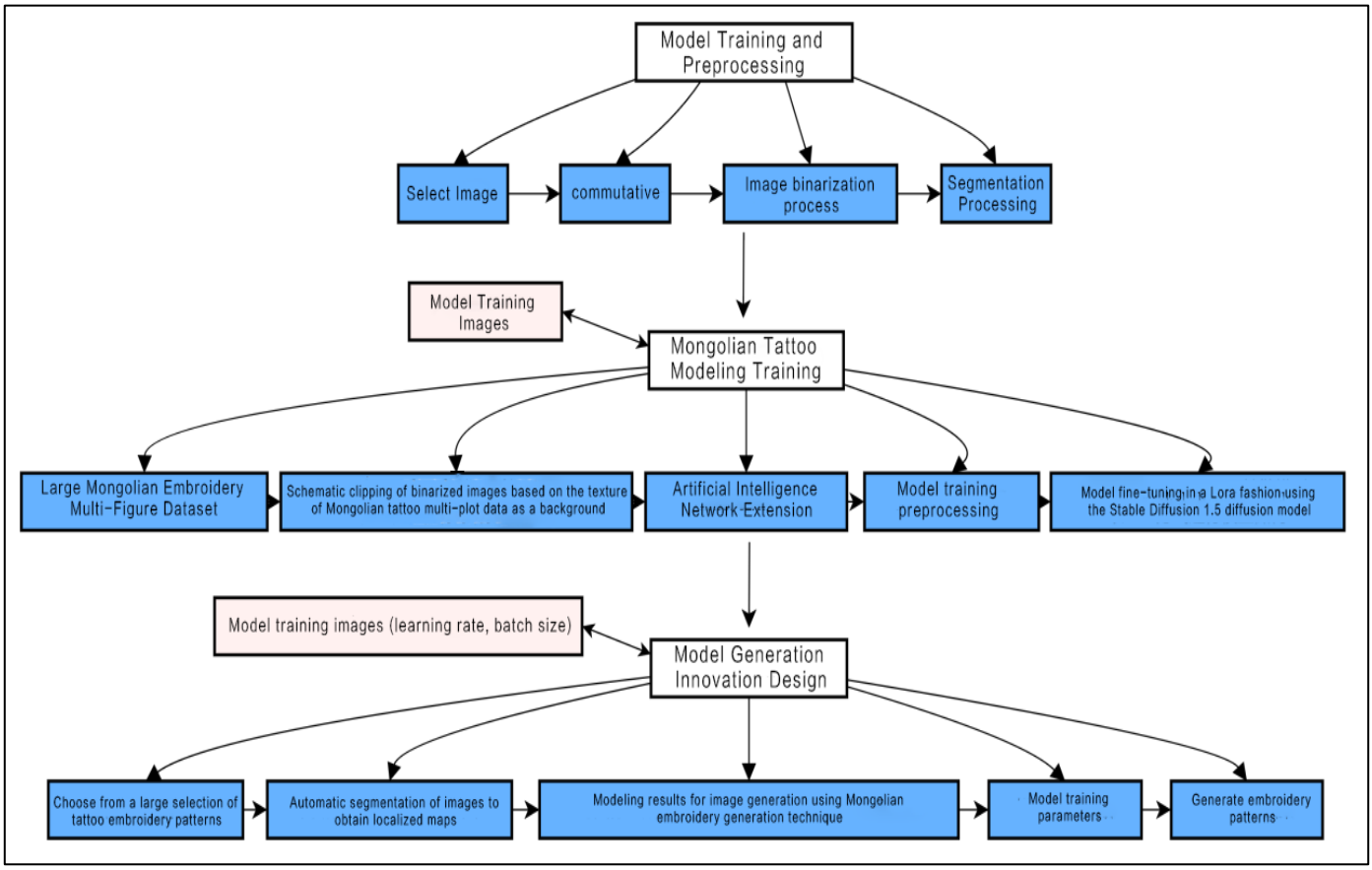

Fig 5: Generated by Chatgpt and Draw.io Together

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B. Model Selection and Training

Currently active programs in the application market, such as Stable Diffusion WebUI, ComfyUI and Midjourney, are trained based on the diffusion model. The core learning idea of the diffusion model is iterative optimization, i.e., gradually adding noise to an image, and training the network to master image generation through an iterative process of adding and removing noise[11] . Specifically, the learning of the model is divided into two processes, one is to transform the image into noise, and the other is to restore the noise to the image, for example, the noise display in the **AIGC** Chinese Aesthetics Cultural and Creative Design Research by Song Yu of the University of Science and Technology Beijing, as shown in Figure 6. Ultimately, the image generation function of these models in the process of using them is actually the display form of diffusion modeling. This study intends to use such diffusion modeling methods as a benchmark, get training data with the help of segmentation of Mongolian embroidery patterns, and use high-performance computing equipment to fine-tune the model, and then conduct model training for embroidery pattern generation. The application and advantages of this method in Mongolian embroidery pattern generation and innovative design will be specifically discussed below.

