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# Digital Reconstruction of the Snake King Festival Intangible Cultural Heritage in Zhanghu Town： A Multidimensional AI-enabled Animation Approach

Bingbing Liang[1], Kittisan Sriruksa[2], Niyom Wongpongkham[3], Arunee Sriruksa[4]

**Abstract**

*The international community has widely recognized the importance of preserving Intangible Cultural Heritage (ICH) for sustainable development. However, due to its inherent intangibility, ICH is at risk of degradation and disappearance. Although public participation is crucial to ICH preservation, it remains insufficient in many systems. Against this backdrop, this paper explores and emphasizes the necessity of public involvement in ICH preservation and proposes an innovative AI-based animation generation workflow to enhance the digital preservation and dissemination of ICH. Integrated into a 12-minute animation, this workflow vividly recreates the core elements of the Snake King Festival in Zhanghu Town, Fujian Province. Based on an extensive survey of the Snake King Festival dataset, this study successfully employs this AI animation generation technology to digitally reconstruct the dynamic elements of ICH, significantly outperforming traditional methods. The strategies proposed not only accelerate the digital preservation of intangible cultural heritage but also provide a technical blueprint for similar projects, offering broad potential for widespread adoption. The ultimate goal is to enhance public understanding and participation in ICH by demonstrating the immense potential of this AI animation technology workflow in the digital preservation of ICH, contributing to the sustainability of global ICH. Despite significant progress, further enhancements in the cultural accuracy and fidelity of the generated content are needed. Future research will focus on optimizing the model to capture cultural characteristics more precisely and explore the application of this method in protecting more types of ICH.*

**Keywords:** *Intangible Cultural Heritage, AI Animation Generation Workflow, Digital Preservation, Snake King Festival.*

## Introduction

In recent years, the international community has increasingly recognized the essential role of Intangible Cultural Heritage (ICH) in the transmission of human civilization and sustainable development. UNESCO and other organizations have emphasized its preservation on global agendas [5]. However, the intangible nature of ICH, along with the rapid changes due to globalization and evolving social structures, has exposed it to severe risks of degradation and disappearance. Traditional preservation methods often fail to adequately consider public participation, resulting in a lack of public understanding and recognition of ICH [7]. Thus, the application of innovative digital technologies to enhance public awareness, participation, and support for ICH has become a crucial task [9]. Although progress has been made in using digital technologies for ICH preservation, challenges such as insufficient public involvement mechanisms, technological application limitations, and the need to balance cultural authenticity and technological innovation persist [10].

The global significance of ICH in safeguarding human civilization and promoting sustainable development is well-established. International organizations have been actively engaged in its protection. The intangibility of ICH, compounded by the far-reaching effects of globalization and social shifts, has put it in a vulnerable position. Conventional preservation approaches have typically overlooked the importance of public engagement, leading to a deficiency in public awareness and appreciation of ICH [7]. Therefore, the utilization of advanced digital technologies to address this issue has emerged as a key area of focus [9].

Significant advances have been witnessed in the integration of digital technologies with ICH preservation,

[1] Faculty of Fine and Applied Arts, University of Khon Kaen, Khon Kaen, Thailand, Guangzhou College of Technology and Business, Email: liangbingbing689@gmail.com, (Corresponding Author)
[2] Faculty of Fine and Applied Arts, University of Khon Kaen, Khon Kaen, Thailand; kitsri@kku.ac.th
[3] Faculty of Fine and Applied Arts, University of Khon Kaen, Khon Kaen, Thailand, Email: Wniyom@kku.ac.th
[4] Faculty of Fine and Applied Arts, University of Khon Kaen, Khon Kaen, Thailand, Email: Arunsr@kku.ac.th

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yet numerous hurdles remain. These include limitations in public participation mechanisms and technological applications, as well as the requirement to maintain a balance between cultural authenticity and technological innovation [10]. Globally, the application of artificial intelligence (AI) in ICH preservation and transmission has shown great promise. For example, Italian researchers' use of deep learning techniques in digitizing and analyzing traditional music could potentially offer valuable insights for digitally capturing and analyzing the unique sonic elements, such as traditional musical instruments or chants, that might be associated with the Snake King Festival of Zhanghu Town [12]. Spanish research teams' application of machine learning methods to model and simulate traditional craft processes can provide a framework for digitally replicating and understanding the intricate artifacts and handicrafts related to the festival's rituals [13]. The employment of natural language processing techniques by cultural institutions in the United Kingdom to organize and interpret historical documents could serve as a model for systematically documenting and analyzing the historical and cultural narratives surrounding the Snake King Festival [15]. These international cases not only highlight the diverse global research efforts in AI applications for ICH but also offer direct relevance and potential transferability to the specific context of the Snake King Festival [18].

Despite the potential of AI technologies in ICH preservation, their application is not without difficulties. While Virtual Reality (VR) and Augmented Reality (AR) technologies can provide immersive experiences for ICH presentation, they often struggle with accurately reproducing details and conveying cultural meanings [20]. In contrast, AI's capabilities in data processing and pattern recognition offer distinct advantages for the digital preservation of ICH [21]. This makes the exploration of AI applications in ICH preservation particularly relevant, as it can overcome the limitations of other technologies and open new avenues for the transmission and revitalization of cultural heritage, especially in the context of the Snake King Festival, which demands innovative approaches to preserve and disseminate its complex cultural elements and process[23].

With the rapid progress of AI and digital technologies, tools like Stable Diffusion have demonstrated significant potential in the ICH preservation domain. From a human-computer interaction (HCI) perspective, the deconstruction of cultural elements has enhanced the cross-cultural appreciation of Chinese ICH. For instance, concerning the Snake King Festival, elements from traditional Chinese painting and puppet art could be incorporated into digital representations to enhance the visual and cultural richness of the festival's digital experience [15]. The use of VR and related digital technologies in museums has increased the interactivity of cultural transmission and deepened public understanding of cultural heritage. Practical applications, such as combining 3D scanning with VR and using platforms like Unity3D for three-dimensional modeling of ICH, could be adapted to create a more immersive and engaging experience of the Snake King Festival, allowing users to virtually participate in its parades and rituals [20]. Additionally, the use of AI technologies, especially through short video formats, has strengthened the dissemination of traditional cultural content and heritage preservation. These efforts provide a theoretical basis for the application of AI tools like Stable Diffusion in activities related to the Snake King Festival [22].

The integration of these technologies offers novel perspectives and methodologies for cultural preservation and transmission and creates new pathways for the global protection of ICH, contributing to the sustainable development of cultural heritage preservation [25].

The Snake King Festival of Zhanghu Town, a unique intangible cultural heritage of Fujian Province, embodies the profound historical legacy and distinct regional characteristics of the ancient Minyue snake worship culture. Originating in the Ming Dynasty, this folk tradition has endured for several centuries and is regarded as a "living fossil" for studying snake worship culture in Fujian [27]. Each year in the seventh lunar month, the Snake King Temple becomes the center of the festival, where residents conduct grand "divine snake parades" and perform significant rituals such as blessings, exorcisms, and offerings to the Snake King [28]. The festival comprises a variety of ritual activities, including processions, sacrifices, and dragon dances, accompanied by local music, dance, and theater, creating a unique visual and cultural spectacle [30]. Some participants even interact closely with large snakes in the wild, highlighting the singularity of this cultural tradition [31]. Due to its profound cultural significance, the Snake King Festival was designated as a provincial-level intangible cultural heritage of Fujian in 2005 [32]. However, in the face

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of rapid social changes and the changing attitudes of younger generations, the festival faces challenges such as difficulties in transmission and the simplification of rituals [34]. Selecting the Snake King Festival of Zhanghu Town as the focal case study enables an in-depth exploration of AI technologies in ICH preservation and provides valuable insights for protecting similar local cultural heritages [35].

