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Article

Innovative Development Pathways for Preserving Chinese Liangshan Yi costume culture in the Digital Age

Adzrool Idzwan bin Ismail [1], Haijing Pan [1,2,*] and Asmidah Alwi [1]

[1] School of Creative Industry Management and Performing Arts, Universiti Utara Malaysia, Kedah, Sintok, Malaysia
[2] School of Art, Xichang University, Xichang, Sichuan, 615013, China; panhaijingphj@126.com

Abstract: Taking Liangshan Yi traditional costumes as the carrier, we extracted the cultural factors from them, and achieved the purpose of inheriting Yi culture through the innovative application in product design. The study extracts five major factors based on hierarchical analysis: form, color, pattern, material and emotional semantics. It also introduces the image style migration technology based on deep learning, using VGG network and ReLU activation function, by calculating the content loss and style loss, so that the white noise image gradually approximates the characteristics of the content image and the style image, thus realizing the stylized expression of the cultural factors. The morphology factor is the core of the design with an absolute high weight of 0.563, and the most important morphology factor is the "erwar cloak" with a weight of 0.578. In the deepest Conv5-3 layer, the average SSIM value of the structural similarity of neighboring feature maps is 0.8471, which proves that the model can stably extract the abstract style features. In the side-by-side comparison experiment of color migration, the model of this paper has PSNR=15.81, which is better than the 11.81 of comparative HSV and 12.56 of RGB, and its SSIM=0.6959, while the FID value is even lower than 168.05, which indicates that the color style of the generated image is the closest to the distribution of the real Yi dress. By analyzing the design and applying the style migration to the Yi dress culture, the study provides a model that can be used as a reference for the digital inheritance and innovation of the Liangshan Yi dress and even other ethnic cultures.

Keywords: Liangshan Yi; traditional costumes; cultural inheritance; cultural factor extraction; style migration

1. Introduction

Yi is one of the oldest ethnic groups in China and the sixth largest ethnic minority in China, and its ethnic culture passed down through the ages is a treasure in the culture of ethnic minorities in China, and Liangshan, as the largest settlement area of Yi within the country, has a complete preservation of its traditional ethnic clothing culture [1-3]. Protecting, inheriting and utilizing intangible cultural heritage is of great significance for the continuation of historical lineage, firming up cultural self-confidence, promoting civilization exchanges and mutual learning, and building a strong socialist cultural country [4-5]. Cultural self-confidence is a more basic, deeper and more enduring force in the development of a country and a nation, without a high degree of cultural self-confidence, without cultural prosperity, there is no great rejuvenation of the Chinese nation to provide theoretical guidance for the study [6-7]. At present, carrying the traditional national spirit and for the enhancement of national self-confidence of the Yi traditional dress culture, in the modern society behind the strong cultural meaning is gradually lost, protection and inheritance of the status quo is increasingly serious [8].

Nowadays, with the rapid development of the society and more frequent cultural exchanges, the different cultures and arts among different ethnic groups in China are highly integrated, and their own characteristics are constantly weakened. In order to survive and continue in the ever-developing society, the traditional handicrafts of ethnic minorities must meet the current market demand and artistic

aesthetics, and be inherited in continuous innovation [9-10]. Liangshan Yi clothing is one of the representatives of Yi traditional handicrafts, and its style, pattern and color are the vivid expression of Liangshan Yi traditional culture, which has high research value [11]. The innovative application research on the cultural connotation of Liangshan Yi traditional costumes can better protect the national costume culture, further disseminate and promote it, and promote the development of Yi costume industry to a certain extent [12-13]. Moreover, it makes people understand the Liangshan Yi dress culture and national spirit more intuitively and profoundly, and further enhances the acceptance of the young people within the Liangshan Yi ethnic group to their national traditional dress culture [14]. From the point of view of enhancing national recognition and identity, the study and understanding of Yi clothing culture not only has very important academic value, but also carries social value that cannot be ignored [15].

In the context of the continuous development of digitalization and informatization society, the rapid development of the Internet of Things, cloud computing technology and the Internet has led to the integration of big data into all walks of life, prompting people to make efficient and full use of it, so that the cluttered data becomes a resource that can bring greater benefits and value, while the digitization of big data has also provided a direction for the development of modern design [16-19]. Using the form of big data to transform Liangshan Yi traditional costumes into intuitive data resources can not only expand its dissemination, but also better utilization and development [20]. Data-enablement of dress information opens up new research avenues for aesthetic research on Yi dress colors and patterns, changes the previous tradition of studying Yi dress with subjective and perceptual methods, and injects new vitality into the cultural inheritance of Yi traditional dress [21-22].

Based on the style migration technique, the article connects the cultural factors of Yi clothing with the design language, so that the traditional Yi clothing culture can not only be seen, but also be applied and recreated. The methodology is divided into two modules, one is to consider Liangshan Yi clothing as a complete cultural system, and firstly to analyze the color, pattern and craftsmanship of the clothing. Based on these perceptual knowledge, we then turn to the systematic extraction of cultural factors. Adopting the hierarchical analysis method, five major categories of cultural factors are extracted from the costumes - morphology (e.g. right-over-right blouse, pleated skirt), color (black, red, yellow), pattern (animal, geometric, religious symbols), material (wool cape, plant dyeing and weaving), as well as emotional semantics (majestic simplicity, mysterious solemnity). Second, coding innovation. Introducing style migration technology based on online image optimization. VGG deep convolutional neural network is utilized. The shallow network can capture the specific details of the image, while the deep network can grasp the overall color scheme of the picture. Specifically, based on a content image, and then select a Yi dress that contains the above cultural factors as the inspiration source for the style image. Then, starting from a white noise image, the network is allowed to continuously adjust itself. The ReLU activation function is chosen to ensure that the creation process is efficient and stable, avoiding gradient disappearance. The content loss function and style loss function are used to continuously measure and narrow the gap between the generated image and the content and style images, and finally a new image that retains the form of modern objects and is imbued with the flavor of Yi clothing style is condensed.

2. Yi Clothing Cultural Factor Extraction and Style Migration Modeling

2.1. Cultural Characteristics of Liangshan Yi Traditional Clothing

2.1.1. Color in Clothing

In the Yi costumes of Liangshan, Sichuan Province, “the Yi people, with clever wisdom, use the three primary colors of black, red and yellow with different patterns and patterns, sewed into more than 300 different styles of dress, dress, regular dress, as well as wedding, funeral, priestly, war and other kinds of special costumes.” In general, the color tone of the whole Yi costume is dominated by the three primary colors, i.e. red, yellow and black, assisted by white and green shades. In the ancient books of the Yi people, it is recorded that there are five colors with five directions and five colors with five elements. In the inheritance and records of the Yi dress culture, there are also five colors, i.e., Shang, Bait, Mu, Ni and Neng, which represent green, red, white, black and yellow respectively. It can be seen that “red, yellow, black, white and green” are the most important colors in the Yi costumes.

