Research on User's Subjective Preference of Taohuawu New Year Painting Based on CycleGAN

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Abstract. Objective. Exploring a feasible method for studying users' subjective preferences of image samples based on style transfer; exploring contemporary young people's subjective preference for different styles in the historical development of Taohuawu New Year painting. **Methods.** A detailed review of the development and style evolution of Taohuawu New Year painting. CycleGAN (Cycle Generative Adversarial Networks) was used to transfer the two artistic styles of Changmen Kusu Prints and Taohuawu woodblock New Year paintings to the typical representative pictures of Taohuawu New Year pictures, and to conduct user preference experiments on the images of the two styles. **Results.** The images of Changmen Kusu Prints style had higher user preference. **Conclusions.** CycleGAN can be effectively applied to the study of users' subjective preference for images; Changmen Kusu Prints is more favored by contemporary young people in terms of quality, style and subject matter, and it is necessary to focus on its inheritance and development.

Keywords: CycleGAN · Taohuawu New Year painting · User preference · Style transfer

1 Introduction

Intangible Cultural Heritage is an important spiritual wealth for the survival and development of a country and a nation. Our country is rich in Intangible Cultural Heritage resources, and as a descendant of Yan and Huang, we have an inescapable responsibility for the inheritance of national culture [1]. Suzhou Taohuawu New Year painting has a long history and are widely circulated among the masses for its fine workmanship and rich decorative effect [2]. Suzhou Taohuawu New Year painting has left many works of different themes and styles after hundreds of years of development, but its development in modern is in trouble. The primary problem is that it does not understand the preferences of contemporary young people and cannot form a wide spread among them. Therefore, it is necessary to understand the style preferences of contemporary young people on New Year paintings from the perspective of user preferences.

1.1 Research Status

Taohuawu New Year paintings were once very popular, and scholars' research on them has never stopped. The first is to systematically study Taohuawu New Year paintings from a broad perspective. Liu et al. [3] used the method of "cultural translation" to extract and design the cultural IP of Taohuawu New Year Woodblock paintings, and finally completed the design of Taohuawu New Year Woodblock paintings digital cultural creation. In addition, Zhang [4] used virtual reality technology to digitally display Taohuawu New Year Woodblock paintings. From the iconographic research of Taohuawu New Year paintings, Zhao et al. [5] interprets the multi-layered cultural images of Taohuawu New Year paintings and applies them to clothing design. Wang et al. [6] extracted the modeling elements of Taohuawu New Year paintings and applied them to modern interior design.

With the advent of the experience era, the research on users' subjective preferences has become the focus, how to collect users' subjective data in a timely manner in real situations, there is no systematic method [7]. Specifically for media research samples such as pictures and videos, there are generally two existing user subjective preference experimental methods. One is the selection of carousel pictures, which is simple to operate, but the physical and psychological burden of the participants will be relatively large when the number of samples is large, and the time cost and labor cost are relatively high. The other is to use equipment such as eye-tracking devices for objective statistics, some eye-tracking devices are head-mounted, although they can more accurately reflect the user's attention on an image. However, the price is high and the samples collected are relatively limited, which not only has a certain impact on the user's psychology, but also makes the operation relatively difficult [8].

Summarizing the above research, it can be found that most of the research on Taohuawu New Year paintings is to select a small number of samples, extract image features and apply them to other design fields, without clearly distinguishing their historical development period and different styles. This kind of research on user's subjective preference for pictures mostly chooses the way of carousel pictures, and the number of samples will greatly affect the experimental results. Therefore, it is necessary to make a clear distinction between the historical development periods and different styles of Taohuawu New Year paintings. At the same time, CycleGAN can be used to train the different styles of New Year paintings, and use the typical representative of Taohuawu New Year paintings themes as content images to style transfer. Which can largely avoid the above problems in the process of researching user preferences, and obtain more accurate experimental results.