Despite existing studies on the application of digital technologies in ICH preservation, significant research gaps remain. Firstly, there is a lack of comprehensive research on the application of advanced AI technologies, particularly generative AI (e.g., Stable Diffusion), in the preservation of ICH [9]. Secondly, few studies have focused on how AI can enhance public understanding and engagement with ICH [12]. Lastly, specific AI-driven preservation strategies for local cultural heritages like the Snake King Festival of Zhanghu Town have been scarcely explored [15]. Against this background, the use of AI-driven animation generation technologies in ICH preservation has emerged as a growing research area. While previous research has underlined the importance of digital technologies in ICH preservation, limited attention has been given to leveraging generative AI technologies, especially Stable Diffusion, to boost public awareness and participation in ICH [18].

These studies establish a theoretical and practical foundation for further investigating the application of Stable Diffusion and other AI technologies in the preservation and dissemination of ICH. In particular, they offer crucial insights into how high-quality image generation and immersive experiences can facilitate public understanding and transmission of the cultural heritage embodied in the Snake King Festival [20]. The main objective of this study is to examine the application of Stable Diffusion AI technology in preserving the Snake King Festival of Zhanghu Town and to propose an innovative digital approach for ICH preservation and dissemination.

Stable Diffusion technology and multidimensional AI techniques possess distinct advantages in the preservation of Intangible Cultural Heritage (ICH), including high-quality image generation with style transfer capabilities, strong customizability, cost-effectiveness, efficiency, and enhanced interactivity [22]. The innovations of this study are mainly manifested in three key aspects: (1) the pioneering application of Stable Diffusion and multidimensional AI technologies to the preservation of a specific ICH [24]; (2) the proposal of a novel cultural presentation method integrating AI-generated imagery with virtual reality [25]; and (3) the establishment of an evaluation framework for AI-assisted cultural heritage preservation [26].

Based on the aforementioned research background and theoretical foundations, this study proposes an innovative approach that employs the Stable Diffusion AI model to preserve and present the Snake King Festival of Zhanghu Town, an important ICH [27]. By envisioning a potential virtual reality exhibition, this study aims to demonstrate the synergy between AI technologies and traditional culture. Specifically, the research intends to use Stable Diffusion to generate high-resolution images and reconstruct scenes of Snake King Festival rituals, combined with virtual reality technology to create an immersive digital experience [30]. This approach not only accurately records and showcases various aspects of the Snake King Festival but also offers the public an inventive and interactive way to understand and appreciate this cultural heritage [32].

To assess the effectiveness of the project, a questionnaire survey has been designed targeting cultural heritage practitioners, technical experts, and the general public. This evaluation framework measures the project's outcomes in three dimensions: "educational impact," "technological effectiveness," and "engagement outcomes" [33]. This interdisciplinary approach not only promotes the preservation and dissemination of the Snake King Festival but also establishes a reproducible model for the digital preservation of other ICHs. It encourages dialogue and integration between cultural heritage preservation and advanced digital technologies.

The study is organized into five sections: an introduction to the research background and origins, a definition of the primary research objectives, a detailed explanation of the methodology, a presentation of empirical findings, and a discussion and analysis. The paper concludes with a summary of the overall research and provides directions for future academic inquiries.

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*Theoretical Background*

From the literature review, it is evident that the utilization of Stable Diffusion large model digital technology based on AI for developing Intangible Cultural Heritage (ICH) content has not been widely explored. Research on ICH, museum studies, and digital technologies has often been conducted in isolation. This section is dedicated to investigating the concept and potential of leveraging digital technologies to enhance the sustainability of ICH. In the subsequent chapter, proposals regarding the digital exhibition of South Korean ICH will be presented.

*Intangible Cultural Heritage (ICH)*

UNESCO, as a leading institution in global cooperation of education, science, and culture, promotes the protection and sustainable development of cultural heritage. Initially, it mainly focused on tangible cultural assets. However, since the 1990s, inspired by South Korea and Japan, UNESCO has shifted its attention to intangible heritage, and a series of measures from 1989 to 2003 have been implemented, signifying its evolution towards a more comprehensive heritage understanding. The 2003 Convention defined ICH as a range of elements passed down and recreated, which is crucial for cultural diversity. Despite its significance, ICH faces the risk of extinction due to its intangible nature and the impact of globalization. UNESCO has thus established lists and projects to safeguard it.

In the context of the increasingly robust global ICH protection system, utilizing AI technology for efficient recording and dissemination of ICH has become an urgent challenge in both academic and practical fields.In alignment with UNESCO's global initiatives, China has proactively contributed to ICH protection, establishing legal frameworks and innovative systems to address the evolving challenges of heritage preservation. China enacted the Law of the People's Republic of China on Intangible Cultural Heritage in 2006, introducing the "Inheritor System of Intangible Cultural Heritage". This law classifies ICH and stipulates the management and support of national-level ICH and its inheritors. Thanks to this system, a large number of endangered ICH items have been protected in Table 1.

Stable Diffusion, based on latent diffusion models, generates high-resolution images by iteratively denoising random noise, ensuring accurate visual representation of cultural elements while enabling style transfer across diverse artistic traditions. For example, the generation of "Nanyin" musical scores, can analyze the unique notation and rhythm patterns of Nanyin and convert them into vivid digital images. The reconstruction of the "Snake King Festival" scene, can reproduce the details of the temple, the appearance of the participants, and the activities of the snakes with high accuracy and adaptability.

**Table1. Intangible Cultural Heritage in Fujian Province.China**

| Category | Total | Examples |
|---|---|---|
| a. Folk Literature | 1 | She Nationality Novel Songs in Xiapu (Ningde), etc. |
| b. Folk Fine Arts | 4 | Zhangzhou Woodblock New Year Pictures (Zhangzhou), Yongchun Paper Weaving Pictures (Quanzhou), etc. |
| c. Folk Music | 13 | Quanzhou Nanyin, Fujian Hakka Folk Songs, etc. |
| d. Folk Dance | 9 | Such as Shaowu Nuo Dance (Nanping), Quanzhou Kicking Ball Dance (Quanzhou), Training Dayuan Nuo Dance (Sanming), etc. |
| e. Traditional Opera | 23 | Min Opera (Fuzhou), Zhangzhou Glove Puppet Show (Zhangzhou), Nanping Nanci Opera (Nanping), etc. |
| f.Quyi(Folk Performing Arts) | 7 | Fuzhou Pinghua (Fuzhou), Zhangzhou Jinge (Zhangzhou), Nanping Nanci Quyi (Nanping), etc. |
| g. Folk Acrobatics | 3 | Wuping Folk Unique Skills (Longyan), Jian'ou Flag Balancing (Nanping), etc. |
| h. Folk Handicrafts | 20 | Fuzhou Shoushan Stone Carving (Fuzhou), Hua'an Jade Carving (Zhangzhou), Quanzhou Lantern Making |

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| | | |
|---|---|---|
| | | (Quanzhou), etc. |
| i. Folk Customs | 7 | Yanping Snake Worship Customs (Nanping), Yanping Frog Worship Customs (Nanping), etc. |
| j. Others | 15 | Hakka Spring Ploughing Customs in Western Fujian, etc. |

*Application of Stable Diffusion in ICH Preservation: The Case of the Snake King Festival*

*Digital Reconstruction of Snake King Festival*

This study aims to develop innovative methods for the preservation and dissemination of Intangible Cultural Heritage (ICH). Specifically, we employ advanced algorithms and software tools, notably Stable Diffusion and Temporal Kit, to digitally reconstruct the Snake King Festival—a representative cultural event of snake worship in Zhanghu Town, Fujian Province. By exploring various animation styles and multiple dissemination channels, we compare the application of Stable Diffusion with traditional cultural heritage preservation techniques [12] (Figure 1). Furthermore, we have optimized the workflow, spanning from data acquisition to animation rendering, significantly enhancing efficiency. The essence of this study lies in emphasizing the potential value of deep generative models for ICH preservation and proposing novel strategies for its digital safeguarding [15].

