



Research on the Innovation and Development of Su Embroidery Design Based on LoRA Fine-Tuning Model

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Abstract. This article discusses the contemporary Suzhou embroidery craftsmanship path based on the innovative development of artificial intelligence and the technical research of the LoRA fine-tuning model. It studies the assistance of artificial intelligence technology to Suzhou embroidery technology from a detailed perspective. The LoRA fine-tuning model is used in the process of improving Suzhou embroidery design to enhance the quality and design innovation of Suzhou embroidery. While increasing the efficiency of artificial work with the LoRA fine-tuning model, it also adds to the artistic and cultural connotations of Suzhou embroidery. Finally, it elaborates on how to apply the LoRA fine-tuning model in Suzhou embroidery design to improve the efficiency of artificial work and innovate the design. Based on a certain innovative practice, it has achieved good application results. Summarizing the experience with examples can provide effective reference and inspiration for the modernization development of traditional craftsmanship.

Keywords: Su embroidery; LoRA fine-tuning model; Design innovation; Artificial intelligence; Traditional craft

1 Introduction

Yao Jianping: Let Su embroidery become a "golden microphone" for telling good Chinese stories^[1]. On the one hand, traditional culture should be better integrated into the lives of the people in the digital age, and the transmission efficiency and influence of intangible cultural heritage should be improved through modern scientific and technological means, so as to make traditional culture such as Su embroidery closer to the lives of the people and enhance its awareness and identity in the society. On the other hand, it is necessary to promote the new transformation of traditional culture, and encourage non-inheriting people to use modern tools to innovate the design of Su embroidery products on the basis of adhering to the tradition, combining with modern aesthetics and market demand^[2].

At present, the inheritance of traditional intangible heritage culture of Su embroidery is urgent. The traditional inheritance skills of contemporary Su embroidery can no longer fully meet the needs of consumers for beauty in the new era. Secondly, due

to the time-consuming production and design of Su embroidery and the high cost of production, Su embroidery can no longer remain in People's Daily

life. In addition, the change and development of The Times and the progress of science and technology are both opportunities and challenges for the progress of traditional intangible heritage culture, especially the huge impact of AI to the traditional intangible heritage culture, and AIGC technology is just a rare good opportunity. For Su embroidery, it is fully able to create a new style that has been tried by the team of Zhong Ming, the founder of Shu Jing Museum, since 2016. Combined with AIGC technology to do Shu embroidery design mode, AIGC technology will be used to quickly transform the customer's photos, patterns, etc. into exquisite design drawings, and can save a lot of hand-drawing time, but also to ensure that each work is unique^[3]. It can be seen that AIGC technology can completely solve the problems existing in Su embroidery, such as single traditional inheritance techniques, limited design ideas, shrinking market and stagnating process. Its innovative ways and new ideas can be well applied to the innovation and development of Su embroidery traditional intangible heritage culture. Based on this, the author hopes that on the basis of this research, By using LoRA fine-tuning model, AIGC technology is applied to the design innovation of Suzhou embroidery to explore a new development path for the revitalization of Suzhou embroidery.

2 Current Status and Challenges of Suzhou Embroidery's Inheritance Technology

(1) The historical inheritance of Su embroidery

Su embroidery, known as one of the four famous embroiderings in China, originated in Wuxian County, Suzhou during the Spring and Autumn Period, and was mainly used for clothing. With the progress of The Times, in the Tang and Song dynasties, with the improvement of life needs and the change of social status, the appearance and technology of Su embroidery reached a certain height. It was gradually increased by the influence of literatorship painting, which created the uniqueness of the inner artistic mood and painting that emphasized the shape and beauty of Su embroidery, and was later favored by the court clothing and some decorations. In addition, the Su embroidery of this period was widely used overseas as people's collection and appreciation concept and the wind of fun prevailed, especially in the late Qing Dynasty and the Republic of China. The Ming and Qing dynasties were the golden age for the development of Su embroidery. During this period, many famous works were born, and a large

number of embroidery artists and national craftsmen were produced. Suzhou, the birthplace of Suzhou embroidery, became the center of Jiangnan silk industry. It is because of painting developed to promote the improvement of the Suzhou embroidery art, in the meantime, painting embroidery embroidery fusion, form "to the needle painting", the characteristics of the "wonderful artical excelling nature".