In the Yi costume, the first dress is usually made of black, with white, green, yellow, red, etc. Yellow and red are the most common colors, which are mainly embodied in the embroidered lace and inlaid color cloth. In order to make the costumes look harmonious and more beautiful, the modulated green color is also used as the transitional color, which fully reflects the characteristics of the costumes of Yi culture. In addition, there are other accessories in Yi costumes, such as triangular belt bags, chest ornaments and so on.

2.1.2. Patterns and Motifs in Yi Clothing

There are a lot of patterns in the Yi costumes, which fully reflect the aspirations and hopes of the Yi people for a better life. In ancient times, the ancestors of the Yi nationality were mainly engaged in sheep herding and hunting, which were the main sources of their life, and naturally cattle and sheep were their domestic animals and prey. Based on this, there are a lot of animal pattern patterns in the Yi traditional costumes, which on the one hand expresses their record of life, and on the other hand reflects the aspiration and pursuit of a better life of the Yi people, and gives the Yi costumes a unique character.

Botanical patterns are also very common in Yi costumes, such as leaves, roots, flowers and fruits of crops, as well as sunflowers, ferns, buds and leaves. There are also some celestial cults that express the harmonious coexistence of man and nature in the Yi traditional typical costumes, such as rainbow pattern, sun and moon pattern, wave pattern, etc. There are also items that reflect the real life of the Yi people, such as window lattice pattern, fire scythe pattern and so on.

2.1.3. Fabrics and craftsmanship in apparel

Yi clothing has a long history and contains rich cultural qualities, and the beauty it shows lies not only in the color, but also in its fabrics and craftsmanship, which gives it different textures through different fabrics and reflects the beauty of modeling with the help of different craftsmanship. In the fabrics used in Yi costumes, wool and linen are usually the main materials, which is mainly due to the Yi tradition of raising sheep, so the raw materials of Yi costumes are also mostly obtained in the way of self-weaving and self-dyeing, such as piqi and erwa, which are the most representative costumes of the Yi people. For example, the shawl and shawl are the most representative costumes of the Yi people. "The shawl and shawl are made of wool rolled into felt or wool twisted into woolen cloth and sewn into it. The shawl is thick and wide, can be wrapped around the whole body, can also be used as a cushion, sunny and rainy can be sheltered from water, the day as a cloak and the night as a quilt cover, and is regarded as the basic clothing that never leaves the body in all seasons."

In terms of characteristics, Erwa inherited more of the connotation of the poncho, and they utilized traditional textile technology to integrate homegrown wool, yak hair, and cultivated cotton and linen products, and then utilized fine craftsmanship to make traditional ponchos and other clothing products, which are also known as “Sacred Capital” or “Gah Sacred” in the native language. In the native language, they are also called “Shengdu” or “Gashang”. According to the craftsmanship of Yi clothing, it usually includes the main types of flower making, embroidery and color painting. Flower making refers to the embroidery craft of Yi clothing, which can be divided into picking, appliqué, wearing flowers, locking flowers, plate flowers, mending flowers and other crafts, and it is mostly used in clothing or supplies. Embroidery is the use of special techniques to decorate the headgear, tops, pants, purses and other parts of the costumes, such as cushion embroidery, luring, wrapping needles and other techniques, so as to make the characteristics of the Yi dresses stand out. Painting craft, on the other hand, emphasizes the matching of colors, using black as the base color, and then combining different patterns for decoration, so as to bring out the unique flavor.

2.2. Extraction and Analysis of Five Types of Cultural Factors of Liangshan Yi Traditional Clothing

The previous paper analyzed the cultural characteristics of Liangshan Yi traditional costumes in depth, in order to further explore the cultural genes embedded behind them in order to find their innovative applications in contemporary clothing design. A hierarchical analysis method is adopted to analyze the cultural factors of Liangshan Yi traditional costumes, and a hierarchical and clear analysis model is constructed. Through screening and classification, the cultural factors are grouped into five categories: form, color, pattern, material and emotional semantics. The hierarchical model is shown in Figure 1.

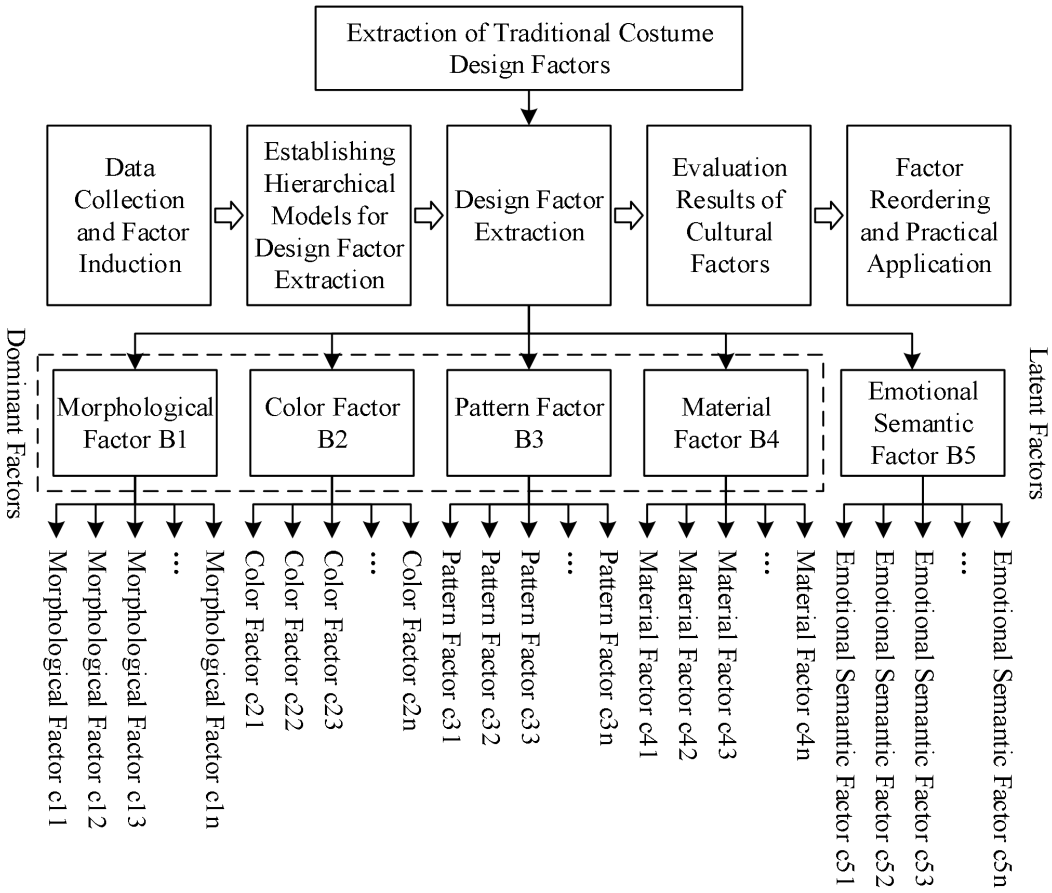

Figure 1. The hierarchical structure model of traditional clothing of the Yi people.

