

# Preliminary Explorations of Generative AI and the Embodied Embroidery of Huayao Intangible Cultural Heritage

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Figure 1: a) Expert Tangmei's traditional Huayao embroidery, b) Embroidering a co-created GenAI image in Huayao style

## Abstract

Generative AI (GenAI) offers opportunities to preserve and more widely share Intangible Cultural Heritage (ICH), whilst at the same time bringing risks of misrepresenting, misappropriating, homogenizing, and devaluing ICH. To explore how artisans undertake embodied craft practice with GenAI fine-tuned on their own ICH and how GenAI might contribute to the future of ICH we report on a preliminary analysis of a cross-cultural collaboration between researcher-designers and Huayao minority culture embroiderers

in rural China. Three GenAI workflows are explored through co-creation and in-situ making of new embroidery pieces. Initial analysis of reflective feedback suggests that GenAI has the potential to enhance creativity and support innovation within cultural norms and sensibilities, but that human creativity, manual refinement, and local nuance remain key to successfully embracing GenAI for Intangible Cultural Heritage.



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*CHI EA '26, Barcelona, Spain*

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ACM ISBN 979-8-4007-2281-3/26/04  
<https://doi.org/10.1145/3772363.3798663>

## CCS Concepts

• Applied computing → Arts and humanities; • Computing methodologies → Artificial intelligence; • Human-centered computing;

## Keywords

Intangible Cultural Heritage, ICH, Huayao, Generative AI, GenAI, Embroidery, Making

### ACM Reference Format:

Nick Bryan-Kinns, Duoduo Zhang, Hao Li, Mengzhi He, Xiaojing Yuan, Xin Zhao, Iliia Pavlov, Yijing Yang, and Sanyi Wang. 2026. Preliminary Explorations of Generative AI and the Embodied Embroidery of Huayao Intangible Cultural Heritage. In *Extended Abstracts of the 2026 CHI Conference on Human Factors in Computing Systems (CHI EA '26)*, April 13–17, 2026, Barcelona, Spain. ACM, New York, NY, USA, 6 pages. <https://doi.org/10.1145/3772363.3798663>

## 1 Introduction

Intangible Cultural Heritage (ICH) faces challenges to survival and growth from globalization and economic pressures [5]. Disruptive technologies on one hand bring opportunities to preserve and more widely share ICH [21]. On the other hand they risk misrepresenting, misappropriating, homogenizing, and devaluing ICH [3, 6, 18]. In between these positions lay opportunities for social innovation [13], situated participatory design [23], and reimagining ICH in a contemporary context [7, 8]. In this paper we collaborated with Huayao minority culture embroiderers in rural South-central China to explore how artisans might undertake embodied craft practice with a contemporary disruptive technology - Generative AI (GenAI) - and how GenAI might contribute to the future of Huayao ICH. A unique part of Huayao ICH is their cross-stitch embroidery technique [27] which can be traced back to the Han dynasty (approximately 202 BC to 220 AD) and is now listed in the China National Intangible Cultural Heritage Catalogue. Notable characteristics of Huayao embroidery include the prevalent use of black fabric and white thread, two-sided embroidery, the nesting of patterns within patterns, and the emphasis on fullness of embroidery [25] as illustrated in Figure 1a. This collaboration with Huayao embroiderers was undertaken as part of the DESIS (Design for Social Innovation and Sustainability; [14]) network at Hunan University, China, which has been engaging in social innovation in the region since 2009 [13].

Researchers have explored how contemporary AI techniques can be used to analyse, document, and provide access to elements of ICH [15]. As well as using AI to document art and ICH, researchers have also explored how AI might be used to generate new content within ICH stylistic norms [2, 9, 11, 19, 20, 25]. For example, Yuan et al. [25] fine-tuned a LoRA (Low-Rank Adaptation) using 152 images of Huayao embroidery patterns and demonstrated that this approach generated images which were considered closer to Huayao style by Huayao artisans than those generated without the LoRA. However, they noted that whilst the visual style was closer to Huayao embroidery, the generated images lacked cultural meaning. Across each of these approaches there is a concern for how to capture, represent, and convey cultural meaning through GenAI. There is also an emphasis on the generation of images fitting within stylistic norms whilst also allowing for contemporary reconfiguration and reimagination. However, none of these approaches explored how the generated images could actually be manifested as cultural objects such as embroidered fabric, or porcelain, or cut paper, or worked filigree. This is in contrast to Cardini and Noguera [8] who worked with craftmakers to use a publicly available GenAI



Figure 2: Huayao community Huxingshan Township

tool (DALL-E) to develop design ideas which were then developed into physical bronze artefacts. In this approach the craft skill and ICH of the artisans drove the selection of GenAI images and then transformation of the digital image into physical artefacts.