Since modern times, Su embroidery has continued to advance and develop under the leadership of a group of new people such as Shen Tao and Jin Jingfen, and even

boldly tried to combine Chinese and western art to show a new type of Su embroidery with a sense of The Times. With the precipitation of thousands of years and the efforts of several generations, the craft level of Su embroidery has reached an unprecedented height, and now it can be said to be perfect. With thousands of years of history and tradition, Su embroidery is still an important symbol of the Chinese

3 Challenges Faced by Su Embroidery

1. The lack of innovation of Su embroidery pattern content

Su embroidery is one of the four famous embroiderings in China. Due to the lack of new pattern content for people to consume, it is also an important reason for the inheritance and development of Su embroidery at present. In this information age, young people have increasingly diverse demand for Su embroidery products, they need some traditional decorative and gift products. They need not only some traditional decorative and gift products but also some products with fashion elements and practicality. However, traditional Su embroidery patterns are mainly based on landscape, flowers and birds, characters and other themes, and do not keep up with the new needs of current consumers, so it is difficult to be loved by the majority of young groups.

2. Difficulties in inheriting the needling skills of Su embroidery

There are many names of Su embroidery stitches, which can be divided into 9 categories and 43 kinds^[4]. These include the full stitch, the brandish stitch, the trowel stitch, the application stitch, the random stitch, the rolling stitch, the cutting stitch, the flat-gold stitch, the dotting, the beating, the tying, the net stitch, the ice grain stitch, the cross-stitch, the brocade, the scale carving stitch, the wool applying stitch, the bead piercing stitch... There are also direct embroidery, pan needling, auxiliary needling, and so on. As for the needling techniques of Suzhou embroidery around the country, such as Wuxi fine embroidery, Nantong imitation embroidery, Yangzhou embroidery, including all kinds of needling techniques in northern Jiangsu cities, these needling skills are very complex and subtle, and these are taught and learned by teachers and apprentices, and are also taught in a teacher-apprentice system. Among them, each stitch has its own difference and difficulty. Almost all of these methods and means are summarized in the process of Su embroidery, under the wisdom of the past generations of Su embroidery people. On the other hand, the addition of LoRA fine tuning model can also be regarded as a new solution to the problem of how to inherit.

3. The situation of single transmission form of Su embroidery

The communication mode of Su embroidery is still relatively single, mainly relying on traditional exhibitions, exhibitions in museums and handicrafts markets. The traditional communication mode is mainly based on display, and it is not really combined with the audience. To some extent, it cannot let more people participate in it, and it is difficult to be understood by more people due to the communication channel. In particular, it is difficult for young people to access the relevant information of Su embroidery.

4. The deteriorating business environment of the inheritors of Su embroidery

In the new era, the development of Su embroidery faces two major problems: inheritance and survival^[5]. The first is the shortage of Suzhou embroidery inheritance talents and the problem of technical fault. At present, with the acceleration of modernization, many young people are reluctant to enter the traditional industry, leaving their hometown to follow the current and flocking to the city for future development. As a result, many traditional handicrafts, including Su embroidery, have lost their inheritance chain, and many skills are difficult to continue. In the early 1980s, due to the growth of foreign trade, the lack of labor force and the loss of technology, the development of local Su embroidery production enterprises was hindered. Among them, although machines replaced manual drawing to speed up the process of plate making at the turn of the century, the government came to the rescue, the rise of Suzhou embroidery master studios at that time, and the prosperity of tourism at that time also promoted the inheritance and development of local Suzhou embroidery to a certain extent, it was still hard to escape the fact that the overall decline of Suzhou embroidery production industry in the past ten years^[6]. Suzhou Zhenhu, known as the hometown of Su embroidery, has a deep cultural heritage and a long history of Su embroidery. In fact, survey data show that there are only about 3,000 to 4,000 Su embroidery embroiderers in the local area, most of whom are aged 40-55 years old. There is a lack of highly educated employees without any form of formal education. Most of them are inherited from their families or learned to embroider after their own love. Because the salary of Su embroidery is relatively low compared with other jobs, and it takes more time to stitch a work well, there is no time arrangement for shutdown and holiday time arrangement for rest in the process, so it is more difficult for young people who want to engage in Su embroidery work^[7]. Generally speaking, it takes about 5 to 8 years to train a Su embroidery master. The economic development of Suzhou area is faster, and there are more employment opportunities. In a sense, more students who study related majors in Suzhou Professional colleges do not engage in Suzhou embroidery related industries after graduation, and the reserve professional strength is lack^[8]. At the same time, the development of Su embroidery also has the problem that the intellectual property rights are difficult to continue, because the creation of Su embroidery takes a long time and is relatively difficult to be imitated. Criminals steal their intellectual property rights by stealing or imitating, which will not only violate the interests of the inheritors of Su embroidery, but also may weaken their enthusiasm to inherit this ancient skill.