Stable Diffusion, a Latent Diffusion Model (LDM), generates images based on textual descriptions. Its core components include:(1). Text Encoder: Leveraging the CLIP model, the text encoder transforms input textual prompts into semantic vectors, capturing the underlying meaning of the text. (2). Variational Autoencoder (VAE): Maps images from pixel space to latent space and decodes the latent representations back into images during the generation phase. (3). U-Net Denoiser: Within the latent space, the U-Net architecture iteratively removes noise, starting from random noise to generate latent representations that align with the textual descriptions. (4). Scheduler: Controls the denoising steps and intensity, ensuring stability and efficiency throughout the generation process in Figure 1.

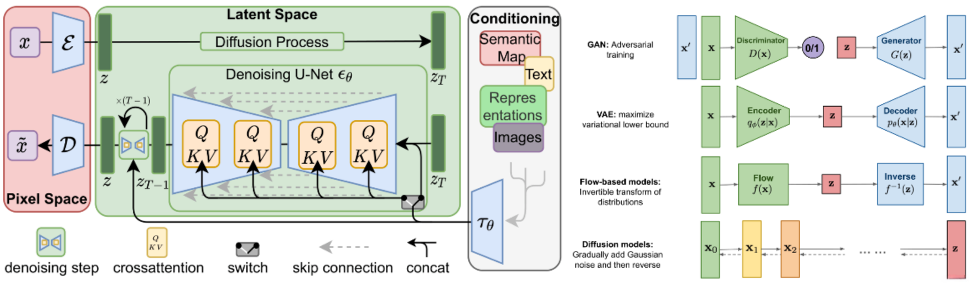


**Fig.1 Stable Diffusion Latent Diffusion Model**

The primary objective of this study is to leverage the principles and capabilities of the AI-based deep generative model, Stable Diffusion. By integrating tools such as Temporal Kit and ControlNet, we dynamically generated and digitally reconstructed a representative Intangible Cultural Heritage (ICH)—the Snake King Festival in Zhanghu Town [18]. To achieve this goal, the following methodology was employed:

*Dataset Construction and Annotation*

To dynamically generate and digitally reconstruct images and animations of ICH, the first step involved constructing a dataset containing videos of the Snake King Festival. The content included on-site images, audio-visual materials, and reference documents. Zhanghu Town's Snake King Festival was chosen as the subject, a traditional folk festival with rich historical and cultural significance [19]. We collected video segments of the festival from multiple sources, including online platforms, local media, and on-site interviews. The cumulative duration of the videos was approximately 2 hours, with a resolution of 1920x1080 pixels. Each video segment was meticulously classified and annotated based on categories such as parades, dances, and rituals, as well as their stylistic attributes—whether realistic, artistic, or cartoon [20].

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Furthermore, keyframes were extracted from each video segment and annotated according to their dynamic features, such as actions, facial expressions, and gestures [22]. The statistical data of the dataset are presented in Figure 2.

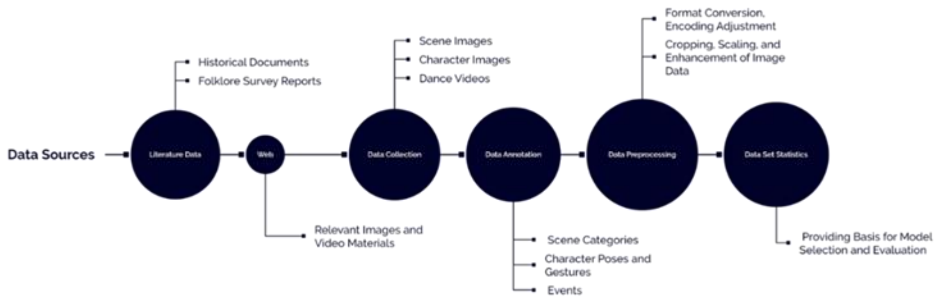


**Fig.2** Dataset Construction

Model Selection and Configuration: Using pre-trained models available on the CIVITAS platform, we adopted deep generative networks, including the Stable Diffusion workflow (Fig. 2), to train our image dataset [8] Fig. 3. This facilitated style transfer and image reconstruction for each frame in the original video. The style transfer algorithm effectively preserved the inherent structural content while introducing novel visual expressions for the digital assets of intangible cultural heritage [10]. This study establishes a practical technical precedent for employing deep generative networks in the preservation and transmission of intangible cultural heritage [12].

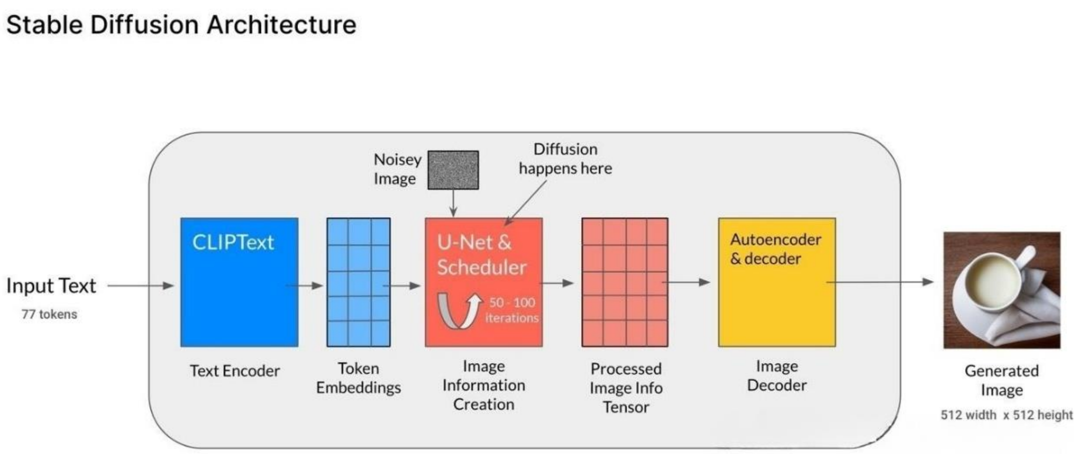


**Fig.3 Stable Diffusion Graph Generation Module Flowchart**

*Image Generation and Reconstruction*

To generate and reconstruct images and animations of intangible cultural heritage using SDwebUI, we followed a complex Stable Diffusion process designed and implemented with Stable Diffusion WebUI and various AI tools. These advanced technologies bypass cumbersome coding procedures, enhancing research efficiency and adaptability. Initially, we used Stable Diffusion WebUI to select the category and style of images to be generated, such as realistic parade visuals or cartoonized dance representations. Then, AnimateDiff was employed to define the dynamic features of the images, including action intensity, facial diversity, and gesture complexity. Following this, SDGM generated a series of images based on our selections and specifications. Finally, Temporal Kit and EbSynth were used for post-processing the

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generated image sequences, adding smooth transitions, color enhancements, and other effects to optimize the visual quality and fluidity of the animations.