2.2.1. Morphological factor extraction

The costume of the Yi ethnic group in Liangshan has distinct morphological features and a strong sense of ethnic identity. Both men's and women's clothing are based on the basic structure of "upper garment and lower skirt". Men mostly wear short-sleeved shirts with front openings and wide-leg pants, and are draped over a "serva" (woolen cape). The style is rough and practical. Women often wear right-sleeved tops and multi-layered pleated skirts. The skirts have fine pleats and wide hems, swaying gracefully when walking. In addition, both men and women are accustomed to tying "hero knots" around their heads or wearing embroidered headscarves, creating highly distinctive silhouettes. Structurally, morphological factors such as C11 "right-sleeved upper garment", C12 "multi-layered pleated skirt", C13 "Zailwa cape" and C14 "headscarf and hero knot" can be extracted, demonstrating that while Yi ethnic costumes adapt to the mountainous living environment, they also pay attention to physical expression and a sense of ceremony.

2.2.2. Color factor extraction

The Yi people value black, Revere yellow and respect red. Their clothing is rich in color and highly symbolic. Black as the base color symbolizes the land and dignity. Red represents life, flame and passion. Yellow symbolizes sunshine, harvest and divine protection. On important occasions such as weddings and festivals, clothing often features a black base with bright embroidery threads like red and yellow, creating a strong visual contrast. Therefore, color factors such as C21 "black", C22 "red", C23 "yellow", C24 "white", and C25 "cyan" can be extracted to reflect the Yi people's worship of natural forces and their emotional expression of praise for life.

2.2.3. Pattern factor extraction

The patterns on Yi ethnic costumes are rich in themes, mostly drawn from nature and belief systems. Common patterns include flame patterns, ox horn patterns, sheep horn patterns, fern pattern, sun pattern,

etc. These patterns not only have decorative functions but also carry the functions of praying for blessings and warding off evil spirits as well as recording history. The pattern composition is often symmetrical and continuous, with exquisite embroidery craftsmanship and distinct color gradation. Based on this, pattern factors such as C31 "animal patterns", C32 "plant patterns", C33 "geometric patterns", and C34 "religious symbol patterns" can be extracted, which reflect the high degree of integration of the Yi people's primitive belief that all things have spirits and the inheritance of handicrafts.

2.2.4. Material factor extraction

The traditional costumes of the Yi ethnic group in Liangshan are mainly made of wool, linen and self-woven local cloth, which have distinct regional characteristics and ecological adaptability. "Chaerwa" is made by rolling wool, which is warm and moisture-proof, and suitable for the climate of high-altitude cold mountainous areas. Women's pleated skirts are mostly made of self-woven linen, which is shaped through plant dyeing and hand-pleating, showcasing a unique texture and craftsmanship. In contemporary inheritance, the integration of materials such as cotton and silk can also be seen. Therefore, material factors such as C41 "wool", C42 "linen", and C43 "plant" can be extracted, reflecting the wisdom of the Yi people in utilizing natural resources and adapting to the ecological environment.

2.2.5. Affective Semantic Factor Extraction

Yi clothing is not only a cover for the body, but also a carrier of ethnic identity, social identity and cultural memory. The overall costume conveys the emotional semantics of “majestic and simple”, “passionate and unrestrained” and “mysterious and solemn”. Men's clothing emphasizes bravery and strength, while women's clothing highlights diligence and dignity. In ritual occasions, clothing serves as a medium for communication with ancestors and holds sacred symbolic significance. Therefore, emotional semantic factors such as C51 "simple and elegant", C52 "passionate and unrestrained", C53 "powerful and simple", and C54 "mysterious and solemn" can be extracted to reflect their social value, artistic attributes, and their influence on people's emotions.

2.3. Style migration based on online image optimization

After extracting five types of cultural factors, namely morphology, color, pattern, material and emotional semantics, we are now faced with the problem of how to integrate these factors into modern design and achieve visual rendering. In this section, we introduce a deep learning-based image style migration technique, using VGG network and optimization algorithm to transform Yi cultural factors into style rendering elements.

The VGG network is initially used for image classification, the feature representation in the network becomes more abstract as the layers increase, the higher layers discard some of the color and texture information, but largely retain the shape and location of the object, the fifth layer is selected for content representation in the topic. The image style is preserved using the GRAM matrix, which computes the eccentricity covariance of the feature mapping, i.e., the correlation of the two-by-two features. The output image is based on a white noise image, defining the content loss function as well as the style loss function, which is continuously updated with gradient descent so that the resulting image approximates the content picture in terms of content and the style picture in terms of style. Fig. 2 shows the difference between image style migration and VGG19 network.

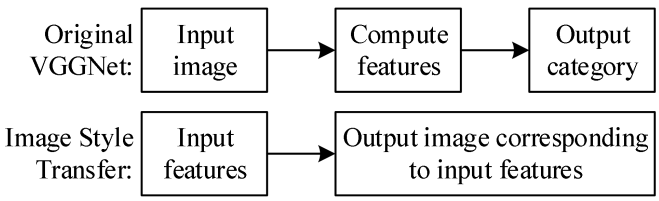

Figure 2. The difference between image style migration and vgg19 network.

As the layers in the network increase the complexity of the filters increases, and each filter corresponds to the ability to obtain a feature map. Assuming there are N_1 filters, the size of each map is M_1, which is the product of the length and width of the feature maps. The result of the computation of

the L th layer of the network is then placed in the matrix $F^l \in R^{N_l * M_l}$, representing the result of the activation values of this filter. The image will be convolved by the pre-trained convolutional neural network, stride indicates the distance the filter moves in the image, which is set to 1. Padding is a padding value to keep the convolved image the same size as the original image, as the size of the convolution kernel is 3*3, i.e., a layer of 0 is padded, the specific implementation of which is shown in the following code:

The feature response of the image in the convolutional neural network layer is F^l, the input on the right in the above figure is the initialized noisy image, the feature response of this noisy image after passing through the convolutional network is calculated to get the loss of the sum of the difference squares of each layer E_L, the total loss is updated by gradient descent of the image pixels $\vec{x}$ so that the value of their GRAM matrix goes to the approximation of the GRAM of the style image to be generated matrix value to be generated.