1.2 Research Content and Process

As shown in Fig. 1, Taohuawu New Year paintings have gone through periods of development such as origin, prosperity, and transformation, and during these centuries of development, numerous works with different themes and styles have appeared. In conclusion, this art would consist of two major periods. In the first period, from the Early Qing Dynasty to the Taiping Heavenly Kingdom period, which is academically called the
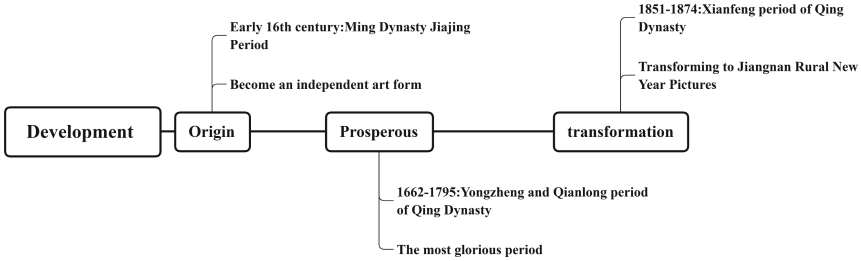
Fig. 1. The development period of Taohuawu New Year painting

Changmen Kusu Prints, which also belongs to the category of Taohuawu New Year paintings. After the Taiping Heavenly Kingdom, it was the Taohuawu New Year Woodblock paintings. These two periods saw a major change in the style of New Year paintings, a detailed comparison of which is shown in Table 1.

Table 1. Comparison of the two periods of Taohuawu New Year pictures

	Changmen Kusu prints	Taohuawu New Year woodblock painting
Period	Early Qing Dynasty-Taiping Heavenly Kingdom	Taiping Heavenly Kingdom-Now
Time background	Social stability, economic development, cultural prosperity	Social turmoil, people's livelihood
Artistic features	The work is magnificent, pays attention to perspective and light and shadow, finely portrayed, and has an elegant style	The style is festive and warm, bright and simple, with strong contrast
Subject matter	Mainly depicting urban life and civic life	Demonstrate rural life and customs

The Changmen Kusu Prints and the Taohuawu New Year Woodblock painting became two styles of samples for the study.

The research process is shown in Fig. 2.

Firstly, collected samples of two major periods of New Year paintings through literature research and field investigation, and screened the obtained samples. Secondly, processed the screened image samples for style training, formed two major New Year painting style libraries. Thirdly, selected content images for style transfer and conducted user preference experiments. Lastly, analyzed the experimental results.
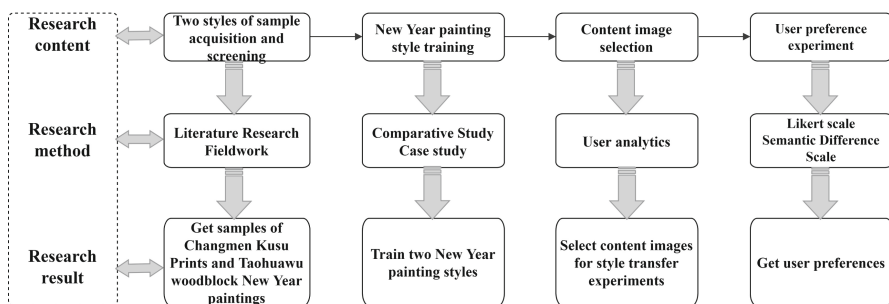
Fig. 2. Research flow figure

2   Materials and Methods

2.1   Sample Acquisition and Screening

Through literature research, field investigation, expert interviews, etc. Obtained a total of 350 samples from Shanghai Library, Suzhou Taohuawu New Year Woodblock Paintings Society, Taohuawu New Year Woodblock Paintings Museum and other places, and screened the collected samples to remove duplicates and resolutions. After the lower sample, there are 338 remaining samples, including 128 samples of Changmen Kusu Prints and 210 samples of Taohuawu New Year Woodblock paintings.