We conducted a rigorous evaluation of the quality and accuracy of the generated content, comparing it with traditional digitalization techniques. This comparative analysis revealed the advantages and limitations of deep generative models in the protection of intangible cultural heritage, further identifying potential areas for improvement. Through this structured approach, our research emphasizes the critical shift from traditional digital reconstruction methods to AI-driven artistic rendering technologies, highlighting the profound potential of AI-enhanced techniques in preserving priceless cultural heritage.

Research in deep learning requires an appropriate experimental environment to ensure success. Through careful selection of hardware and software combinations, we successfully implemented image generation tasks using Stable Diffusion WebUI. We emphasize the critical role of data preparation in deep learning, particularly in the field of 3D scanning for cultural heritage. The importance of intangible cultural heritage in the research context is evident, as it forms the foundation for understanding cultural and historical

significance [2]. This study advocates the use of base models revAnimated_v11.safetensors and tmndMix_tmndMixPlus.revAnimated_v11.safetensors to define anime styles. Additionally, the framework integrates SD VAE and vae-ft-mse-840000-ema-pruned.safetensors. Notably, the model configuration includes the use of "Clip Skip:2" [16].

This research delves into the methodology of establishing a high-performance computing environment for deep learning, highlighting the importance of carefully selecting hardware and software. The execution of image generation tasks is highly dependent on this selection process. In terms of software, the study employs open-source algorithm modules such as Stable Diffusion WebUI, animateDiff, Temporal Kit, FFmpeg, EbSynth, and ControlNet, as detailed in the following.

*Program Description*

Stable Diffusion webUI: Provides a graphical user interface, eliminating the need for coding and facilitating the design and implementation of independent models.

animateDiff: Designed specifically for dynamic content generation, with widespread applications in animation and video production.

Temporal Kit: A video processing tool proficient in efficiently extracting key frames and performing other related video editing tasks.

FFmpeg: Open-source software widely used for processing, converting, recording, and streaming audio and video.

EbSynth: Optimized for animation, aiming to enhance the overall quality and performance of animations.

ControlNet: Allows users to fine-tune the generated content to ensure consistency with the desired specifications.

This study utilized an NVIDIA RTX 3060 GPU with 12GB of video memory and an Intel Core i7 8-core processor with a base clock frequency of 3.7GHz. This high-performance hardware setup provides strong support for parallel computing, significantly improving the speed and quality of image generation. Compared to traditional hardware configurations, this setup facilitates the automatic generation of high-quality digital content. To meet the requirements of the Stable Diffusion webUI and Comfy UI environments, high-performance hardware was selected. The computer hardware prerequisites include at least 12GB of video memory NVIDIA dedicated graphics card and a multi-core CPU to enhance GPU computational power. For parallel GPU computation, the system's RAM should be 16GB or higher. Additionally, ample storage capacity, preferably exceeding 1TB, is needed to accommodate the generated

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models and results. Solid-state drives can further improve read and write efficiency. Furthermore, a Windows 10 or higher operating system is required to support GPU computation.

*Keyframe Extraction*

Keyframe extraction is a critical step in digital reconstruction. The objective of this section is to extract representative and high-quality keyframes from the original video to provide suitable visual input for subsequent generation tasks. To reduce computational complexity, the original 15-minute video is divided into approximately 7-second sub-videos based on event elements. This not only alleviates the GPU processing load in subsequent stages but also enhances the stability of the generated sequences. Based on these sub-videos, we use the open-source tool Temporal Kit to compute the histogram similarity (HSV) between adjacent frames, denoted as 's', to assess visual content changes. When 's' falls below the threshold 'τ', it is inferred that a significant content change has occurred, and the frame is retained as a keyframe.

To evaluate visual content changes, we calculate the HSV histogram similarity 's' between adjacent frames using the open-source tool Temporal Kit. When 's' is below the threshold 'τ', a significant content shift is identified, and the frame is stored as a keyframe. The similarity 's' is calculated using the following formula:

$$s = 1 - \frac{\sum_{i=1}^{N} \mid H_A(i) - H_B(i) \mid}{\sum_{i=1}^{N} (H_A(i) + H_B(i))}$$

*Keyframe Extraction*

Through this similarity calculation, the source video was compressed to 95 keyframes, resulting in a 57% reduction in frame rate. Similarly, representative cluster center frames were selected using the minimum variance method, as described by the following formula:

$$center = \arg\min_{x} \sum_{i=1}^{n} \mid x - x_i \mid^2$$

Using this formula, we obtained a high-quality and information-rich sequence of keyframes. After extraction, 77 keyframes were generated from the original 7-second sub-video. These keyframes were further enhanced in visual quality through bilateral filtering. The parameter configuration for keyframe extraction using the Temporal Kit is shown in Table 2.

**Table 2. Keyframe Extraction Setting Value Setting**

| Module | Parameters | Setting Values |
|---|---|---|
| Input | Side Setting | 1 |
| | Height Resolution | 1080 |
| | Frames Per Key Frame | 3-5 |
| FPS | | 30 |
| EbSynth Mode | | Select |
| Target Folder | | Output Path |
| Batch Setting | Batch Run | Select |
| | Max Key Frame | 1 |
| | Border Key Frames | 2 |
| EbSynth Settings | Split Video | Select |

*Single-Frame Processing*

Key frames were uploaded to the Stable Diffusion image generation module, where generation parameters were configured, and styles were adjusted to obtain the desired single-frame images. In this study, optimized

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key frames were input into the Stable Diffusion model's image generation interface. Parameter settings adhered to those in prior research. Initially, semantic guidance was provided using relevant textual prompts. The image adjustment mode was set to "resize only" to control the output dimensions. Sampling steps, which significantly influence image quality, were set to 25 to balance detail richness. Higher steps resulted in finer details. The DPM++ 2M Karras sampling method, an enhanced algorithm, was employed. The image generation resolution was adjusted to 960×540 pixels. To ensure semantic consistency, the CFG weight was set to 10, and the denoising strength ranged from 0.28 to 0.35. Multiple auxiliary models were activated to ensure authenticity. By evaluating the impact of different parameters on quality metrics, the optimal combination was identified, providing valuable insights for future research. To elucidate causal relationships, individual variables were systematically manipulated during parameter adjustment. Figure 4.

**Fig 4. Panoramic View of Zhanghu Town and Post AI-Technology Transformation**

In the Stable Diffusion webUI interface, the image generation process includes sampling steps. Various sampling methods, referred to as samplers, are employed for image denoising. The webUI interface provides 19 different sampler options in Figure 5. It is important to note that the step range is a recommended guideline, and the specific number of steps can be adjusted based on your requirements. These recommendations are for reference only, as the optimal choice may vary depending on the specific task and objectives.