Pooling operation in the convolution kernel size of 2 * 2, in the image to move a distance of 2, after pooling operation can be derived from the size of its image for the pooling before 1/4, the purpose is to avoid the image style migration process will produce the phenomenon of overfitting. The following code is the implementation of the pooling method:

The neurons in each layer take the results obtained in the previous layer of the network as inputs to their own layer and give the outputs to the next layer, while for the input layer, regardless of whether it is an output layer or a hidden layer below it, the input information is directly requested to be transmitted downward as outputs. When the composition of a neural network is multiple layers, the inputs and outputs of each layer of the network have different correlations with the outputs of the previous layer and the inputs of the next layer. We can regard the corresponding correlation as an activation function. When the function representing the correlation is a linear function, we can use only two layers to express any functional relationship; when the function representing the correlation is a differentiable function, we need to optimize the function based on the gradient function; when the function representing the correlation is a monotonic function, the implementation of the convex function only requires one layer of network structure. When the function of correlation has a finite output, we optimize the function on the basis of the gradient function, the stability of the method will be better, the reason is that under the premise of limited weights, the mapping of the features under the function will be more obvious; when the function of correlation has an infinite output, the network training process under the function will be more efficient, but at the same time, it will require a learning rate will be smaller.

2.3.1. Selection of the activation function

As shown in Figure 3 below sigmiod function, tanh function and ReLU function are the activation functions that are usually used. The activation functions mainly used in the initial stage of neural network research are tanh function and sigmoid function, which have the characteristics of finite output value, so it is easier to manipulate when used as input value. But now as the number of layers of the network increases more and more researchers are using the Relu function or a modified Relu function as the excitation function.

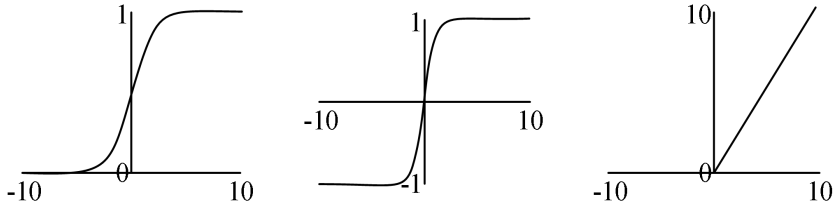

Figure 3. Sigmiod function diagram, tanh function diagram and relu function diagram.

The following equation is the expression for the Sigmoid activation function:

$$f(z) = \frac{1}{1+e^{-z}} \tag{1}$$

The activation function, sigmoid, maps successive uninterrupted input values in the interval $[0,1]$. When the initial input value in the network is a real number greater than 0 and less than 1, it is known that in the process of gradient back propagation, the gradient value derived by the formula will become smaller and smaller with the increase of the network level, generally speaking, the size of the output

value is a quarter of the input value, the network structure of the number of levels is more, the gradient value will infinitely converge to zero, which results in the disappearance of the gradient of the problem. Similarly, if the initial input value of the network is a real number greater than 1, after passing through multiple layers of the network, the output value is getting bigger and bigger, which will lead to the gradient explosion. sigmoid function calculated value is not 0, so the following level of the network neurons will be the value of the above is not 0 as the input value of the network of the layer, resulting in the gradient value of the calculation of the input value of the input value of a positive number of values are greater than zero. Similarly, when the input value is negative, the gradient value is also negative, which has a strong correlation. Another disadvantage of the sigmoid function is that its functional expression has a power operation step, which takes a long time to compute, and with the increase in the number of layers of the network and the complexity of the structure, the network model takes a long time, which affects the efficiency.

The tanh function analytic formula is:

$$\tanh(x) = \frac{e^{x} - e^{-x}}{e^{x} + e^{-x}} \tag{2}$$

Improved compared to the Sigmoid function in cases where its output value is not zero-mean. But the expression of tanh function still has a power function and it has the same possibility of vanishing gradient.

In this paper we use ReLU activation function, ReLU function does not exist power function calculation process, so in time than the sigmoid function tanh function is shorter, in recent years has been widely used, and its function expression is:

$$\mathrm{Re}\,LU = \max(0, x) \tag{3}$$

ReLU, although simple, is also effective in solving the problem of vanishing gradients that may occur in positive real regions and improves the training efficiency.

2.3.2. Generation of feature styles

First a white noise image is fed into the network and the gradient descent method is utilized to make this white noise image constantly converge to the features corresponding to the content image and the style image. When this white noise image is input into the network, there are different filters in each layer, in the formula of the content loss function, $\vec{p}$ and $\vec{x}$ are the original image and the generated image, respectively, and l refers to each convolutional layer, and the response of the filter i at j in the content image is denoted as P^{l}, and the response of filter i at the initial white noise image, which is the target The response of filter i at j in the initial white noise image, which is the target image, is denoted as F^{l}. The squared loss function between the content image and the response in the target image is the content loss, and its expression is as follows:

$$L_{content}(\vec{p}, \vec{x}, l) = \frac{1}{2}\sum_{ij}\left(F_{ij}^{l} - P_{ij}^{l}\right)^{2} \tag{4}$$

The style image and the initialized white noise image are inputted into the network, and when calculating the style loss, the GRAM matrix values of different network layers in the initial white noise image and the GRAM matrix values of different network layers in the style image need to be differed and then summed to obtain the style loss function. When calculating the GRAM matrix, the more the number of network layers, the stronger the ability to express the style after the abstraction of the style image. Therefore, the style loss function in the experiment is chosen to calculate the sum of the GRAM matrix difference between the initial white noise image and the five-layer network of the stylized image.

The style loss function is understood in the same way as the content loss function, and a Gram matrix G is established to represent its feature association:

$$G_{ij}^{L} = \sum_{k} F_{ik}^{L} F_{jk}^{L} \tag{5}$$

The loss of the l layer can be normalized to:

$$E_{i} = \frac{1}{4N_{l}^{2}M_{l}^{2}}\sum_{ij}\left(G_{ij}^{l} - A_{ij}^{l}\right)^{2} \tag{6}$$

Where A is the representation of the original image in l layers, w is the weight of each layer, i.e., the coefficient of influence of the loss value of each layer, when we want to increase the rendering effect of a certain layer then increase the weight coefficient of this layer, similarly add we want to weaken the

rendering effect of a certain layer then reduce this weight coefficient. The style loss function is represented as:

$$L_{style}(\vec{a},\vec{x},l)=\sum_{l=0}^{L} w_l E_i \tag{7}$$

Through experiments, we found that the stylized images generated through the above steps have slightly abrupt changes between neighboring pixel points, so we considered adding the mean square deviation between neighboring pixel points in the total loss function, so that the results we get will be relatively smoother in terms of visual effect. The expression is as follows:

$$L_{total}=\alpha L_{content}+\beta L_{style}+\gamma L_{pixel} \tag{8}$$

α , β is a parameter that controls the degree of stylization of the output image, the greater the proportion of the α value, the closer the target image is to the semantic content representation of the content image, the greater the proportion of the β value, the closer the target image is to the degree of stylized rendering of the style image and the γ is the pixel variable's influence factor. Using the optimization algorithm, the calculated total loss function results in a value converging to 0. Initially, a random white noise image is input to gradually approximate the content texture of the content image and the feature representation of the GRAM matrix of the stylized image, which is converted into the target stylized image we want to obtain.