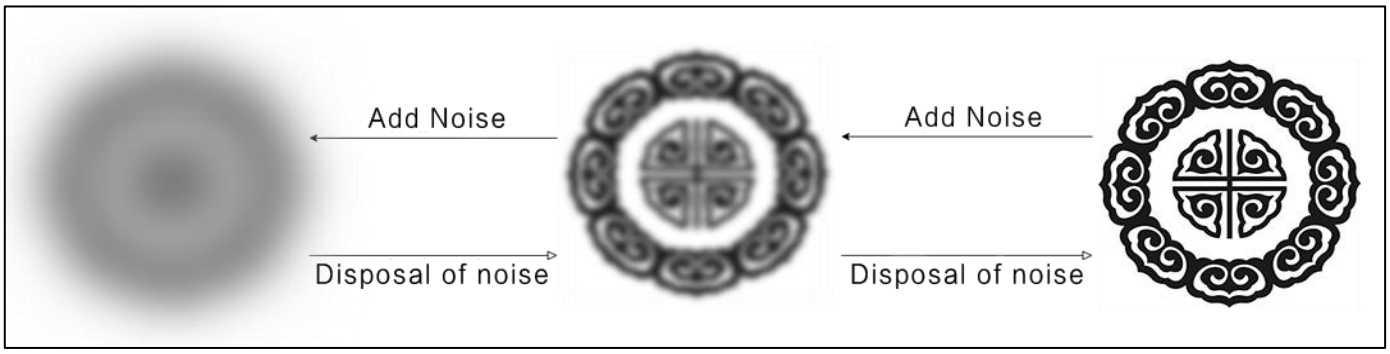

Fig 6: Schematic Diagram of the Diffusion Model
(Reference Source: Author Song Yu)

V. PATTERN GENERATION WITH THE EXAMPLE OF MONGOLIAN HAMUR PATTERNS

As a unique traditional pattern, Mongolian Hamur pattern has deep cultural connotation and unique artistic style. With the development of AIGC technology, especially the pattern generation techniques based on diffusion models, such as Stable Diffusion WebUI, ComfyUI and Midjourney, have demonstrated great potential in the field of pattern generation. In this paper, we will explain in detail the specific applications of these techniques in Mongolian Hamul pattern generation.

A. Methodology and Process

High-quality image data of Mongolian hamul patterns were collected. These images were digitized by a high-definition scanner and pre-processed, including denoising, color correction and geometric distortion correction, to ensure the clarity and accuracy of the data. In order to improve the learning effect of the model on the Hamur pattern, the images were subjected to saliency detection and segmentation. The image is processed by Otsu's algorithm (Otsu's method) to segment the Hamur pattern part of the complex graph. The segmented image will be used as training data for the model to ensure that the model can focus on learning and generating the key features of the Hamul pattern. In this study, seven Hamur patterns are segmented from the complex graphs as shown in Fig. 7 . The keywords are extracted for each of these graphs and the large model is trained with the combination of graphs and text. The model building is completed by modeling through safetensors file and placed into the pathway.

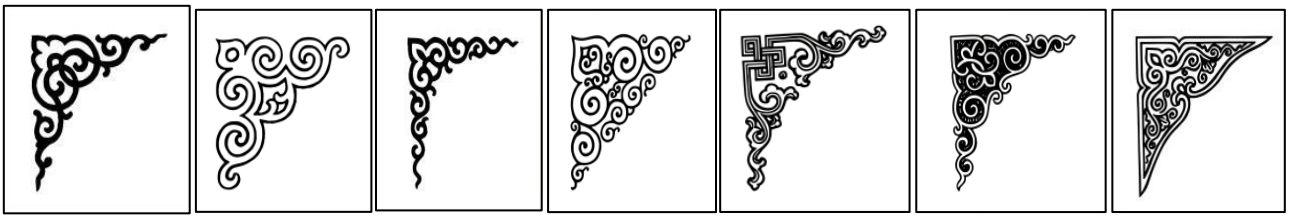

Fig 7: Hamur Pattern

In this study, Stable Diffusion 1.5 was chosen as the baseline model and fine-tuned using the Low-rank Adaptation of Large Language Models (Lora) method. The specific steps are as follows:

- The preprocessed Hamour pattern image is gradually added with noise to generate a series of noisy images.
- The noisy image is gradually reduced to a Hamul pattern image through a denoising process. This process is repeated until the model is able to generate high quality hamul pattern.