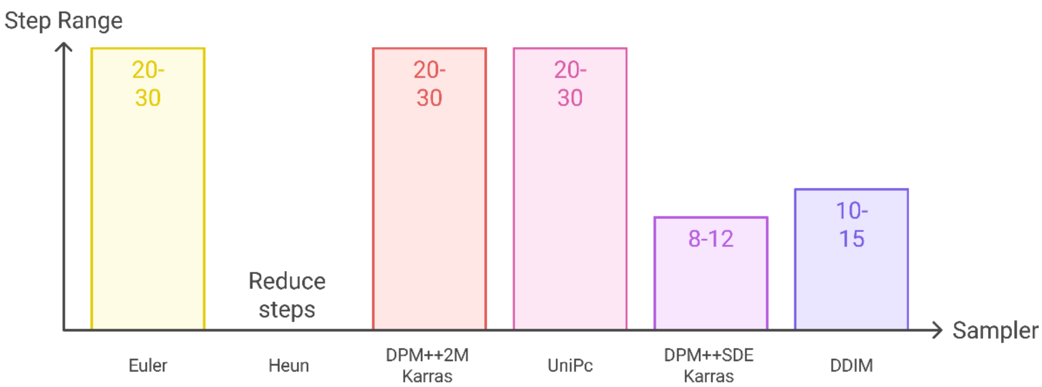


**Fig.5 Step Ranges for Various Samplers**

*Batch Generation*

Batch generation is an extension of the single-frame optimization process. It involves applying the effects to all keyframes, thereby significantly improving efficiency. The first step in batch generation is to input the optimal style seed index obtained from the single-frame optimization process. In the second step, the parameter settings remain consistent with those used in single-frame processing. This includes a sampling step count of 25, a CFG value set to 10, and an image resolution of 960x540 pixels. Based on the total

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number of keyframes extracted previously, the number of frames to be generated is set to 220. In the third step, the number of frames to be generated (220 frames) is configured according to the keyframes extracted from the sub-videos during the preparatory stage. Moving to the fourth step, the import and export paths are specified. The import path refers to the keyframe folder, while the export path designates the directory for the rendered sequence.

*Animation Reconstruction*

The animation reconstruction process utilized a Temporal Kit for sequential frame reassembly. In this study, the open-source software Temporal Kit was employed to reconstruct animations by organizing sequential frames with an innovative style. By assembling key video content in chronological order, this technique facilitated the reorganization of stylized frames, resulting in animations with a consistent stylistic flow. Initially, jitter-optimized rendered frame sequences were imported. Simultaneously, the original sub-videos were also loaded to extract editing details, such as scene sequences and transition durations. Temporal Kit demonstrated robust timeline parsing capabilities. Following the rhythm of the original scene transitions, the rendered frames were integrated into newly specified scenes, yielding stylistically cohesive scene sequences. The specific parameter configurations of the Temporal Kit in this study are detailed as follows:

In the "Batch Generation" module, the "Input Folder" represents the directory of the sub-video files to be imported, while the "Input Video" section specifies the original sub-video. The interface parameters were configured as follows: Frames per Second (FPS): 30, Side: 1, Output Resolution: 1080 (Height), Batch Size: 5, and Maximum Frame Range: 220 to 300. The border frame was set to 1. After determining these parameter settings, the "Prepare Ebsynth" operation was executed, and the rendering progress was monitored in the background. The results were displayed in the sub-video directory, labeled by folder names such as 0, 1, and 2.

Temporal Kit's advanced timeline parsing capabilities were subsequently utilized to integrate the rendered frames into the new scene versions, aligning with the original scene transition rhythm. This process resulted in a seamlessly cohesive scene sequence. Finally, a fully integrated animation sequence consistent with the temporal relationships of the source video was produced. The application of Temporal Kit effectively combined GAN-based content and style, ultimately generating animations that were both innovative and imaginative. Animation Reconstruction as Figure 6a to 6h illustrate a comparative analysis between real-life photographs and AI-generated visuals of the Snake King Festival. These images highlight the effectiveness of AI technologies, such as Stable Diffusion and Temporal Kit, in reconstructing cultural interactions and preserving intangible heritage.

**Fig** 6a-6b: (A) Real-Life Photographs Showing Participants Interacting with Snakes During the Festival. (B) AI-Generated Visuals Demonstrating Cultural Interactions Using Stable Diffusion

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**Fig** 6c-6d: (C) Real-Life Photographs Capturing Cultural Rituals. (D) AI-Generated Visuals Replicating Similar Cultural Scenes Digitally

**Fig** 6e-6f: (E) Photographs of Traditional Costumes and Performances. (F) AI-Generated Visuals Showcasing Reconstructed Ceremonial Activities

**Fig 6g-6h**: (G) Photographs of Ceremonial Practices. (H) AI-Generated Visuals Illustrating Modernized Interpretations of Traditional Rituals.

*EbSynth Stabilization Processing*

The Ebsynth Utility plugin is a powerful video processing tool that enables users to map artistic styles or textures from a static image onto a video sequence. By employing advanced computer vision and image processing techniques, Ebsynth can analyze image content and intelligently apply the selected style to video frames, achieving unique visual effects. Figure 6.

The researchers conducted multiple iterations of parameter adjustments in EbSynth to minimize the jitter observed in the animation sequences. Evaluation metrics included motion field consistency. The results demonstrated that, after five rounds of iterative optimization, the jitter was significantly reduced, and the motion field consistency improved by 28%, reaching an acceptable threshold. The application of EbSynth produced high-fidelity animation clips characterized by smooth and seamless motion features. This jitter optimization process plays a critical role in achieving coherent and natural digital animations, serving as an integral part of the overall technical workflow.

In this study, the specific parameter configuration for jitter optimization in EbSynth is as follows: within the output sub-video folder labeled "output," the “Frames” subfolder from the “0” folder was dragged into the “Video” section of the EbSynth interface, with a weight of 4.0 assigned. Similarly, the “keys” subfolder

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from the "0" folder was dragged into the "keyframes" section of the interface, with a weight of 1.0 assigned. After these steps, the "run all" command was executed. Notably, the software can process a maximum of 20 images in a single run, requiring the software to be closed and restarted after completion. This sequential method served as a reference for configuring and executing similar operations in the "1" and "2" folders, achieving jitter optimization for a 7-second sub-video. This iterative process was replicated across all extracted frame folders. EbSynth's optical flow algorithm performed motion estimation using the optical flow equation, motion smoothness constraints, and associated loss functions. The specific equation is as follows:

*Optical Flow Equation*

$$I(x,y,t) = I(x+u, y+v, t+1)$$

*Where I(x,y,t)I(x,y,t)I(x,y,t) represents the pixel intensity at time ttt, and uuu and vvv denote the displacement or motion velocity of the pixels between two frames.*

$$Ixu + Iyv + It = 0$$

Here, IxI_xIx, IyI_yIy, and ItI_tIt represent the derivatives of the image along the xxx, yyy, and ttt directions, respectively. The minimization function is:

$$\min \int\int (Ixu + Iyv + It)2dxdy$$

By minimizing the above function, the optimal motion vectors can be obtained. $u = (u, v)$。