4 The Innovation Path of Su Embroidery Development in the Era of Artificial Intelligence

(1) AIGC software and the working principle of LoRA model

The combination of AIGC software and LoRA model has injected new vitality into Su embroidery design. AIGC software, also known as artificial intelligence generated content software, relying on deep learning algorithm, can create text, image, audio and other forms of content. At present, the mainstream core algorithm Diffusion mod-

el on the market is Stable Diffusion (sd). webui and comfyui are user interface tools developed on Stabel Diffusion. Although both of them are based on the sd model, there are obvious differences in their operation methods and performance patterns. For example, the basic working principle of webui visualization operation is that the user inputs information such as text, the model is loaded and configured, mapped to the latent space, iteratively refined by sampling, and then decoded to generate image output. Comfyui is a node operation, which is a bit more complicated than webui. Trained on massive datasets, these algorithmic models are able to understand and generate works that are comparable to those created by humans. The main working principle can be understood as data input, feature extraction, content generation, output and optimization. In THE FIELD OF SU EMBROIDERY DESIGN, AIGC SOFTWARE CAN HELP DESIGNERS TO QUICKLY create a variety of design schemes, WHICH can greatly reduce the design cycle. LORA(Low-Rank Adaptation) model, as a fine-tuning and lightweight fine-tuning method for pre-trained large models, reduces the number of training parameters by low-rank decomposition of the pre-trained model, and then reduces the burden of calculation and memory. In the research based on stable diffusion model, the application of LoRA fine-tuning model provides a new method for improving the quality of image generation. Specifically, LoRA technology is integrated into the U-Net network of the stable diffusion model, and the weight adjustment mechanism across the attention layer and the convolutional layer is optimized through low-rank decomposition, so as to enhance the performance of the model under specific tasks. In the cross-attention module, LoRA technology performs low-rank matrix factorization on the linear transformation of Query, Key and Value, so as to strengthen the guiding role of conditional information on image generation, so that the generated image is more consistent with the input text description. At the same time, the LoRA module is applied in the convolutional layer, and the low-rank weight is used to update and optimize the clothing texture, material and light and shadow details to further improve the accuracy and quality of the generated image. The combination of LORA model and large model enables the model to maintain high generation quality when dealing with complex tasks, especially showing significant advantages in generating complex clothing details or embroidery patterns and natural visual effects^[9]. For example, designers can use LoRA model to adjust the details of Suzhou embroidery design drafts generated by AIGC, optimize line thickness, color matching and pattern layout, so as to integrate modern aesthetic and innovative elements while retaining the essence of traditional craftsmanship^[10]. The introduction of digital technology not only improves the efficiency of Su embroidery design, but also opens up a new path for the inheritance and innovation of traditional crafts^[11]. According to the Convention for the Protection of Intangible Cultural Heritage of UNESCO, digital technology is an important tool for the protection and inheritance of intangible cultural heritage . Studies show that the application of artificial intelligence technology in traditional processes can effectively solve the problems of long design cycle, high cost and limited dissemination scope^[12]. Taking traditional Japanese craftsmanship as an example, AI technology has been widely used in kimono design, successfully attracting young consumers by generating diverse patterns and optimizing production processes. Similarly, the application of LoRA model provides a

referable example for the digital transformation of Suzhou embroidery, and promotes the deep integration of traditional crafts and modern technology. In addition, the advantages of LoRA model in cross-task generalization and privacy protection make it show strong application potential in multimodal tasks. For example, in tasks such as image segmentation and visual tracking, LoRA significantly improves task efficiency and accuracy by fine-tuning pre-trained models^[13]. The versatility and powerful capabilities of this technology provide technical support for the modernization of Su embroidery design, and also provide new possibilities for the global dissemination of traditional crafts.

Table 1. Differences between

Features	WebUI	ComfyUI
Interface design	Intuitive graphical interface for beginners to get started quickly	The node workflow interface, which requires manual connection of modules, is suitable for advanced users or scenarios that require highly customized processes
Performance	Higher hardware requirements (such as a larger video memory occupation), slow graphics output speed	Higher video memory utilization (minimum 3GB video memory can run), faster map
Flexibility	Extend functionality through plugins, but workflows are difficult to fully replicate	It supports custom nodes and complete workflow saving, and can reproduce the generation process 100%
Update and maintenance	The original version has been discontinued, and some branches (such as Forge) are still being optimized	Frequent updates (almost daily iterations), support for the latest technologies (e.g. SD3.5, new versions of ControlNet, etc.)