3. Analysis of the design and application of style transfer of Yi dress culture

In order to transform the Yi dress culture into modern innovative designs with market competitiveness in an informed manner, this chapter realizes the innovative development of the traditional dress culture of the Yi ethnic group in Liangshan based on the investigation of the current situation, analysis of the market demand, screening of cultural factors, and the application of the style migration model.

3.1. Survey on the Current Situation of Yi People's Awareness of Traditional Dress Culture

Based on the goal of better exploring how to take the innovative development path of the traditional dress culture inheritance of the Yi ethnic group in Liangshan, firstly, a survey was conducted to investigate the current situation of the Yi ethnic residents' cognition of the national dress culture. A total of 68 Yi people were invited for fieldwork, 14 from the youth group of 12-18 years old, 25 from the young group of 18-30 years old, 21 from the middle-aged group of 30-50 years old, and 8 from the middle-aged and old-aged group of more than 50 years old. The study analyzes Liangshan Yi people's perception of their ethnic traditional costumes in two categories: wearing traditional costumes and reasons for not wearing traditional costumes.

3.1.1. Reasons for wearing traditional clothing

Table 1 shows the results of the survey on the reasons for wearing Yi dress for all age groups of the Yi ethnic group.

Table 1. The investigation results on the reasons for wearing Yi ethnic costumes.

	Teenagers (N=14)		Young group (N=25)		Middle-aged group (N=21)		Elderly group (N=8)	
	N	P	N	P	N	P	N	P
Attractive	11	78.57%	17	68%	8	38.1%	3	37.5%
Reflecting national culture	12	85.71%	23	92%	20	95.24%	8	100%
Wearing requirements	8	57.14%	12	48%	18	85.71%	5	62.5%
Convenience	3	21.43%	5	20%	3	14.29%	4	50%
Taking photos	3	21.43%	14	56%	5	23.81%	1	12.5%
Others	5	35.71%	7	28%	7	33.33%	2	25%

The biggest reason why people choose to wear Yi national costumes is because they reflect the national culture, and the percentage of this option grows with age, from 85.71% among teenagers to

100% among middle-aged and old-aged people, indicating that the function of Yi costumes as a carrier of national culture is highly recognized by all Yi people.

Different age groups also focus on different points of concern. Teenagers and young people attach much more importance to looking good than middle-aged and old people, accounting for 78.57% and 68% respectively. At the same time, the proportion of "taking photos" in the younger group is 56%, which is significantly higher than that of other groups. This reveals that the younger generation sees traditional dress as a fashion expression and social media, and they are both seeking beauty and happy to show their Yi cultural identity on social media.

3.1.2 Reasons for not wearing traditional clothing

Table 2 shows the results of the survey on the reasons why Yi ethnic groups of all ages do not wear Yi dress.

Table 2. The investigation for people not wearing Yi ethnic costumes.

	Teenagers (N=14)		Young group (N=25)		Middle-aged group (N=21)		Elderly group (N=8)	
	N	P	N	P	N	P	N	P
Unconvenient	11	78.57%	17	68%	18	85.71%	8	100%
Not fashionable	7	50%	19	76%	5	23.81%	0	0%
Not attractive	3	21.43%	7	28%	4	19.05%	0	0%
Don't like	3	21.43%	5	20%	2	9.52%	0	0%
Others	2	14.29%	3	12%	1	4.76%	1	12.5%

Through the survey and analysis, there are several reasons why the Yi ethnic group does not wear traditional costumes, among which inconvenience is the most important factor. This option is very high in all age groups, especially in the middle-aged and old-aged groups, reaching 100%. This shows that for the older Yi residents, the reason they do not wear traditional costumes is only because of inconvenience, and other factors do not have a great influence. This intuitively reflects the fact that traditional Yi costumes cannot adapt to the modern fast-paced life due to cumbersome wearing procedures, restricted activities, or inconvenient maintenance and cleaning. This suggests that we need to overcome this dilemma in the subsequent innovation and product design of traditional Yi costumes.

Generational aesthetic differences are also reflected in the survey. As many as 76% of the young group thought that traditional costumes were not fashionable, while no one in the middle-aged and old-aged groups chose this option. This shows the deepest helplessness of traditional costumes in modern inheritance, in the eyes of young people, they seem to be out of touch with contemporary aesthetic trends. This also suggests that we need to improve the fashion sense of their design.

3.2. User Research Based on the Innovative Design of Liangshan Yi Traditional Clothing

Based on the above investigation and analysis of the Yi people's intrinsic cultural cognition, it is possible to see the opportunities and challenges it faces. In order to transform cultural heritage into specific innovative design, it is not enough to understand the current situation, but also need to grasp the real preference of users in the target market. Now turn the perspective to the broader external consumer market, carry out targeted user entity research.

According to the target user group set in the previous design results, it is mainly the consumer group with purchasing power between 18 and 60 years old who are interested in the traditional Yi culture. A total of 56 valid questionnaires were collected, including 21 men and 35 women. The questionnaire centers on the willingness to pay, value preference and style orientation, and the three dimensions determine the market acceptance of the product in an all-round way. The results of the research questionnaire are shown in Figures 4, 5 and 6 respectively.

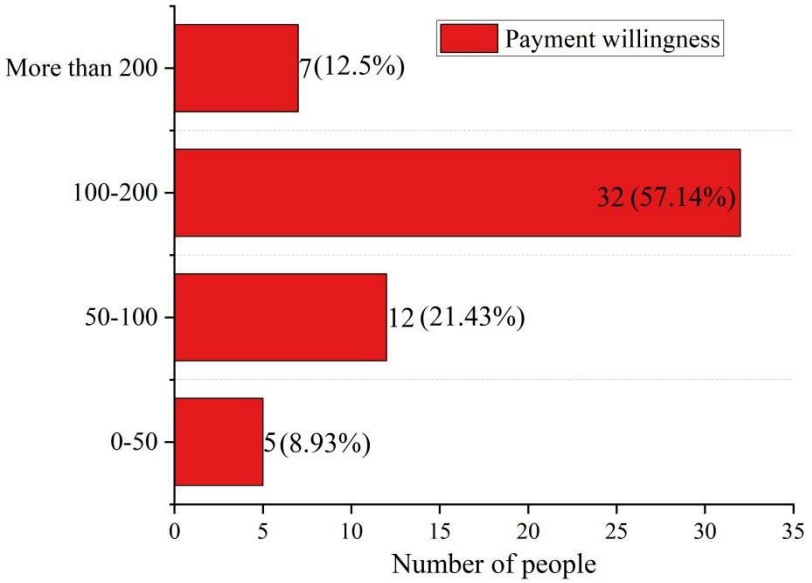

Figure 4. The results of the survey on payment willingness.