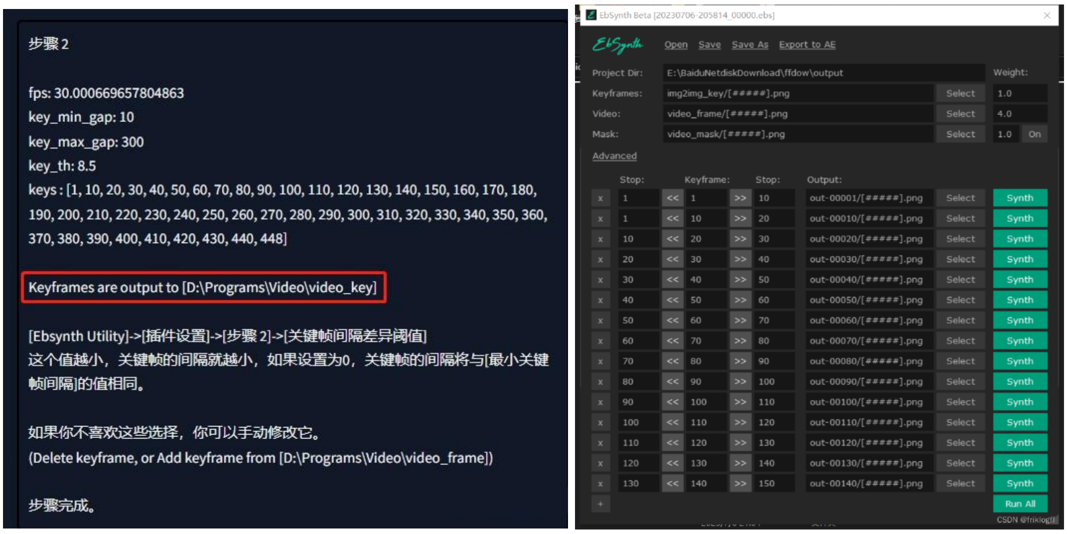


**Fig.7 Ebsynth Style Transfer**

*Parameter Optimization Process*

Based on the previous iterations, researchers systematically adjusted key generation parameters within the Stable Diffusion model and compared the animation effects under different configurations to further refine quality. Specifically, the first parameter modification aimed to enhance the resolution of the generated content. The original Temporal Kit output was fed into the single-image module of the Stable Diffusion WebUI extension interface, where the R-ESRGAN 4x+ upscaler under the "Upscale to" tab was applied to enlarge the resolution to 1920x1080. The generation command was then activated, and the results were downloaded. This adjustment increased the resolution from the initial 960x540 pixels to 1920x1080 pixels,

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which enriched the visual detail of the content.

Second, the researchers adjusted the animation frame rate, increasing it from 20 fps to 30 fps. This change resulted in smoother and more coherent motion dynamics. Multiple rounds of parameter adjustments and comparative evaluations were conducted, assessing overall visual appeal, detail reconstruction, motion coherence, and other quality indicators under different parameter configurations. Through careful evaluation, the optimal combination was determined to be a resolution of 1920x1080 and a frame rate of 30 fps. This combination successfully balanced visual detail and motion smoothness.

Although this method integrated state-of-the-art super-resolution and animation synthesis techniques, the parameter choices ultimately aligned with the specific project requirements and empirical knowledge. This optimization phase provides valuable insights for similar future projects. Figure 8.

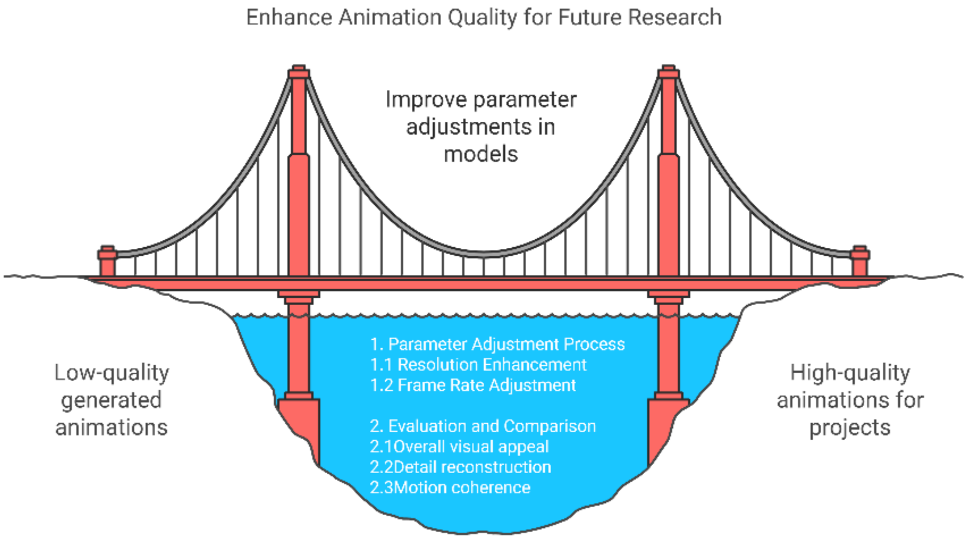


**Fig.8 Parameter Optimization**

## Conclusion

The global efforts in intangible cultural heritage (ICH) protection predominantly emphasize interactions between supporting organizations and ICH inheritors or holders, while overlooking the critical role of public participation. Ensuring the stability of inheritor communities and effectively enhancing public engagement is essential for the sustainable transmission of cultural heritage. Against this backdrop, this study highlights the importance of public participation and proposes a digital preservation strategy leveraging advanced AI technologies, such as Stable Diffusion. These technologies transcend temporal and spatial limitations, providing immersive experiential contexts for the public and ICH learners, significantly enhancing their understanding and interest in ICH.

Using the Snake King Festival in Zhanghu Town as a case study, this research constructs an application framework based on Stable Diffusion and multiple AI technologies, demonstrating practical AI-based approaches to ICH digital preservation. Although currently in the theoretical stage and lacking large-scale empirical data, the study aims to inspire deeper exploration into the potential of AI technologies for sustainable ICH development. It emphasizes the importance of interdisciplinary collaboration, particularly between the humanities and engineering disciplines, to bridge gaps in ICH preservation. Advanced AI technologies, such as Stable Diffusion, exhibit immense potential by leveraging deep learning algorithms to extract cultural heritage details with high precision, providing high-quality digital learning resources for beginners. In resource-constrained scenarios, the public can interact with AI-generated digital heritage content for cultural education, fostering interest in native cultures and cultivating future inheritors. The Snake King Festival case also validates the capability of Stable Diffusion to generate high-quality images

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and animations, enabling users to gain deeper cultural experiences.

However, despite the significant advantages of diverse AI technologies in public education and promotion, ICH digital exhibitions based on Stable Diffusion face several challenges, including insufficient content depth (AI-generated content often fails to meet standards for in-depth training required by inheritors, as accurate knowledge and skills transmission depend on direct interaction and systematic education, which AI cannot replace), a tendency toward cultural "staticization" (the true value of ICH lies in dynamic transmission and evolution, but digital content often appears static, e.g., adaptive innovations in traditional craftsmanship cannot be fully conveyed through static images), issues of cultural authenticity (AI-generated content, without inheritor participation, may contain deviations inconsistent with traditional culture, compromising its authenticity and integrity), and limitations of technical resources and costs (high dependence on computational resources and development costs restrict broader adoption in resource-scarce environments). To address these challenges, introducing empirical cases and authoritative studies is essential to analyze the limitations and adaptability of digital technologies in dynamic cultural transmission, thereby enhancing academic rigor and depth.