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During model training, key parameters such as learning rate, sampling method, maximum number of iterations and number of single training data are set. The learning rate is set to 0.0005, sampling method is selected as Euler and the number of sampling steps is 50. the maximum number of iterations is set to 200, 600 and 800 to conduct multiple experiments to find the best combination of training parameters.

After data preparation, the model was fine-tuned using high-performance computing equipment. The purpose of the fine-tuning is to adapt to the specific style and characteristics of the Mongolian Hamur pattern so that the model can generate high-quality Hamur patterns. Through iterative optimization, the parameters of the model are adjusted so that it gradually learns the details and styles of the Hamur pattern in the process of noise addition and denoising. During the training process of the model, image processing is carried out through two stages: forward and backward. The forward process is to gradually add noise to the original image to generate a series of noisy images; the backward process is to gradually reduce the noisy image to a high-quality Hamur pattern through the denoising process. With this training method, the model is able to recognize and generate the key features of Hamul pattern in a noisy environment[12-17] .

In order to ensure the stability and generation of the model, this study used a combination of training parameters for the experiments. For example, different maximum iterations (e.g., 50, 200, 600, 800) were set to observe the performance of the model in different training stages, as shown in Table 2. The experimental results show that the model's generation quality and detail retention for Hamur pattern significantly improve with the increase of the maximum number of iterations. In addition, the effect of training using segmented maps is better than that of training directly using long format, which indicates that image segmentation and saliency detection play an important role in improving the model learning efficiency and generation quality.

Table 2: Iterative Experimental Data

clue word	50 iterations	200 iterations	600 iterations	800 iterations
Hamur pattern Traditional Culture Mongolian Embroidery		 Symmetry, repeatability, bipartite continuity, hamming, quadratic continuity.	 Rectangles, symmetry, repetition, hamul patterns, Mongolian pattern combinations, adding hamul patterns in the center and other pattern fills.	 Rectangles, symmetry, repetition, hamul patterns, Mongolian pattern combinations, adding hamul and other pattern fills in the center, and coloring.

Process: chatgpt touch up prompt words and prompt sentences; Stable Diffusion WebUI generates localized diagrams and approximate effect diagrams; ComfyUI generates detailed drawings using exclusive models.

B. Hamour Pattern Innovation Generation

After completing the model training, the generated Hamur pattern is utilized for creative design. The patterns generated by AIGC technology can be used to design various cultural and creative products, such as clothing, jewelry, and home decorations. These products not only retain the unique style of traditional Mongolian culture, but also incorporate modern design concepts to enhance their market competitiveness and cultural dissemination effect. For example, when designing apparel products, the generated Hamur pattern can be applied to fabric printing, embroidery and clothing accessory design to show the unique beauty of Mongolian embroidery through a variety of craftsmanship, as shown in Figure 8.