Willingness to pay examines what the price range of Yi ethnic dress cultural and creative products is acceptable to consumers, and more than half, or 57.14%, are willing to pay 100 to 200 yuan for the products. It reveals that our product positioning should focus on the mid-range market.

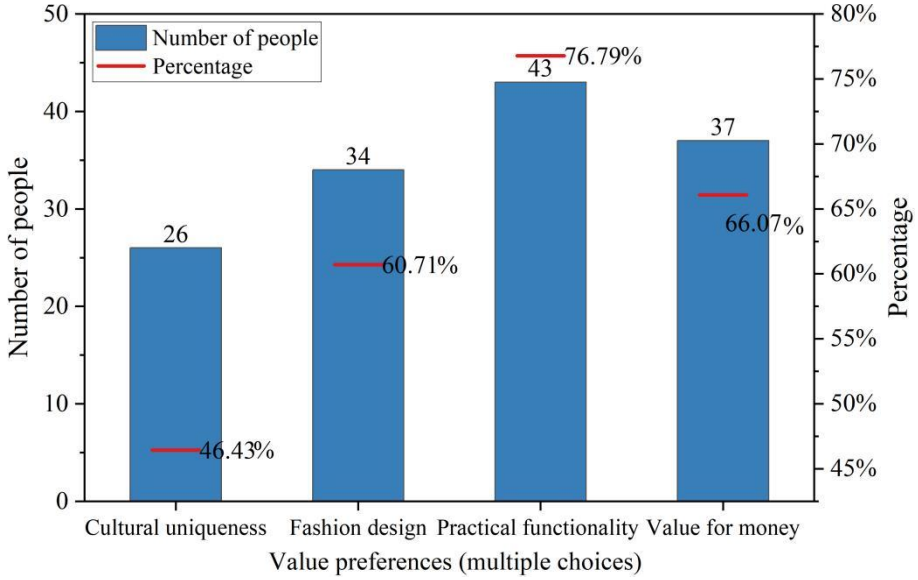

Figure 5. The results of the research on value preferences.

In terms of value preference, 76.79% of users favor functionality and practicality, while 66.07% and 60.71% choose cost-effectiveness and design fashionability. Reflecting the consumer mindset that practicality is the main focus and value and price coexist.

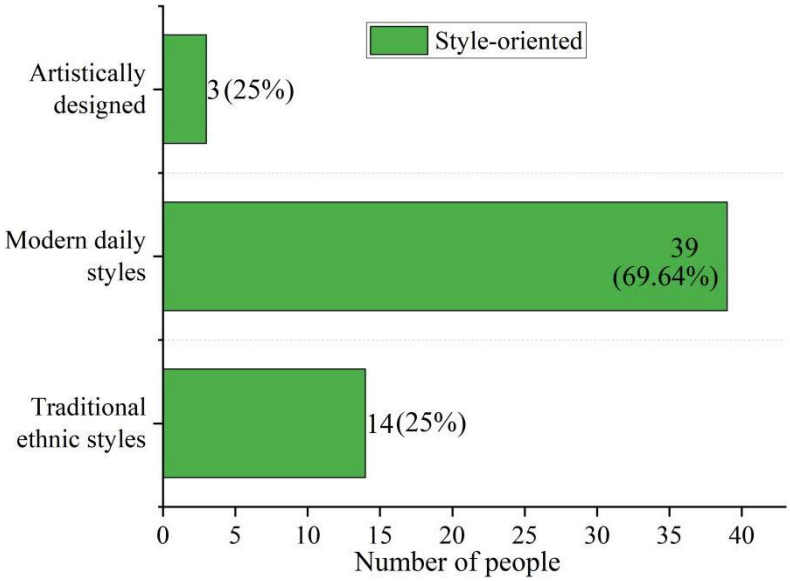

Figure 6. The results of the research on style orientation.

In terms of style orientation, nearly 70% of consumers clearly choose modern daily style that retains the ethnic elements, compared with the narrower audience of conceptual design that completely reproduces the tradition or is too avant-garde, which indicates that daily style is the absolute mainstream market direction.

Through the cross analysis of the above three aspects, this research has pointed out the direction for the innovation of Yi clothing design, and guided us to refine into modern daily wear products that are oriented to the mid-range, practicality-oriented, and retaining the Yi ethnic elements.

3.3. Liangshan Yi Traditional Clothing Culture Design Factor Screening

In order to transform the fuzzy ethnic style into quantifiable design language, based on the five types of cultural factors of Liangshan Yi traditional dress extracted in section 2.2, the weights of each factor are now analyzed.

The hierarchical analysis of the design factors of the Liangshan Yi dress is for the testers to make an importance position between the two design factors provided at the same level based on the importance of the superior factors and to construct the judgment matrix of evaluation indexes.

The test group consists of 15 people who have a deeper knowledge of Liangshan Yi traditional costumes, and the test adopts the way of focus group discussion and decision-making, and calculates the final data obtained through the hierarchical analysis method in order to obtain the weights and consistency ratios of the various design factors, and the results of the calculation are shown in Table 3.

Table 3. Factor weight and consistency ratio of the Yi nationality clothing.

Category	Weight	Factor	Weight	C.I.	C.R.
Morphological factor	0.563	C11 Right-shouldered coat	0.173	0.1023	0.0832
		C12 Multi-layer pleated skirt	0.088		
		C13 Chevalier's cloak	0.578		
		C14 Headscarf and Hero Knot	0.161		
Color factor	0.082	C21 Black	0.548	0.0985	0.0907
		C22 Red	0.192		
		C23 Yellow	0.103		
		C24 White	0.092		
		C25 Blue	0.065		
Pattern factor	0.106	C31 Animal patterns	0.416	0.1084	0.0913
		C32 Plant patterns	0.328		
		C33 Geometric patterns	0.157		
		C34 Religious symbol patterns	0.099		
Material factor	0.197	C41 Wool	0.512	0.0992	0.0916
		C42 Linen	0.381		

		C43 Plants	0.107		
Emotional factor	0.052	C51 Simple and elegant	0.283	0.1112	0.0849
		C52 Passionate and unrestrained	0.374		
		C53 Bold and simple	0.219		
		C54 Mystical and solemn	0.124		
Overall				0.0958	0.0875

Calculated by hierarchical analysis method, the overall test coefficient C.R. of Liangshan Yi traditional costumes is 0.0875, and the test coefficients of the judgment matrices of each design category and design factor are also less than 0.1, which indicates that the test group's importance ranking of the cultural design factors of the traditional costumes of the Liangshan Yi ethnic group passes the consistency test with a more satisfactory consistency.