(2) AIGC software assisted Su embroidery pattern design process

Referring to the modeling method of generative AI such as Stable Diffusion and Lora fine-tuning, a Suzhou embroidery design methodology based on the combination of these two methods is proposed. In the first part, according to the content of the article and related information, the staff of Su embroidery used text and image to describe the content related to Su embroidery

The software will output the corresponding pattern image (including pattern theme, style, etc.) according to the specific title information. Then relevant personnel can make preliminary opinions or post processing and modification according to the generated content. (Note: This step can be simplified by a human drawing to simulate the process.) AI can freely play various forms of line, color, pattern distribution and style design according to the input image of human line art, giving more space to play on the basis of the simple and thick lines of the figure in the previous link. In the second

part, due to the characteristics of low-rank decomposition of LoRA model, it can quickly achieve the same effect as traditional Su embroidery in terms of lines, colors and pattern layout under the condition of ensuring excellent performance. According to the different requirements of the design, in the design debugging stage, the workers using Su embroidery can use LoRA's cross-task generalization ability to generate graphs from graphs, and then combine with ControlNet to lock and extract the generated pictures and transfer the style to realize the color editing of Su embroidery patterns. Different styles can be fused together to form a Su embroidery pattern with different style characteristics. At THE END OF THE DESIGN, THE final design DRAFT generated by AIGC IS MADE BY Suzhou EMBROIDERY artists, which greatly shortens the design cycle, enriches the design idea and connotation, improves the artistic value of the design, and is conducive to contributing to the modernization of Suzhou embroidery.

5 Innovative Practice of Su Embroidery Design based On LoRA Fine-Tuning Model

(1) Su embroidery pattern generation

LoRA fine-tuning model has accelerated the creation speed of Su embroidery patterns. Designers can obtain multiple initial patterns after inseting theme, style, color and other elements by using AIGC software such as StableDiffusionwebui or Comfyui. Because the LoRA model can adjust the lines, colors and layouts in different initial drawings, different types of the gallery can be freely selected and used by designers, so that different types of Su embroidery patterns can be adjusted. The above research finds that AIGC technology has been well applied in the field of art design, which provides some inspiration for the design of traditional crafts^[14]. In addition, the LoRA model is also versatile, enabling colorization from text to graph, from graph to graph, style transfer, and adding line art. Among them, it is also possible to add different style elements to form exclusive Su embroidery patterns. Scholars say: in some cases, it is a good choice to combine the two (traditional elements + modern style) to create more attractive works^[15]. On the basis of the previous section, the LoRA fine-tuning model is used to solve the problem of insufficient innovation of Su embroidery patterns. AIGC software and LoRA fine-tuning model are used to generate different pattern forms, which makes Su embroidery design easier to accept consumers' personalized and fashionable requirements, and makes Su embroidery products more competitive and attracts more young people's attention. Related research proves that AIGC can improve the innovation ability and market competitiveness of traditional process. The influence of AIGC technology on traditional process innovation^[16].

(2) Color optimization and matching

LoRA fine-tuning model is of great significance for Su embroidery color optimization, because the color matching of traditional Su embroidery mainly depends on the experience accumulation of Su embroidery women, but the Su embroidery colors in their hands are some traditional experience color schemes, which are more suitable for inheriting classic things. But for the diverse aesthetic needs of people now, In this

regard, people with a lot of color knowledge need to help to carry out innovative color matching work. Here, it is inseparable from LoRA's knowledge of Su embroidery and modern color, which brings us richer color matching. Through the pattern, it can more accurately reflect the primary and secondary style of some patterns. The color adjustment can also be more appropriate to show the emotion that the work wants to express, and improve the visual impact and appeal of the work for the artistic expression and expression of the emotion with reasonable color collocation^[17]. Moreover, the model can also simulate the color effect under various lighting conditions when drawing, and make the preview map of the finished product, so that the embroidery workers can match different embroidery colors in the most suitable position to meet the different use scenarios of the product. The science here fits with research showing that digitization is helping old skills keep up with The Times. Similarly, based on LoRA fine-tuning model, it is possible to customize the color scheme to meet specific Suzhou embroidery orders. For example, after analyzing user preferences and user needs, the color scheme required by a specific customer is produced for a Suzhou embroidery order. This ability not only improves customer satisfaction, but also opens up a broader market for Su embroidery. More importantly, it can have certain advantages in such a fierce competition market.

(3) Expansion of application scenarios

(VR) With the development of technology, the application field of Su embroidery is also wider. Su embroidery designers use Lora fine-tuning model to generate a large number of Su embroidery patterns suitable for clothing, and make certain adjustments for different application scenarios, and greatly adjust the designed works on this basis. Using this method can make the combination of traditional technology and modern ideas, and greatly expand the application range of traditional technology. In addition, LoRA fine-tuning model can also play a huge role in home decoration. Process designers can use LoRA fine-tuning model to design Suzhou embroidery cushion, curtain, screen and other home decoration products. Relevant academic research shows that integrating traditional technology into home decoration will make the home space more beautiful and better foil the cultural atmosphere of the space. At the same time, LoRA fine-tuning model also has great potential in the expansion of Suzhou embroidery applied to cultural creative products. Cultural creative products such as notebooks, mobile phone cases, jewelry boxes and so on can be designed by LoRA fine-tuning model. In addition, academic experts also say that cultural creative products are effective media for the continuation and communication of traditional crafts. It can be seen that in the process of realizing the integration of Su embroidery and modernization, its role in education and cultural inheritance cannot be ignored. As an intangible cultural heritage, Su embroidery has great educational value. Digital means are used to replace or transform the original mode of education and communication. For example, VR technology is used to make students and the public feel the production of Su embroidery in an immersive way, so as to better understand and love this ancient Chinese traditional art. In addition, digital archives have cataloged and archived the patterns of Su embroidery and information about its long history and tradition. The digitization of Su embroidery can also involve the field of education and explore new possibilities in the process of cross-cultural communication. Moreover,