Two strategies of using GenAI for ICH are evident from this brief survey: i) fine-tuning GenAI to generate images [19, 20, 25]; or ii) using generic GenAI combined with embodied craft skills [8]. This informs the research question of this paper: *RQ: What forms of creativity emerge when artisans use their embodied craft skills to create with GenAI fine-tuned on their own ICH?*

## 2 Method

A team of six researcher-designers from Hunan University, China, worked with a team of three researcher-designers from the University of the Arts London, UK, and engaged with eight embroiderers in the Huayao community in rural China. The embroiderers (29 to 75 years old) were recruited through existing community connections, and all were female as Huayao embroidery is traditionally and currently undertaken solely by women. Embroiderers gave informed consent for their name, images, and embroidery work to be used in research publications under the ethics committee of Hunan University. Pinyin versions of embroiderers' Chinese names are used throughout the paper: Aihua, Dianhua, Fouhua, Huying, Juanhua, Lingling, Tangmei, and Yuanhua.

The study was structured into four stages over six months loosely following the Qi2He co-creation method - a framework for structuring cross-cultural co-design [5]. The first stage (Jan - March 2025) involved learning about each other through in-person and online sharing of traditional embroidery and GenAI tools. In the second stage (March - May 2025) a dataset of 152 Huayao embroidery images was created and proprietary GenAI models were configured, trained, fine-tuned, and tested with embroiderers to assess their ability to generate Huayao style embroidery images.

The final stages took place over eight days in June 2025 in Huxingshan Township (Figure 2) and surrounding rural areas. The third stage involved co-creation and mutual inspiration between embroiderers and our research team using three GenAI workflows described later to co-create small embroidery designs to the design goals of the embroiderers (Figure 3a). A semi-structured interview was then undertaken to understand embroiderers' perceptions of



Figure 3: a) Initial co-creation with GenAI, b) Focus group discussions

the images generated and the potential for using GenAI in their own practice. In the fourth stage the embroiderers embroidered one of their GenAI images onto fabric illustrated in Figure 1b. The aim of this stage was to identify where and how GenAI might support reimagining of ICH. Researchers interviewed embroiderers during the making process, and the whole team of researchers and embroiderers came together for a focus group to discuss the process of generating patterns with GenAI, embroidering the generated images, and hopes and concerns about GenAI (Figure 3b).

## 2.1 Data Analysis

All interviews and the focus group were video recorded and transcribed into Chinese by the researchers along with notes kept by researchers during the interviews themselves. Recurring themes and topics in the transcriptions and notes were then identified by researchers using an open coding approach [22] in which each researcher independently reviewed the data to identify themes and then researchers together discussed their themes to develop a shared set of themes reported in the section 3. These themes and topics were then translated into English and discussed with the one researcher with no Chinese literacy. Preliminary analysis of themes and observations are reported in this paper in English translation.

## 2.2 Generative AI workflows

Three GenAI workflows were developed to reflect three key approaches to GenAI image generation for ICH: text based [1, 8, 19, 20, 24, 28], image based [19], and composition based generation [11, 20, 24]. The GenAI workflows built on Stable Diffusion XL (SDXL), a latent diffusion model for text-to-image synthesis [17]. To encode the visual grammar of Huayao embroidery, the SDXL was fine-tuned and a series of custom LoRA modules were trained from the embroidery image dataset carefully curated in the second stage of this research. Images were manually filtered, normalised in resolution and colour balance, and categorised according to their functional role within embroidery compositions: primary motifs,