The importance ranking of the design categories of Liangshan Yi traditional costumes are: morphology>materials>patterns>colors>semantics, and the weights of the categories are 0.563, 0.197, 0.106, 0.082 and 0.052 respectively, which indicates that the outline structure is the most important in the design of Liangshan Yi costumes. The order of importance of the form factor is as follows: C13 Erwa cape > C11 right-over-right blouse > C14 head-paw and hero's knot > C12 multilayered pleated skirt. The importance ranking of the color design factors are: black, red, yellow, white, and green, which is consistent with the color representation of the traditional costumes of the Liangshan Yi ethnic group described in the previous section. Animal pattern is the most important of the pattern factors, and its weight accounts for 41.6% of the pattern category. Wool is the most prominent in the material factor, which also reflects that Yi costumes are mainly made of sheep's linen; in the emotion category, the test group believes that Yi costumes mainly reflect the characteristics of passionate and unrestrained emotions, and its weight is 0.374.

3.4. Experimental Research on Style Migration Method Based on Yi Clothing

After completing the systematic sorting of cultural factors of Yi clothing, the study constructs a style migration model based on online image optimization based on the content of section 2.3. In order to investigate the actual effect of this cultural factor + style migration method, a series of comparison experiments were conducted.

Firstly, the internal analysis of the model is conducted to verify the model's intrinsic ability in capturing and maintaining style consistency by analyzing the structural similarity of feature maps (SSIM) of different network layers. Then focusing on the training process itself, we verify that the choice of scheme in this paper is state-of-the-art by comparing the convergence of the loss function under different activation functions. Finally, the model of this paper is compared with color migration methods based on HSV and RGB color spaces.

3.4.1. Analysis of images generated by different convolutional layers of the model

In order to verify the specific performance of the optimized style migration model based on online images in this paper on the structural similarity of adjacent feature maps, the images generated from different convolutional layers are analyzed.

Based on the improved VGG19 pre-training model, the SSIM metrics are selected, and the SSIM between the first 10 neighboring feature maps of each layer is calculated, and the results are shown in Table 4, and the box line statistics of the neighboring feature maps under each convolutional layer are also plotted as shown in Fig. 7.

Table 4. The SSIM of the first 10 adjacent feature maps of each layer of VGG19.

Feature maps index	SSIM				
	Conv1-1 MAP	Conv2-1 MAP	Conv3-1 MAP	Conv4-1 MAP	Conv5-3 MAP
0,1	0.3227	0.3045	0.5382	0.5361	0.9274
1,2	0.2029	0.2728	0.8977	0.7465	0.8857
2,3	0.2842	0.8626	0.4261	0.6548	0.7395
3,4	0.4986	0.8682	0.5034	0.6768	0.8643
4,5	0.5575	0.4133	0.5058	0.7798	0.7235
5,6	0.5653	0.3742	0.3072	0.8868	0.8657
6,7	0.3917	0.6114	0.3994	0.8611	0.9094
7,8	0.5108	0.4664	0.4718	0.5981	0.8518

8,9	0.2974	0.3911	0.6925	0.8159	0.7444
9,10	0.6805	0.3661	0.6756	0.6767	0.9595
Average	0.4312	0.4931	0.5418	0.7233	0.8471

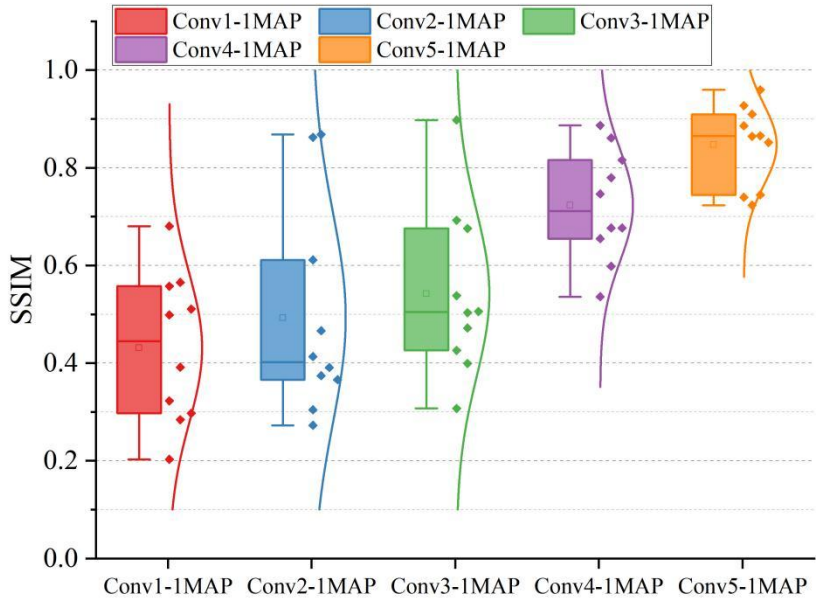

Figure 7. SSIM of adjacent feature maps of each layer in the VGG19 model.

It can be seen that the deeper the network, the more image styles are retained between feature maps. The average SSIM of Conv1-1 and Conv2-1 in the shallow layer is 0.4312 and 0.4931 for 10 neighboring inter-feature maps, respectively, indicating that in the early stage of the model, it is still capturing diversified details in the images. As the network layers deepen, a large amount of image information is still retained in the fifth layer, with an average structural similarity of 0.8471, and the similarity between multiple sets of neighboring feature maps is more than 0.92. It shows that this paper is based on the online image optimization of the VGG19 model, which focuses on extracting the most core abstract stylistic features of the image in the deeper layers of the network, and the ReLU activation function has done a great job of capturing the layer-level correlation.

3.4.2. Loss function

In order to compare the content loss and style loss under different activation functions, the sigmiod function, the tanh function and the ReLU function are selected for comparison experiments on the CycleGan model. The test images are from 150 Liangshan Yi traditional costumes the test set ratio is 1:9, and this training is iterated 200 times with batchsize 2.

Fig. 8 and Fig. 9 show the content and style loss changes under three different activation functions, respectively.

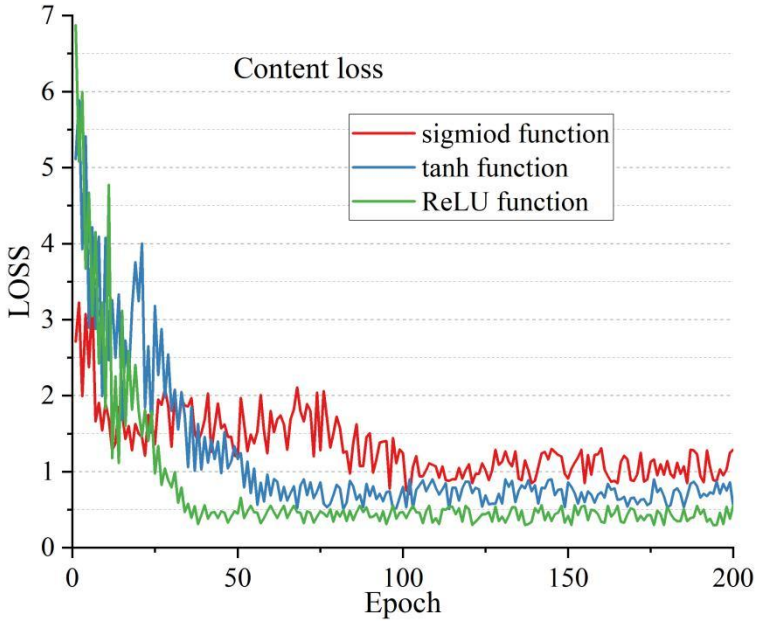

Figure 8. The changes in content loss under three different activation functions.