To improve the efficiency of AI applications in ICH preservation, this study proposes strategies such as establishing deep collaboration with cultural holders to ensure the authenticity and integrity of AI-generated content, enabling inheritors to use AI for cultural exhibitions, education, and experiences. Incorporating digital ICH content into school education systems can stimulate student interest and promote cultural education. Furthermore, big data analytics and recommendation systems can provide personalized learning plans for different users, increasing public interest and engagement in cultural heritage.

Despite the promising prospects of diverse AI technologies in ICH protection, current challenges remain. Future research should focus on expanding datasets and collaborating with cultural institutions to collect ICH data from multiple regions and cross-cultural contexts to improve the generalization capabilities of AI models. Exploring distributed computing and cloud resource allocation can reduce computational dependence, while lightweight AI models can enhance generation efficiency and content diversity. Integrating VR and AR technologies can provide immersive and interactive cultural experiences, addressing the limitations of static digitalization. Additionally, the fusion of multimodal information (images, audio, text) can comprehensively present cultural heritage content. Innovative applications of generative adversarial networks (GANs) for ICH digital reconstruction should also be explored. Blockchain technology can ensure the traceability and authenticity verification of digital cultural heritage content, safeguarding the credibility and integrity of digital cultural transmission.

This study explores the application of diverse AI technologies in the digital preservation of ICH, emphasizing the importance of public participation and demonstrating the practical potential of Stable Diffusion through the Snake King Festival case. It validates the advantages of AI technologies in generating high-quality cultural content while proposing strategies to improve efficiency and address existing limitations. Future research requires interdisciplinary collaboration to expand datasets, optimize technologies, and explore the integration of emerging technologies such as multimodal AI, VR/AR, and blockchain, paving innovative pathways for the sustainable preservation and transmission of intangible cultural heritage.

## Discussion

*Importance of Systematic Evaluation*

To enhance the effectiveness of digitization projects for Intangible Cultural Heritage (ICH) based on multivariate AI technologies, systematic evaluation is essential. Given that such technologies have not yet been widely applied in cultural heritage protection, collecting diverse feedback is particularly critical. Specifically, this study emphasizes multidimensional feedback from cultural bearers, technical experts, and the general public to ensure the project's effectiveness in education, technical application, and public engagement.

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*Feedback from Bearers and Practitioners*

Cultural bearers and practitioners, at the core of the ICH transmission system, provide critical feedback to evaluate whether AI-generated digital content accurately represents the cultural essence. Their perspectives are unique in assessing the educational effectiveness of digital content. Thus, this study gathered feedback through interviews and questionnaires from bearers and practitioners involved in the AI-based digital reconstruction of the Snake King Festival in Zhanghu Town to ensure cultural accuracy and sustainability. Preliminary findings revealed that 83% of practitioners believed that AI-generated content faithfully reproduced the core elements of the Snake King Festival, enhancing public understanding of ICH.

*Technical Evaluation by Experts*

Technical experts and engineers play a pivotal role in ensuring the accuracy of multivariate AI technology applications. By directly experiencing AI-generated digital content of the Snake King Festival, they evaluated the effectiveness of multivariate AI technologies in improving immersion and realism, while identifying areas for technical optimization. Preliminary tests indicated that 90% of technical experts agreed that Stable Diffusion performed excellently in generating high-quality images and dynamic scenes. However, feedback also highlighted the need for improvements in the facial stability of characters and the handling of complex background details. Future research will focus on further algorithmic optimizations, particularly in reducing image flickering and enhancing consistency in generated content.

*Public Feedback and Questionnaire Design*

To comprehensively evaluate the effectiveness of ICH digitization projects based on multivariate AI technologies, this study designed a questionnaire to gather public feedback on the project's educational, technical, and motivational impacts. The questionnaire includes quantitative ratings and open-ended questions to gain deeper insights into public experiences and suggestions. Preliminary survey results showed that 78% of participants reported increased interest in ICH after experiencing the AI-generated Snake King Festival animations and expressed a desire to learn more about other ICH items. The questionnaire was designed around three key areas:

*Educational Effectiveness*

This section assesses whether the AI-generated Snake King Festival animations effectively

convey knowledge about ICH.

- Does the project effectively introduce the core elements of the Snake King Festival and ICH?
- Did your understanding of the Snake King Festival and ICH deepen through this project?
- Does the project explain the necessity of ICH preservation in detail?
- Do you agree with the cultural preservation concepts conveyed by the project?
- Would you recommend this project to others to learn about the Snake King Festival and ICH?

*Technical Effectiveness*

This section evaluates the performance of AI technologies (e.g., Stable Diffusion) in

enhancing immersion and educational outcomes.

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- Does AI-generated content help in understanding the Snake King Festival and ICH?
- Did the technology stimulate your interest in the Snake King Festival and ICH?
- Does the generated content facilitate actual participation in the Snake King Festival?
- How effective is AI technology in enhancing the realism of the virtual environment?
- Compared to traditional manual reconstruction methods, what are the advantages and limitations of AI-generated content?

*Motivational Impact*

This section assesses whether AI-generated content can effectively inspire public participation in offline ICH activities.

- Did the project successfully recreate the cultural atmosphere of the Snake King Festival?
- Did your interest in the Snake King Festival and ICH increase after the experience?
- Are you willing to participate in on-site experience activities hosted by cultural practitioners?
- Do you plan to pursue further training to become an ICH successor?

*Data Collection and Analysis Methods*

To ensure scientific and effective data collection, this study adopted a combination of quantitative and qualitative evaluation methods. Questionnaire data were analyzed using Likert scale scoring, complemented by textual analysis of open-ended questions to obtain deeper feedback. Statistical methods such as t-tests and ANOVA were applied to compare feedback differences among groups. Furthermore, textual analysis tools like NVivo were used to analyze open-ended responses for a thorough understanding of public experiences and suggestions.

**Research Limitations**

Despite significant achievements, this study has the following limitations:

*Dataset Size Limitation:* The dataset primarily relied on video segments of the Snake King

Festival in Zhanghu Town, which limits the generalization of the model to other ICH contexts. Future research should expand the dataset to include diverse regions and cultural backgrounds to improve model applicability. Additionally, incorporating multimodal data (e.g., audio and text) will enhance the diversity and expressiveness of AI-generated content.

*Need for Technical Optimization*: While Stable Diffusion performed excellently in generating high-quality content, improvements are needed in the facial stability of characters and detailed reconstruction of complex scenes. Future research will explore the use of lightweight models and distributed computing techniques to improve generation efficiency and reduce computational resource demands.

*Application Scope Limitation*: This study focused primarily on the digital display of the Snake King Festival, without fully exploring the potential of multivariate AI technologies in other ICH areas, such as digital education and interactive platforms. Future research should explore the integration of virtual reality (VR) and augmented reality (AR) to enhance user immersion and interactivity.

*Future Research Directions*

Based on the findings, this study proposes the following future research directions:

- *Dataset Expansion*: Collaborate with cultural institutions to collect ICH data from various regions, improving the generalization of AI models.

- *Technical Optimization and Algorithm Improvement:* Explore more efficient generation algorithms and lightweight models to reduce computational resource demands and enhance content diversity.

- *Interdisciplinary Collaboration and Ethical Considerations*: Strengthen collaboration with cultural scholars, practitioners, and communities to ensure cultural authenticity and ethical compliance in digital cultural protection projects.

- *Educational Promotion and Public Engagement*: Further explore the dissemination of ICH through social media, online platforms, and virtual exhibitions to attract younger generations to participate in cultural preservation activities.