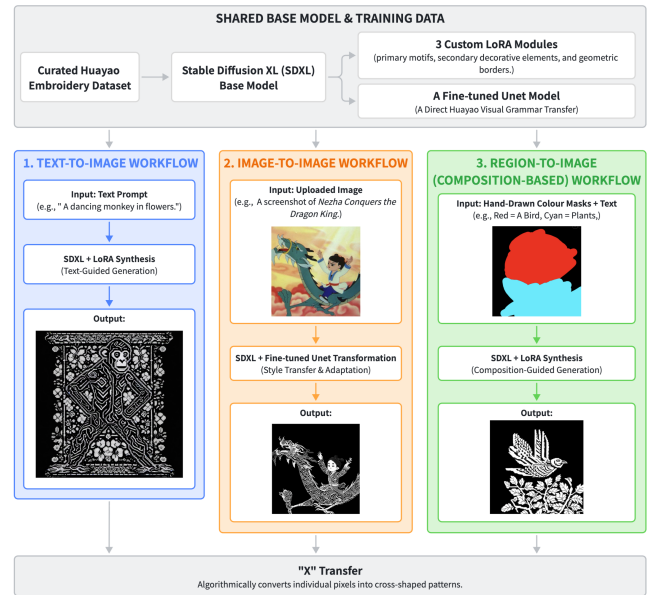


Figure 4: Overview of three GenAI workflows

secondary decorative elements, and geometric borders. These components were assembled into three GenAI workflows (Figure 4) which generate images in Huayao cross-stitch embroidery style using ComfyUI [10] in 10 to 60 seconds allowing for rapid iteration: **Text-to-Image** generates an image from a text prompt; **Image-to-Image** transforms an uploaded image into Huayao embroidery style; **Region-to-Image** allows users to control the composition of a generated image using hand-drawn colour masks in which each colour corresponds to a region within the image, such as central motif, decorative borders, or background. Each GenAI workflow was used by each embroiderer.

### 3 Findings

Initial analysis of the interviews suggests that each embroiderer had different creative goals as illustrated in Figure 5 along with images of the final embroidered pieces, chosen image generated by our GenAI tool and a selection of discarded generated images. Visually inspecting the final embroidered works revealed different forms of creativity drawing on Boden's theory of creativity [4]. *Combinatorial* creativity where people combine existing elements together was evidenced across participants, whereas *exploratory* creativity which involves exploring new forms and styles within existing norms was undertaken predominantly by younger participants which may suggest that younger participants were more open to exploring new possibilities within Huayao embroidery styles. In contrast, *transformative* creativity where the existing conventions are themselves challenged and modified was undertaken solely by Tangmei, the most experienced embroiderer.

#### 3.1 Opportunities for GenAI and ICH

In the interviews and focus group participants discussed the embroidery of their GenAI generated images. All participants agreed that the GenAI workflows could **enhance creativity** by offering quick visualizations, new ideas, and speeding up the design process. They could also support ideation, especially for those who don't draw from scratch. For example, Huying noted that without the GenAI they would "be embroidering and then unpicking, unpicking and then embroidering, very troublesome... If we had this [AI] generation, then I definitely would not need to work so hard". And Aihua noted that "This [GenAI] can let some of the things imagined in our brains completely take form, letting us embroider them out". Participants also noted that GenAI could **inspire innovation** through unexpected layouts, color schemes, or motifs, and that GenAI had the potential to support **innovation within tradition**. However, all participants emphasized that **cultural knowledge is essential**. For example, Lingling emphasized the importance of visual harmony, line density, and aesthetics in embroidery. They all also noted the **importance of cultural symbolism and emotional expression** in their work and believed that AI could support innovation in traditional crafts provided that such tools respect cultural nuance and incorporate authentic cultural elements. For example, Huying noted "If AI could recognise the octagonal flowers from around here, and add them inside [the generated pattern], then it would be more like the patterns from around here".