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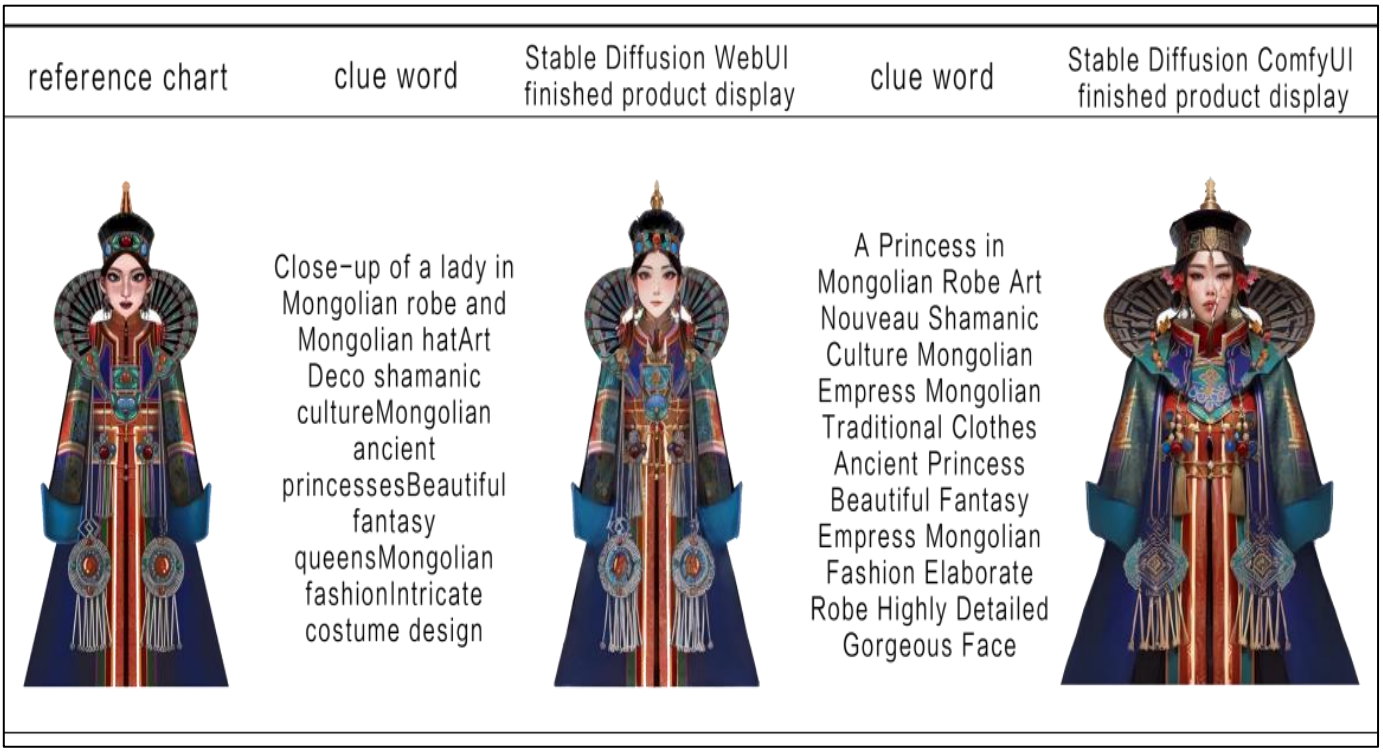

Fig 8: Drawing Generation Display

In order to ensure the controllability of the generated patterns, this study used a variety of control methods for the experiments, including the use of textual guidance and the use of image and textual co-guidance. Using text guidance alone, the generated images have more room for imagination in terms of content. This approach helps designers to brainstorm and expand their ideas. For example, when generating the Mongolian Hamur pattern, keywords such as "Hamur pattern", "geometric pattern", "traditional embroidery", etc. can be input to guide the model to generate the relevant pattern[17-21] .

The use of "sketch + text" co-prompting allows for more constraints to be added to the generated image, making the AI-assisted creative process more manageable. By providing sketches, the model can refer to specific graphic outlines during the generation process, and at the same time combine with textual descriptions to generate patterns that are more in line with expectations. For example, when generating a Hamur pattern, the designer can provide a sketch, labeling the main geometric shapes and layouts, while entering keywords such as "symmetry" and "grassland elements". The model will generate a high-quality pattern in the Hamul style based on this guiding information.

During the model training process, experiments were conducted using the above mentioned control methods to generate Hamur patterns with various styles and layouts. The experimental results show that the patterns generated using image and text co-guidance are more in line with expectations in terms of details and overall layout, and the generation results are better than those of text-only guidance. Analysis of the experimental data reveals that the model's semantic retention of the generation of the guiding words and the aesthetic style of learning are improved with the increase of the maximum number of iterations, as shown in Table 3.

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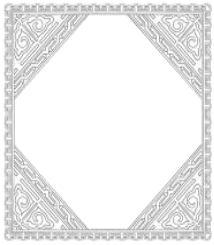
Table 3: Experiments on Different Cue Word Generation