2.2   Style Training Experiment

2.2.1   Select Content Image

This experiment required the selection of content images for the style transfer of the two styles trained. According to research and observation, most of the Taohuawu New Year paintings show folklore, historical stories, operas, ladies and flowers, etc. Therefore, this paper conducted a photo search with the keywords "Suzhou + five main themes" and obtained 25 sample pictures. 20 experimenters in the field of design and culture were invited to select 5 samples (one for each of the 5 main themes) that best matched the impression of Taohuawu New Year paintings as content images according to their subjective impressions. The final selected content images are shown in Fig. 3.

| Book drying | Lixuetang | Peony Pavilion | Lady | Tulip |

Fig. 3. Content image selection

2.2.2 Training Model Selection

The implementation of this experiment mainly relies on the image style transfer technology in the computer field. The current mainstream image style transfer technology based on deep learning can be roughly divided into two types, one is CNN (convolutional neural network), and the other is through CycleGAN. CNN consists of a series of convolutional matrix operation layers and is widely used in image analysis and object recognition. CycleGAN can capture features from one image set [9] and can transfer these features to other image sets, enabling domain-to-domain image transformation.

Firstly, the effect of the two technical models is compared through the pre-experiment. The pre-experiment selects the Changmen Kusu Prints as the experimental sample for the control experiment. The comparison results are shown in Fig. 4.

As shown in Fig. 4, in terms of content retention, CycleGAN can retain more details than CNN, and a lot of details in the images processed by CNN are lost, and only part of the edges are enhanced. In terms of style retention, the style features retained by Cycle-GAN technology are also more obvious and vivid. For a comprehensive comparison, we use CycleGAN technology to conduct the following experiments.

Fig. 4. Comparison of CycleGAN and CNN

2.2.3 Training Process

The resolution of the sample images screened in Sect. 2.1 is processed to 256 * 256, and the main body of the content should be ensured to the greatest extent possible during the processing. The final training sample picture is shown in Fig. 5 (only the part is shown).

The experiment was carried out using a cloud server, the server was a Linux system, the CPU model was Intel Xeon Gold 5218, the GPU model was Tesla T4, and the video memory was 16G. The software platform used in the experiment is PyCharm Professional 2021.3.1, which is connected to the cloud server through PyCharm, and the programming language used is Python 3.8. First, the two styles of generators are trained separately for 200 epochs, and then the trained generator is used to generate style images.
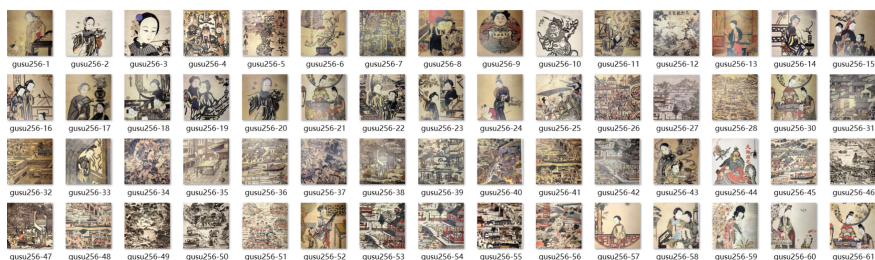
Fig. 5. Training sample display (part)

Finally, five images of each style are obtained, with a resolution of 1024*1024, and the numbers are as follows shown in Fig. 6.

Style:
Changmen Kusu
Prints

C1   C2   C3   C4   C5

Style:
Taohuawu New Year
Woodblock Paintings

S1   S2   S3   S4   S5

Fig. 6. User preference experiment image

2.3   User Preference Experiment

In order to accurately measure the user's preference for the two styles of Changmen Kusu Prints and Taohuawu New Year Woodblock paintings, authoritative image evaluation standards are needed. At present, most of the academic research on image evaluation is based on the three-layer theory proposed by German art historian Erwin Panofsky. The three-layer theory refers to pre-iconography, iconography, and iconology, and perfected and optimized on this theoretical basis [10]. In 2015, Huang [11] proposed a three-layer theory of image topic description on the basis of Panofsky's theory, including the visual characteristics of images, the meaning and interpretation of images, and the functions of images. Among them, the visual features of an image are mainly the evaluation of visual elements such as color, shape, and form, and the meaning and interpretation of an image is to reflect the meaning of the image. The image function mainly emphasizes the emotional and psychological impact of the image on the viewer.