#### 3.2 Challenges of using GenAI for ICH

Yuanhua noted "I feel the little animals designed using this [GenAI] just don't look like ours... I still like this kind that our Yao people designed ourselves in the past, even though you might not understand it". Dianhua commented that she didn't think that the GenAI rabbit image she embroidered was good, and that it **lacked something**. Yuanhua commented that it lacked the feeling of jumping or doing something such as eating grass, and that to embroider something it is important to observe what that thing looks like and how it behaves first. Several discussions in interviews and the focus group related to this theme about the GenAI images **not being 'vivid' or 'lively'**. For example, Tangmei spent a long time trying to generate a pig that was eating grass or being affectionate with their piglets

as illustrated in the discarded GenAI images of pigs and rabbits in Figure 5 which were seen as not looking like local animals and lacked liveliness. Moreover, the absence of recognizable patterns such as stone flower motifs reduced the authenticity of generated images. For all participants **human creativity remains essential**. For example, participants expressed a strong desire to maintain creative control and cultural depth in their work. Finally, **manual refinement** was considered necessary to ensure authenticity and feasibility of actually embroidering the AI-generated images e.g. Dianhua noted "when I embroider [the GenAI image], I still have to change it a bit. If I don't change it, it doesn't look nice". Whilst participants were open to using GenAI, they insisted on modifying outputs to match their artistic standards and traditional values.

#### 3.3 Reflections on using the GenAI workflows

When asked about any differences between using the GenAI workflows and their usual embroidery process, participants all noted that it was faster than their usual design process. For example, Dianhua noted that the GenAI tool sped up the process overall, but she still had to spend time to change the design herself. However, there were no clear preferences for GenAI workflows.

**Image-to-Image** was favoured by most participants but producing suitable outputs required searching for images before the GenAI was used. Fouhua (embroidery in Figure 5), Huying, Lingling, and Juanhua felt that this workflow offered more realism in the outputs and more visibility of cross-stitching detail (though note that all workflows produced images in cross-stitch style). They also found the workflow was more intuitive than others and closer to their existing creative process. However, Huying and Dianhua noted that some AI-generated images lacked clarity or completeness (e.g. missing limbs), and emphasized the need for images to include symmetry and cultural symbolism.

**Text-to-Image** was less popular, and some participants encountered difficulty finding the right words to describe the elements they wanted in a local style. Aihua (embroidery in Figure 5) suggested that it produced clearer, more structured results that resembled traditional Huayao embroidery more than others. In contrast, Dianhua disliked the Text-to-image workflow because the AI-generated animals often looked unrealistic or resembled other animals, whilst Lingling felt that the need to express creative ideas through text restricted the usefulness of this workflow.

**Region-to-Image** generation was not well received. Only Dianhua (embroidery in Figure 5) and Tangmei (embroidery in Figure 1b) preferred the Region-to-Image workflow as it allowed them to iteratively refine their designs through the composition process. Tangmei also noted that it more closely matched her traditional workflow than other workflows - starting with a mental or visual layout and then refining details manually.

## 4 Discussion

The aim of this study was to explore what forms of creativity emerge when artisans use their embodied craft skills to create with fine-tuned GenAI models. Reflecting on the in-situ embodied use of our GenAI we note that the quick prompting workflow allowed participants to rapidly change and refine their images through text













Embroiderer	GenAI Image	Embroidery	Goals	
 Aihua				Aihua aimed to create playful, pet-themed embroidery designs for toys and bags. She wanted the designs to appeal to younger audiences and tourists, incorporating Huayao elements like traditional motifs and handwoven accessories. Her goal was to blend traditional aesthetics with modern consumer preferences.
 Dianhua				Dianhua designed a rabbit-themed embroidery pattern for a bag, featuring a lively rabbit in motion among grass and flowers. The design aims to be innovative while aligning with traditional Huayao aesthetics, with a balanced composition that is neither too dense nor too sparse.
 Fouhua				Fouhua wanted to design a small wall hanging featuring a Huayao girl picking honeysuckle (金银花). She envisioned a framed embroidery piece with a girl and a honeysuckle bush, aiming to create a culturally rich and visually appealing product for home decoration or tourist sales.

Figure 5: Left to right: Embroiderer and final piece; Discarded GenAI images; Selected GenAI image; Final piece; Creative goals

prompts, images, and compositional elements to better fit their personal preferences in contrast to GenAI studies which pre-generated a set of images which were then evaluated by artisans [25]. We suggest that by offering the wide range of kinds and styles of images that GenAI can produce we can explore personal preference and cultural significance within the local context.