the digital era has opened up new ways for the marketing and brand management of Su embroidery products, seeking new opportunities for development on the digital platform, and allowing more audiences to gain opportunities to appreciate Su embroidery. With the help of the digital platform, it can face the target consumer groups more directly, and adjust the product design ideas and carry out marketing activities in time according to the actual situation of data changes, so that the competitiveness of Su embroidery brand is strengthened, and the brand operation shows a positive circular development trend. Digital technology is an important way to carry out the copyright protection of Suzhou embroidery in the digital age, and it is also a means to better preserve it in the digital age. For example, blockchain technology is used to trace back to the source, ensure the creative identity of Suzhou embroidery works, and safeguard the interests of creators.

Table 2. Questionnaire

Questionnaire Questions	
1	The Su embroidery patterns generated by artificial intelligence can rival the traditional hand-generated patterns in artistic quality.
2	The color performance of Su embroidery patterns generated by artificial intelligence is superior to that of traditional manual generation.
3	The Su embroidery patterns generated by artificial intelligence are more efficient than the traditional manual generation.
4	The Su embroidery patterns generated by artificial intelligence can better retain the essence of traditional Su embroidery.
5	The cost of Su embroidery patterns generated by artificial intelligence is lower than that of traditional manual generation.
6	The AI generated Su embroidery patterns are satisfactory in the harmony of color matching
7	Ai-generated patterns incorporate modern aesthetic elements better than traditional designs
8	The Su embroidery patterns generated by artificial intelligence can better meet personalized needs.
9	The Su embroidery patterns generated by artificial intelligence are superior to traditional manual production in detail processing.
10	The influence of artificial intelligence generation of Su embroidery patterns on traditional Su embroidery culture is positive.
11	The AI-generated patterns are outstanding in uniqueness (avoiding repetitive design)
12	AI generation technology lowers the threshold for Su embroidery design
13	Traditional hand-designed patterns are still irreplaceable in art collection value
14	Ai-generated patterns can complement traditional designs in terms of cultural heritage value
15	The application prospects of AI-generated Suzhou embroidery patterns in the future are broad.

6 Research and Design

6.1 Questionnaire Design

The five-level Likert scale used in this study was investigated through the form of questionnaire. The scale took the artistic characteristics of Su embroidery as the framework, and took the color expression, production efficiency and creative design as the focus of examination. The topics were selected from the core journal papers of art and design in the past three years. On this basis, the evaluation system was further organized and optimized to form a final evaluation system containing 15 standardized items (see Table 1), including 5 items of color dimension, 4 items of efficiency dimension and 5 items of creativity dimension. The Scales in the Table Response options were assigned points on a scale of strongly agree (5) -Agree (4) -neutral (3) -disagree (2) -strongly disagree (1). Among them, the color dimension was focused on traditional color reducibility and modern color innovation. The efficiency dimension involves whether the production process is more optimized, time consuming, cost and other issues. The creative dimension includes whether it shows the corresponding cultural meaning and has the originality of design. Each of the above questions is a problem statement jointly developed by the author, Suzhou embroidery practitioner and Suzhou embroidery research experts, and the language is simple and easy to understand while ensuring that the problem statement is professional.

6.2 Data Sources

This study takes Suzhou embroidery industry cluster as the scene of sample extraction, and carries out empirical research in Suzhou embroidery town. After full demonstration, the sample frame is divided into three groups: traditional craftsmen group, young designers group and cultural managers group. The above classification can accurately reflect the identity of the three groups themselves, and clearly show the different characteristics of the professional identity and group belonging of the objects concerned in the classification process. On this basis, it is more helpful to accurately locate the attitude and view of various groups of people towards the development of Suzhou embroidery industry. The researchers actually distributed 210 questionnaires, and finally returned 200 questionnaires, with a recovery rate of 95.23%. All the questionnaires were completed in the form of online answers, and the way that the respondents and the data collectors did not know each other's names eliminated some interference caused by subjective bias. In addition, in order to ensure the objectivity and accuracy of statistical data, a third party research assistant was used in the process of issuing and retrieving questionnaires, and its quality control was

6.3 Reliability and Validity Analysis

In this study, the data were imported into SPSSAU system to analyze the reliability of the questionnaire, and the results are shown in Table 2. The Cronbach α coefficient is 0.965, which is greater than 0.9, indicating that the reliability of this survey is high,

so the reliability quality of the research data is high. For the "deleted α coefficient", after reliability test, the item "traditional art collection value" which has no direct impact on the coefficient has been removed. For the "CITC value", the CITC values of the analysis items are all greater than 0.4, indicating that there is a good correlation between the analysis items, and also indicating a good level of reliability. In summary, the reliability coefficient value of the research data is higher than 0.9, which comprehensively indicates that the reliability quality of the data is high. KMO and Bartlett test are used to verify the validity. It can be seen from the above table that the KMO value is 0.934, and the KMO value is greater than 0.8, so the research data is very suitable for extracting information (the validity is very good from the side).