Since this study uses the same content images for style transfer, excluding the meaning and explanatory factors of the images, the preference study for image style will be

conducted from two dimensions, the visual characteristics of images and the emotional and psychological effects of images on viewers.

The first is the visual characteristics of the image, excluding the influence of the same visual factors (shape, color, line, etc.) brought by the same content image, and comprehensively evaluates from the two aspects of color and texture. With the help of literature research related to design and iconography, vocabulary describing the color and texture of Taohuawu New Year paintings is collected and filtered to obtain nine subdimensions for evaluation. The style image color dimensions were evaluated as: harmonious and unified, real and imaginary, soft, rich and crystal clear; the style image texture dimensions were evaluated as: uniform, gorgeous, clear and rich in texture. The experimenters gave a score of 1–5 based on their subjective feelings about the style images of New Year paintings, and the collected data were used to analyze the preference survey for the visual characteristics of style images.

The second is the experiment on the influence of style images on users' emotions and psychology. Using semantic analysis method and desktop research to collect 56 adjectives with user perception descriptions of Taohuawu New Year paintings from the Internet, Taohuawu New Year painting books and papers. Preliminary screening was carried out by eliminating the same words and synonyms, and 36 primary semantic words were selected; through interviews with relevant staff and research enthusiasts, the words were further screened, and finally 9 groups of adjective phrases with opposite semantic expressions were selected. The final choice of words must have the following characteristics.

Firstly, they can better reflect the psychological or emotional feelings of the Taohuawu New Year painting style. Secondly, there are clear and opposite emotional semantics between phrases. According to the emotional and psychological influence words corresponding to the above samples, the corresponding Richter seven-level scale was established, and the user's subjective preference survey questionnaire was made. The final semantic difference scale is shown in Table 2.

Table 2. Semantic Difference Scale

Semantics (negative)	Score							Semantics (positive)
Detached	−3	−2	−1	0	1	2	3	Complete
Discord	−3	−2	−1	0	1	2	3	Harmonious
Ugly	−3	−2	−1	0	1	2	3	Beautiful
Old	−3	−2	−1	0	1	2	3	Novel
Boring	−3	−2	−1	0	1	2	3	Interesting
Vulgar	−3	−2	−1	0	1	2	3	Elegant
Ordinary	−3	−2	−1	0	1	2	3	Unique
Rough	−3	−2	−1	0	1	2	3	Exquisite
Worthless	−3	−2	−1	0	1	2	3	Valuable

The procedure of the experiment is that the experimenter watches the experimental samples, and comprehensively judges the two styles from the two dimensions of the visual characteristics of the image and the impact of the image on the user's emotion and psychology.

In this experiment, the user is completely based on subjective ideas, without any human interference.

3   Results

The purpose of this research is to investigate users' preferences for the two styles of Changmen Kusu Prints and Taohuawu New Year Woodblock paintings. A total of 100 online questionnaires were sent out, of which 30 participants were postgraduates in the field of design and culture, college teachers and Taohuawu related practitioners, while the rest of the questionnaires were sent to people aged 16–30 in different cities, with different educational backgrounds and different occupations.

Before the data analysis, the reliability and validity of the questionnaire need to be analyzed to ensure that the data obtained from the questionnaire has analyzable value. After testing, the reliability and validity of this scale questionnaire are good, and the data obtained have analytical value. The collected samples were tested by paired sample T test in SPSS, and the final results are shown in Table 3.

Table 3. Statistical table of user preference experiment results (use shorthand for sample names)

Dependent variable	Mean (SD)		
	Changmen	Taohuawu	p
Image visual features	3.40 (.12)	2.91 (.18)	0.042
The impact of images on users' emotions and psychology	1.01 (.35)	0.29 (.42)	0.032

As shown in Table 3, in terms of the visual characteristics of the images, there is a significant difference between the Changmen Kusu Prints and the Taohuawu New Year Woodblock paintings ($p < 0.05$), and the average value of the Changmen Kusu Prints of 3.40 is greater than that of the Taohuawu New Year Woodblock paintings 2.92, therefore, the visual features of Changmen Kusu Prints are more popular with contemporary young people; there are also significant differences between the two styles in the impact of images on users' emotions and psychology ($p < 0.05$), and Changmen's scored higher than the Taohuawu.