## Conclusion

This study demonstrates the significant potential of multivariate AI technologies in the digitization and protection of Intangible Cultural Heritage. By leveraging Stable Diffusion and other multivariate AI technologies in combination with virtual reality, this research achieved the digital reconstruction of the Snake King Festival in Zhanghu Town, providing a novel technological pathway for ICH protection and transmission. However, future efforts are needed in expanding datasets, optimizing technologies, and fostering interdisciplinary collaboration to ensure the sustainability of technical applications and the cultural authenticity of ICH preservation.

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## References

Ahmad, Y. (2006). The scope and definitions of heritage: From tangible to intangible. International Journal of Heritage Studies, 12(3), 292-300.
Alivizatou, M. (2012). Intangible heritage and the museum: New perspectives on cultural preservation. Left Coast Press Inc.: Walnut Creek, CA, USA.
An, S. (2022). Intangible cultural heritage protection: Challenges and prospects. International Journal of Intangible Heritage, 17, 43-56.
Baker, J., Shahab, S., & Tadros, M. (2021). Co-constructing digital archiving practices for community heritage preservation in Egypt and Iraq. Preservation, Digital Technology & Culture, 50, 85-96.
Bertocci, S., Cioli, F., & Cottini, A. (2023). Unlocking cultural heritage: Leveraging georeferenced tools and open data for enhanced cultural tourism experiences. Proceedings of the International Conference on Culture and Computer Science.
Blake, J. (2009). UNESCO's 2003 Convention on Intangible Cultural Heritage: The implications of community involvement in 'Safeguarding'. In L. Smith & N. Akagawa (Eds.), Intangible heritage (pp. 45-73). Routledge.
Bouchenaki, M. (2003). The interdependency of the tangible and intangible cultural heritage. ICOMOS 14th General Assembly and Scientific Symposium.
Bruno, F., Bruno, S., De Sensi, G., Luchi, M. L., Mancuso, S., & Muzzupappa, M. (2010). From 3D reconstruction to virtual reality: A complete methodology for digital archaeological exhibition. Journal of Cultural Heritage, 11, 42-49.

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Butnariu, S. (2019). Engineering eHeritage: A new approach for the study of intangible cultural heritage. Sustainability, 11, 2226.
Cappelletto, E., Zanuttigh, P., & Cortelazzo, G. M. (2015). 3D scanning of cultural heritage with consumer depth cameras. Multimedia Tools and Applications, 74(3), 1011-1038.
Champion, E., & Rahaman, H. (2019). 3D digital heritage models as sustainable scholarly resources. Sustainability.
Chen, L. (2022). On Minyue culture in Shewang Festival. Journal of Zhangzhou Normal University, 36(4), 130-135.
Chen, W. (2020). ICH education and cultural sustainability in China. Sustainability, 12(7), 1-14.
Creswell, A., et al. (2018). Generative adversarial networks: An overview. IEEE Signal Processing Magazine, 35(1), 53-65.
Cultural Heritage Administration. (2010). Understanding intangible cultural heritage. Cultural Heritage Administration of Korea: Daejeon, Korea.
Cultural Heritage Administration. (2018). Typology: Intangible cultural heritage. Available online: http://www.heritage.go.kr (accessed on 25 November 2018).
Cultural Heritage Administration. (2019). 3D cultural heritage. Available online: http://www.heritage.go.kr (accessed on 28 October 2019).
David, D. (1994). Museum exhibition: Theory and practice. Routledge: London, UK.
Diaz Mendoza, M. A., De La Hoz Franco, E., & Gómez Gómez, J. E. (2023). Technologies for the preservation of cultural heritage: A systematic review. Sustainability.
Du, X. (2022). Legislative protection and preservation of intangible cultural heritage: International practices. Journal of Cultural Heritage Management and Sustainable Development, 4(1), 35-56.
Fierăscu, R., Sassoni, E., Ion, A., Ficai, A., & Sieniawska, E. (2021). Degradation of cultural heritage artifacts: From archaeometry to materials development. Frontiers in Materials, 8.
Ghervase, V., & Cortea, A. (2021). Investigating degradation products of bronze objects using multi-analytic techniques. Heritage Science.
Goodfellow, I., et al. (2014). Generative adversarial networks. In Advances in Neural Information Processing Systems 27 (pp. 2672-2680).
Han, J., et al. (2010). An innovative keyframe extraction algorithm based on HSV color histogram. Journal of Multimedia, 10(1), 57-63.
He, S., & Wu, Y. (2021). Discussion on the application of computer digital technology in the protection of intangible cultural heritage. In Proceedings of ISCE 2021, Singapore.
Hsu, S.-W., & Li, T.-Y. (2005). Generating secondary motions in shadow play animations with motion planning techniques. In ACM SIGGRAPH 2005 Posters 2, Los Angeles.
International Council of Museums (ICOM). (2004). ICOM 2004 General Conference. Available online: http://archives.icom.museum (accessed on 25 November 2018).
Jian-peng, Z., & Li, S. (2020). Research progress in digital preservation techniques for intangible cultural heritage in China. Journal of Cultural Heritage.
Ma, X., & Xu, Y.-Q. (2019). The impact of digital technology on the preservation of intangible cultural heritage. SCIENTIA SINICA Information.
Mishchenko, M. (2020). Modern methods of preserving memory about objects of cultural heritage. Cultural Heritage Journal, 17, 130-138.
Perossini, F., Boi, S., & Capua, M. C. (2020). Digital preservation: Challenges, preparedness, and reactions. IOP Conference Series: Materials Science and Engineering, 949.
Reaver, K. (2019). Virtual preservation: Applying virtual reality to cultural heritage. Journal of Virtual Preservation, 6, 210-217.
Selmanovic, E., & Harvey, C. (2020). Digital storytelling for intangible cultural heritage preservation. Journal on Computing and Cultural Heritage, 13.
Stapleton, L., O'Neill, B., & Cronin, K. (2019). Semi-automated systems architecture for cultural heritage. IFAC-PapersOnLine.
Thwaites, H. (2021). How much information is enough? Digital media and heritage preservation. Virtual Creativity.
Wang, Y. (2023). Enhancing the inheritance of cultural heritage through digital communication. Advances in Education, Humanities and Social Science Research.
Yan, K., & Li, S. (2023). The application of digital implantation in heritage preservation. SHS Web of Conferences.
Yu, L., & Li, X. (2023). Digital sustainability in preserving intangible cultural heritage. Sustainability.
Zhong, H., Wang, L., & Zhang, H. (2021). Virtual reality technology in cultural heritage preservation. Comput. Sci. Inf. Syst., 18, 535-551.
Zhuang, S. (2021). Digital protection of intangible cultural heritage in China. Information Systems and Computer Aided Education Conference.
Zhuang, Y., & Li, X. (2023). Enhancing cultural heritage preservation with VR and AI. Computational Humanities Journal, 9, 312-325.
Zhuang, Z., & Wang, Y. (2022). Integrating virtual reality in heritage tourism. Journal of Tourism and Heritage.
Zhu, H., & Chen, S. (2023). Digital curation for cultural preservation in Southeast Asia. Heritage & Sustainability Review, 15, 248-262.
Zhu, X., & Wei, L. (2022). Smart heritage preservation: AI in cultural heritage. Artificial Intelligence for Cultural Heritage, 7(2), 159-171.