6.4 Factor Analysis

In this study, SPSSAU software is used to carry out factor analysis of questionnaire data, find out the potential data structure, and realize the reduction of variable indicators. Now the variable indicators of questionnaire data are changed to Q1~Q14, factors are extracted based on principal component analysis, and the maximum variance method is used to reduce the data dimension, so that the factors are interpretable. The first principal component principal factor was selected based on the criterion that the eigenvalue was greater than 1. From the rotated component matrix, it is known that the variable with higher factor loading is divided into this factor, as shown in Table 3. Factor F1: It consists of variables such as Q4, Q5, Q7, Q8, Q9, Q10, Q11, Q12, and Q13. This factor mainly includes the artistic expression of artificial intelligence presented in the AI-generated Su embroidery patterns, as well as the contents of improving work efficiency, saving costs, retaining culture, updating and transforming, and application prospects. We call it the "artificial intelligence Suzhou embroidery design comprehensive efficiency factor". It can be seen from Table 4 that the variance contribution rate of this factor is 67.779%, which can well explain most of the original 14 evaluation items and has a strong explanatory power. The specific characteristic values of the factor and the variance contribution rate are shown in Table 3. The factor analysis is used to extract the common factors of a person with clear interpretation significance, and the factors can reflect the comprehensive situation of artificial intelligence technology in Su embroidery design from multiple angles(The equivalent of the number of factors observed from the gravel plot is at most two (see Figure 1).). It simplifies the data structure and provides a solid theoretical foundation for further mining.

Table 3. Reliability analysis table

Cronbach reliability analysis			
NAME	Correction term Total correlation (CITC)	Alpha Coeffi- cient with terms removed	Cronbach α coefficient
The Su embroidery patterns generated by artificial intelligence can rival the traditional hand-generated patterns in artistic quality.	0.786	0.963	0.965
The color performance of Su embroidery patterns generated by artificial intelligence is superior to that of traditional manual generation.	0.832	0.962	
The Su embroidery patterns generated by artificial intelligence are more efficient than the traditional manual generation.	0.811	0.963	
The Su embroidery patterns generated by artificial intelligence can better retain the essence of traditional Su embroidery.	0.878	0.961	
The cost of Su embroidery patterns generated by artificial intelligence is lower than that of traditional manual generation.	0.800	0.963	
The AI generated Su embroidery patterns are satisfactory in the harmony of color matching	0.829	0.962	
Ai-generated patterns incorporate modern aesthetic elements better than traditional designs	0.823	0.962	
The Su embroidery patterns generated by artificial intelligence can better meet personalized needs.	0.788	0.963	
The Su embroidery patterns generated by artificial intelligence are superior to traditional manual production in detail processing.	0.848	0.962	
The influence of artificial intelligence generation of Su embroidery patterns on traditional Su embroidery culture is positive.	0.801	0.963	
The AI-generated patterns are outstanding in uniqueness (avoiding repetitive design)	0.816	0.963	
AI generation technology lowers the threshold for Su embroidery design	0.695	0.965	
Traditional hand-designed patterns are still irreplaceable in art collection value	0.563	0.967	
Ai-generated patterns can complement traditional designs in terms of cultural heritage value	0.791	0.963	
The application prospects of AI-generated Suzhou embroidery patterns in the future are broad.	0.816	0.963	

Note: Standardized Cronbach α coefficient = 0.965

Table 4. Factor analysis

Factors	Eigenvalues	Variance contribution rate (%)	Cumulative variance contribution rate (%)
F1	10.167	67.779	67.779