Based on the above results, the user preference of Changmen Kusu Prints is higher than that of Taohuawu New Year Woodblock paintings. That is to say, Changmen Kusu Prints style are more popular among contemporary young people. Next, analyze the reasons for this result by analyzing specific image samples.

Figure 7 shows the representative samples of the Changmen Kusu Prints and Tao-huawu New Year Woodblock paintings. First of all, in terms of craftsmanship, the Changmen Kusu Prints is very exquisite, and the engraving and multi-color overprinting techniques are extremely high. Therefore, its works are more exquisite, in line with the quality of life pursued by contemporary young people.

Secondly, in terms of style, the Changmen Kusu Prints is not so full of New Year's flavor, its vivid charm and elegant style, and thus more in line with the hobbies and aesthetic needs of contemporary young people.

In addition, in terms of subject matter, the Changmen Kusu Prints mostly depicts urban life and civic life, and is basically a depiction of actual scenes, which is closer to the life of contemporary young people; while Taohuawu New Year Woodblock paintings focus on gods and Buddhas, which are in line with modern times. On the whole, there are traces of the Changmen Kusu Prints gaining a higher user preference.
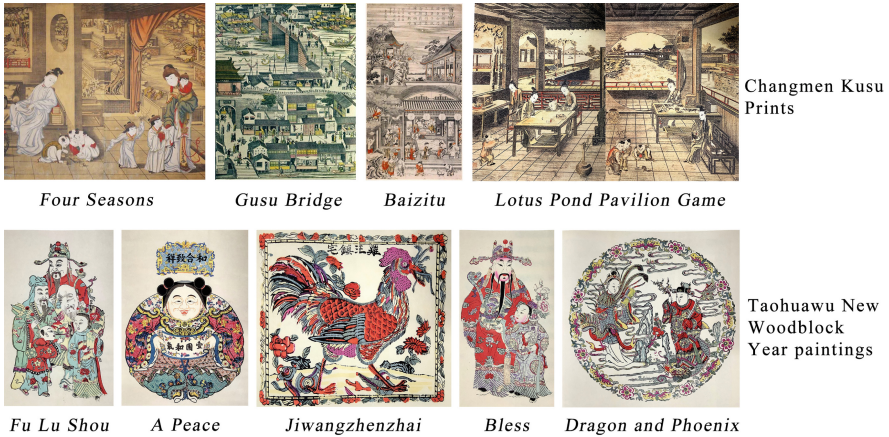

Changmen Kusu Prints

Four Seasons   *Gusu Bridge*   *Baizitu*   *Lotus Pond Pavilion Game*

Taohuawu New Woodblock Year paintings

Fu Lu Shou   *A Peace*   *Jiwangzhenzhai*   *Bless*   *Dragon and Phoenix*

Fig. 7. Two styles of New Year pictures

4   Discussion

Through a detailed review of the historical period and style evolution of Taohuawu New Year paintings, the Taohuawu New Year pictures are divided into two artistic styles: Changmen Kusu Prints and Taohuawu New Year Woodblock paintings. CycleGAN was used to train two styles of New Year paintings samples for adversarial generation and transfer their styles to typical representative images of the Taohuawu New Year painting's theme for user preference experiments, finally concluding that the Changmen Kusu Prints are more popular among young people, and arguing the reasons for this result from various aspects.

The conclusions drawn are helpful for the targeted inheritance and development of the styles that users prefer. This experimental research is only the first step, and the follow-up research will in-depth explore the reasons for the style preference, and

explore the contemporary development path of Changmen Kusu Prints from the aspects of technology, materials, media, etc., so as to bring this classic art to the public and rejuvenate it.

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