General cue words, diagrams to produce diagrams	line drawing output	imagery development	assembled phonograms	Finished product output
Best quality, masterpiece, colorful, detailed, 8K texture, 1.15 size intricate detail Mongolian embroidery, soft natural light, soft colors, ray tracing, cinematic lighting, bloom effect, volumetric light, glass ring texture pattern generation, hamul pattern 			 Rectangles, symmetry, repetition, hamul patterns, Mongolian pattern combinations, center additions of hamul patterns and other pattern fills, black and white line drawings.	 Rectangles, symmetry, repetition, hamul patterns, Mongolian pattern combinations, adding hamul and other pattern fills in the center, and coloring.
General cue words, diagrams to produce diagrams	line drawing output	imagery development	assembled phonograms	Finished product output
Generates a group of detailed, high-quality images showing a set of square motifs specifically designed to demonstrate the symmetrical, repetitive attributes of the Mongolian people, especially the complex Hamur pattern. The scene consists of a centrally located person wearing a Mongolian robe, surrounded by symmetrical geometric shapes, floral motifs, and animal designs. These motifs are colorful and self-determining, reflecting the harmony between nature and spirituality in Mongolian culture.	 Symmetry, repetition, triangles, hamul patterns, and Mongolian pattern groups.	 Square, symmetry, repetition, hamul pattern, Mongolian pattern combinations, center empty self.	 Squares, symmetry, repetition, hamul patterns, Mongolian pattern combinations, adding a blank inside the circle in the center, and using hamul and other pattern fills around the circle.	 Square, symmetry, repetition, hamul pattern, combination of Mongolian patterns, figure added to the center, figure to be dressed in Mongolian clothes, have a distant view, and coloring, use of dark blue, gold, and so on.
Process: chatgpt touch up prompt words and prompt sentences; Stable Diffusion WebUI generates localized diagrams and approximate effect diagrams; ComfyUI generates detailed drawings using exclusive models.				

C. Embroidery Design Practice

In order to explore the application of diffusion modeling in cultural creative design, we first collected and organized a large number of Mongolian embroidery patterns. Hamur patterns are traditional Mongolian decorative patterns with strong national characteristics and historical and cultural connotations. We take these patterns as training data and use tools such as Stable Diffusion Stable Diffusion WebUI, ComfyUI and chatgpt to train a diffusion model capable of generating images in the style of Hamur patterns.

In the design practice, we use Hamul pattern as the training data for generating experiments. The generated image not only maintains the symmetry and geometric beauty of the original Hamur pattern, but also shows rich variations in color and details. This dynamic generation based on Hamur patterns not only highlights the artistic value of traditional culture, but also provides new creative inspiration for modern design.

In order to further validate the application of diffusion modeling in cultural and creative design, several design practice cases were conducted. The innovative design generated based on Mongolian embroidery is shown in Figure 9. As can be seen from the figure, the generated embroidery pattern not only maintains the characteristics of traditional patterns in form, but also shows more diversified design styles through the creative generation of the model. There is a strong sense of geometric beauty and color hierarchy in the generated pattern, which makes the innovative design more attractive visually. In design practice, the Hamur pattern generated by the diffusion model is applied to different innovative designs, such as clothing, jewelry items and so on. The generated patterns are not only rich in the flavor of traditional culture, but also able to meet the needs of modern aesthetics through changes in color and graphics. Compared with the traditional design of single style, the patterns generated based on the diffusion model have higher flexibility and adaptability. These designs not only reflect the classic elements of Mongolian nomadic culture, such as symmetry, simplicity and cultural connotations, but also show a unique modern sense through the innovation of diffusion modeling. The addition of character elements makes the picture more vivid, while the pure texture design is full of the atmosphere of nomadic culture.

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Fig 9: Innovative Design Showcase

VI. CONCLUSION

In this study, we explored the application of generative artificial intelligence (AIGC) techniques in Mongolian embroidery pattern generation and innovative design, and achieved remarkable results. By using AIGC techniques, especially Generative Adversarial Networks (GANs) and Variable Auto-Encoders (VAEs), we successfully realized the efficient generation and innovative design of Mongolian embroidery patterns. The experimental results show that the embroidery patterns generated based on AIGC technology not only retain the unique style of traditional Mongolian patterns, but also incorporate modern design concepts, which greatly enhances the market competitiveness and cultural dissemination effect of cultural and creative products. In all aspects of data collection, model training and design practice, we continuously optimize the technical methods to ensure that the generated embroidery patterns meet high standards in terms of visual effects and cultural connotations. This study not only solves the problem of time-consuming and low efficiency of traditional embroidery pattern design, but also provides a new path for the digital protection and modernization application of Mongolian embroidery.

In the future, AIGC technology is expected to play an important role in the protection and innovation of more traditional cultural heritage. By continuously upgrading the technology and optimizing the application scheme, we can further promote the in-depth integration of traditional culture and modern science and technology, and realize the

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sustainable development and wide dissemination of cultural heritage. This study provides a valuable reference for the protection and innovation of other traditional cultures, and demonstrates the great potential and broad prospects of AIGC technology in the field of cultural creative design.

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