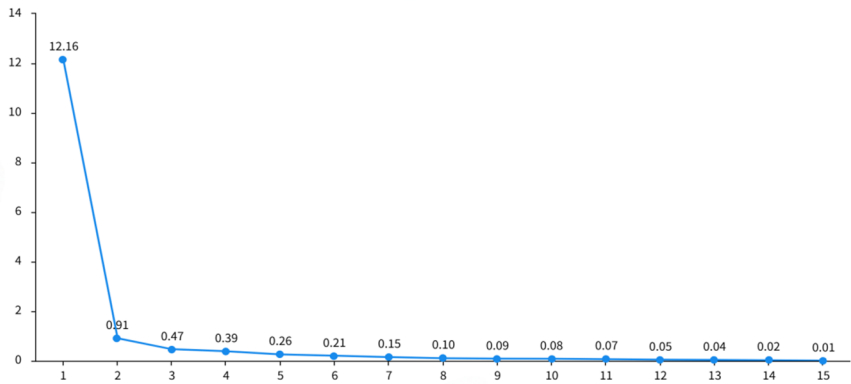


Fig. 1. scree test

7 Discussion on the Innovation Strategy of Su Embroidery Design Based on LoRA Fine- Tuning Model

(1) Integration of traditional and modern elements

Su embroidery is one of the four famous embroiderings in China, with a long history of thousands of years and unique cultural deposits. However, in the face of today's society, the survival and development of Su embroidery has encountered many difficulties and obstacles. In this case, in order to better establish Su embroidery in modern society, it is necessary to integrate some traditional elements and modern elements, and integrate them into the innovative design of Su embroidery. Some studies believe that the combination of traditional Su embroidery patterns and some modern design concepts can not only maintain the cultural heritage of Su embroidery, but also reflect the aesthetics in line with the current people. For example, we can not only use Su embroidery to process our traditional clothing, but also use Su embroidery to create modern clothing, including some such as wedding dresses or haute couture dresses. In this way, Su embroidery will be loved by young people, and then the market competitiveness of Su embroidery products will be increased^[18].

(2) Cross-field cooperation and innovation

Cross-field cooperation brings a new opportunity for Su embroidery design. Experts in related fields join in the design innovation, and bring some new technologies and new concepts into the design of Su embroidery, which can greatly promote the innovation of Su embroidery. For example, the combination of Su embroidery and modern science and technology, the use of digital technology to improve the production process of Su embroidery, improve productivity, increase the application of Su embroidery; The combination of Su embroidery and cultural and creative industry, the research and development of Su embroidery cultural and creative products, makes Su embroidery have more possibilities of grafting, enriches the content of Su embroidery design and expands the development space of Su embroidery market. Research shows that cross-field cooperation is conducive to the innovation of traditional crafts and can

improve their market competitiveness, so that the inheritance of Su embroidery has a new driving force^[19].

(3) Personalized customization

Personalized customization caters to the individual needs of current consumers. Through the fine-tuning of LoRA model, Suzhou embroidery patterns that can be designed for customer needs are designed, and the unique embroidery works of customers are generated according to user needs information to meet user personalized customization requirements. It innovatively meets the individual needs of current people, has strong universality, improves the customer experience to a certain extent, and can expand the radiation range of Suzhou embroidery market, greatly enhance the market competitiveness of products. According to relevant survey data, personalized customization is conducive to improving product competitiveness and helping Suzhou embroidery to better inherit and develop^[20].

8 Conclusion and Discussion

This paper focuses on the traditional innovation path of Suzhou embroidery, and introduces AI technology into its production and processing process as the innovation point of this paper. Through the research and experiments of LoRA fine-tuning model, an innovative method of Suzhou embroidery design based on LoRA fine-tuning model is proposed, which uses AI technology to improve the innovation and creation efficiency of Suzhou embroidery design, and gives it a new artistic atmosphere and cultural heritage. Efficient parameter tuning method in LoRA fine-tuning model is used. Without affecting the traditional artistic characteristics of Su embroidery, a lot of attempts have been made to generate patterns, so that the generated patterns are more vivid and creative. Combined with AI and Su embroidery drawing process, it can complete the generation task of Su embroidery design template drawing in the practical application process, and can quickly produce a large number of new embroidery manuscripts that not only have the characteristics and charm of Su embroidery but also meet the current aesthetic. At the same time, it uses the color optimization algorithm to transform the traditional color mode into the digital color pattern. It has changed the problem that the color matching of Su embroidery must be accumulated through long-term experience and can not reflect the regularity well. According to the existing literature, the design cycle of Su embroidery is shortened by about 58%, and the design cost is reduced by about 42%, which is conducive to the realization of subsequent industrialization.

However, the LoRA model has the characteristics of a very good balance between cultural inheritance and technological innovation, and can well capture the unique stitch texture and composition logic of Su embroidery with a small number of samples, and the generated patterns have obtained a professional recognition rate of 82.6%. In addition, in terms of application scenarios, the combination of digital art exhibition and intelligent design platform makes Su embroidery not only exist as a single product category, but can be transformed into design products that drive Su embroidery non-body examination projects. Moreover, digital Su embroidery has

attracted the attention of a large number of young people in the current application scenarios. According to relevant data, the market acceptance of cultural and creative products assisted by intelligent AI design and production has increased by 37%, and 64% of consumers are young people, which reflects the reality that technology enforces traditional culture and attracts more young people's attention.