In the handmade embroidery of GenAI images we saw evidence of multiple forms of creativity. Importantly, many of the modifications made during the making offer **insights into features** of Huayao ICH that may have been missed without the hands-on making. For example, whilst researchers had paid close attention to Huayao traditional aesthetics in training the GenAI model it was not until the making stage that the nuance and cultural meaning of the outline of shapes became evident. For example Yuanhua's and Tangmei's detailed work on the outlines of their flower and pig respectively highlighted the importance of outline and shading. Moreover, in participants' modifications of the GenAI images during the embroidery process there is a question about whether the selected GenAI images represent Huayao culture to the Huayao embroiderers, or whether the embroiderers themselves aligned the GenAI images with Huayao culture through reconfiguration and reinterpretation through their craft making.

Finally, there is the question of the understanding of 'vivid' which was mentioned by participants as lacking in the GenAI images. Vividness is not only about the imagery, but may also be an **emergent quality of craft practices** arising from the real-time interaction between the human body, materials, and the surrounding natural environment. This resonates with other art forms such as painting and music, but in Chinese aesthetics it carries a particular emphasis through the notion of *qi yun sheng dong* (气韵

生动), the vital, affective moment in which artistic atmosphere and intention come into being. In this sense, GenAI should support real-time human participation and interaction, moving beyond textual prompts to enable context-sensitive and even multimodal exchanges grounded in the creator's situated environment.

Overall, we suggest that an added value of our approach lies in the co-creative **combination of rapid GenAI and slow making in-situ with cultural inheritors** which we refer to as **praxis GenAI** as shorthand for ICH praxis oriented GenAI. In our view the ability to rapidly ideate images with GenAI allowed participants to express their personal preferences, styles, and understanding of their own ICH. For example the lack of lively GenAI images prompted further discussion on what are important features of Huayao embroidery aesthetic. In this way our praxis oriented **GenAI workflows offered a way for researchers to learn more about Huayao ICH through embodied practice**, and at the same time for artisans to learn more about the potential and limitations of GenAI through their embodied practice cf. [8] rather than primarily evaluating the aesthetics of GenAI outputs cf. [19, 20, 25]. The challenge for praxis GenAI is to generate content that is good enough and flexible enough to be useful for cultural inheritors in their practice - it is not necessarily about generating high quality, high resolution images that perfectly mimic or reproduce ICH.

There are clearly limitations in the depth of engagement with GenAI and making as the in-situ part of the research was undertaken in eight days restricting the size and ambition of the embroidery that could be completed. In addition, spending a short time in local settings brings risks of superficial engagement with local communities. To reiterate, these risks are somewhat mitigated as this research was undertaken as part of an engagement of more than 10

years with the same community, with extensive personal networks and connections developed and cherished over the years, and substantial pre-making work undertaken with the local embroiderers over six months prior to the full team visit.

Finally, Huayao embroidery has important elements of *narrative*, *local imagery*, and *aesthetic style* [26] which were difficult for our GenAI workflow to capture. For example, narrative prompts such as ‘a pig eating grass’ did not produce satisfactory results for participants. This in turn led to images which were not seen as lively or vivid. This difficulty of ‘compositionality’ of objects within AI generated images is a well known limitation of current GenAI approaches [12] for which substantial research and development is needed. Whilst we as researchers focussed on developing a GenAI model which could generate images in something similar to Huayao embroidery aesthetic style, we found that the ability to generate local objects was in some way more important for local craftspeople than the aesthetic style of the GenAI images as the GenAI image was typically used as a starting point for embroidery.

## 5 Conclusions

Generative AI brings opportunities and challenges for the preservation, sharing, and reimagining of Intangible Cultural Heritage. We explored how fine-tuned GenAI workflows could inspire in-situ embodied making of ICH. We suggest that our combination of rapid iterative GenAI and in-situ slow making by hand, praxis GenAI, created a space in which discourses on the meaning and value of Huayao ICH could be explored in new ways, revealing insights that we may have missed with other approaches. As with Reitsma et al. [16], we suggest that in-situ co-creation and engagement was essential to (further) developing empathic understanding between researchers-designers and the Huayao cultural inheritors.

## Acknowledgments

Many thanks to the embroiderers who collaborated with us on this project: Aihua, Dianhua, Fouhua, Huiying, Juanhua, Lingling, Tangmei, and Yuanhua. This work was funded by “Hunan University: Research and Application of Sustainable Design for Intangible Cultural Heritage Communities Towards AIGC Technology”.

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