However, while using technology, we should pay more attention to the essential attributes of traditional technology. Although AI can automatically form new patterns according to images, with high efficiency and strong innovation, manual embroidery belongs to a form of living works with characteristics, and the expression of texture and emotion is far from being reflected by simple patterns converted into real objects. After the actual test of researchers, it is found that the premium of works is 28% higher than that of single AI design in the way of joint design of AI and human (the correction rate of human-computer interaction is 35%-40%). Therefore, artificial intelligence is not the core direction of future development, but innovation is achieved through human-computer interaction, and a good innovation ecology of human-computer complementation is formed.

This study has the problem that the training data set does not cover the industry comprehensively and the mining of cultural connotation is not deep enough. In the later stage, multi-modal generation technology can be used to strengthen the three-dimensional presentation of Su embroidery. This paper studied how to use dynamic generation algorithm to realize intelligent interaction of embroidery design. Explore the technical means of using blockchain technology to establish a digital copyright protection system for Suzhou embroidery, so as to achieve the purpose of promoting the development of traditional crafts with the help of technology.

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References

1. News Network of Jiangsu Provincial Committee of the CPC. The National People's Congress Yao Jianping: joint effort to promote "quintessence of water from the point of" towards the world [EB/OL]. [2025-3-26]. https://www.zgjssw.gov.cn/yaowen/202503/t20250320_8468353.shtml.
2. Chinadaily.com.cn. To culture to economic and social development [EB/OL]. [on March 26, 2025]. http://www.npc.gov.cn/c2/c30834/202503/t20250311_444190.html.
3. Chinanews.com. New splendid shu Zhong Ming founder Kim pavilion, "AI" for traditional intangible huan new [EB/OL]. [2025-3-26]. <https://www.chinanews.com.cn/cul/2022/05-22/9760712.shtml>.
4. China Academy of Arts and Crafts. Appreciate | suzhou embroidery: with needle embroider, wonderful artical excelling nature [EB/OL]. [2025-4-7]. <https://www.cnacs.net.cn/19/202108/4027.html>.

5. Jiangsu Arts and Crafts. From traditional to modern, challenges and opportunities in the process of the marketization of suzhou embroidery [EB/OL]. [2025-4-7]. <http://www.jsact.cn/paper/info/11516>.
6. Gao Xuqian. Research on the living situation of the New generation of Su embroidery craftsmen [J]. Youth Years, 2022, (17): 65-67.
7. LyUYanchi. Digital non-material cultural heritage protection and inheritance for suzhou embroidery - for example [J]. Journal of natural and cultural heritage, 2019, 4 (08) : 53-55, DOI: 10.19490/j.carol carroll nki issn2096-0913.2019.08.012.
8. LIU Beituo. Artificial intelligence can assign for suzhou embroidery intelligent traditional technology innovation, for example [J]. Journal of art and design (theory), 2023, 2 (4) : 142-145. The DOI: 10.16824/j.carol carroll nki issn10082832.2023.04.029.
9. LIU Dawei, YU Bihui, SHI Jiawei, et al. Clothing model image generation method Based on stable Diffusion and adaptive enhancement Technology [J/OL]. Computer application research, 1-8 [2025-04-21].
10. Microsoft. (2021). Low-Rank Adaptation of Large Language Models. arXiv preprint arXiv:2106.09685
11. UNESCO. (2003). Convention for the Safeguarding of the Intangible Cultural Heritage . United Nations Educational, Scientific and Cultural Organization
12. Zhou, F. (2024). Research on the Inheritance and Innovation Path of Contemporary Suzhou Embroidery Product Design. Design, 9 (2), 326-334
13. Zhang, Y., et al. (2024). A Survey on LoRA of Large Language Models. arXiv preprint arXiv:2407.11046
14. Application Research of AIGC technology in Art Design [J]. Art Design Research, 2022, 34(2): 34-38
15. The fusion design of traditional elements and modern style [J]. Designer, 2021, 29(5): 45-48.
16. The influence of AIGC technology on traditional process innovation [J]. Traditional Process Research, 2023, 35(1): 23-26.
17. Li Jiao. Effect analysis of color collocation on visual communication effect [J]. Color, 2024(2): 42-44.
18. YAO Linfen. Exploration on the integration of traditional Chinese embroidery and modern design [J]. Art and Design (Theory), 2024, 24(08): 42-49.
19. ZHOU Fen. Research on the innovative design and marketization path of Suzhou embroidery cultural and creative products from the perspective of interdisciplinary [J]. Design, 2023, 23(04): 142-145.
20. XU Zike, Huang Ying. Research on the inheritance and innovation path of contemporary Su embroidery product Design [J]. Design, 2024, 09(02): 326-334

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