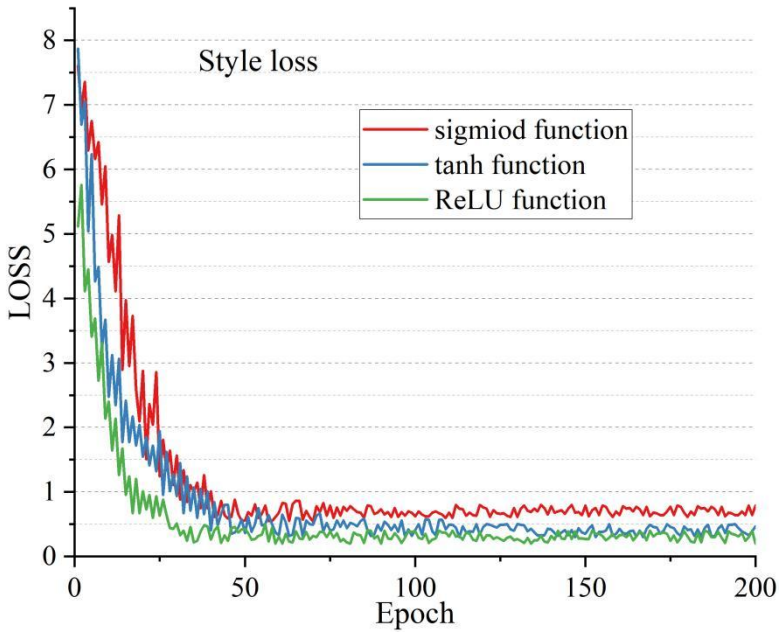

Figure 9. The changes in style loss under three different activation functions.

The ReLU activation function achieves the fastest and lowest loss change in both content loss and style loss. In content loss, the loss of the ReLU function decreases rapidly, stabilizes under 30 iterations, and finally converges to a lower level around 0.44, indicating that the model can efficiently capture and retain the core semantic structure of the content image. In contrast, the tanh function can converge, but the rate of decline is obviously slow, and stabilizes only under 50 iterations; while the sigmoid function almost comes to a standstill, with a flat loss curve, which can easily lead to the disappearance of the gradient in the deep network, and is unable to carry out content reconstruction effectively.

In terms of style loss, the differences among the three are conversely not so obvious. Each function can fit the loss well, but the ReLU function still shows the best performance, and the loss curve decreases rapidly and steadily. It shows that it can accurately match the texture and color features of the stylized images. The loss function confirms the prospective and correctness of choosing ReLU function as the activation function strategy in this paper.

3.4.3. Color Migration Task Comparison Experiment

In order to further validate the research on the superiority of the style migration model based on online image optimization, comparison experiments on the color migration task are conducted. Again using the VGG-19 model as a benchmark, the HSV-based ethnic dress color style migration and the RGB-based ethnic dress color style migration in HSV color space are selected as comparison models. The PSNR, SSIM and FID values are used as indicators to test its generalization ability.

PSNR (Peak Signal-to-Noise Ratio): evaluates the quality of images generated by the network, with higher values representing better quality of generated images.

SSIM (Structural Similarity): Evaluates the structural similarity between the generated image and the input image, which shows whether the spatial structural information of the image has been lost during the generation process, and a higher value of SSIM represents that the generated image is approximately similar to the input image.

FID (Frechet Distance): evaluate the similarity between the generated image and the color style features in the real sample domain, the lower the value of FID, the more similar the distribution of the color features between the generated image and the real sample domain, and the color style migration effect of the network is about good.

Figure 10 shows the experimental results of the generalization ability of the three models in 150 images.

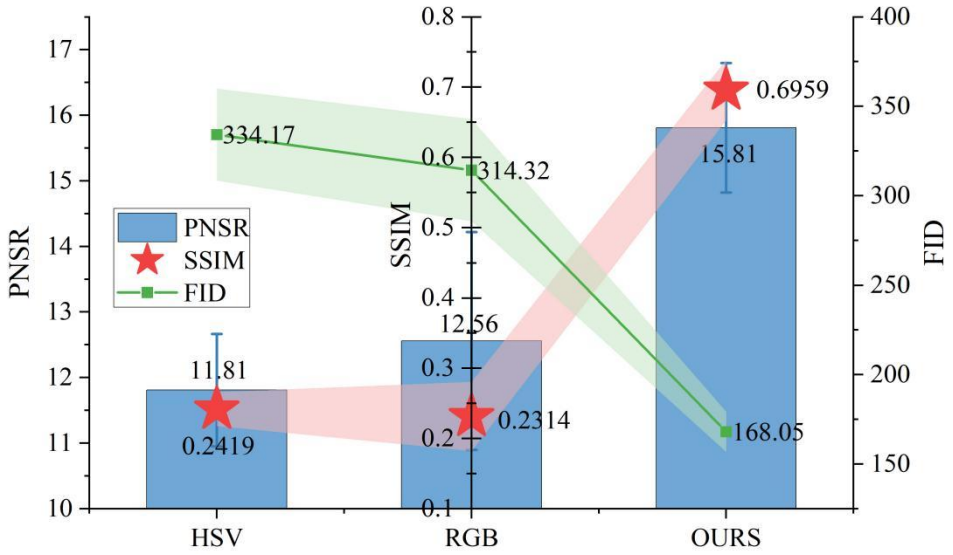

Figure 10. The experimental results of the generalization ability of 3 models.

The proposed method in this paper shows comprehensive advantages in the color migration task, the PSNR metrics indicate that the generated images are of high quality, the SSIM proves that the similarity of the real images is high, and the FID verifies that the generated data expresses the color features uniformly, which is good for the color style migration task. It also proves that the VGG-19 network architecture can effectively train the generator network with image color style migration.

This paper's method achieves the highest score of 15.81 in the PNSR metric say, which is 33.87% and 25.86% higher than the 11.81 of HSV and 12.56 of RGB. In terms of structural similarity, the SSIM of this paper's method is 0.6959, which is more than three times of the two compared methods. This means that the image generated by the model in this paper is not only color accurate, but also retains the texture details and structural features of the original Yi dress. While the other two comparison models in the complex color style migration task, the generator lost a lot of spatial structure information in the process of feature extraction and feature transformation. the FID index of this paper's online image-based optimization method is 168.05, which indicates that the color style of the generated image in this paper is closest to the color distribution of the real Yi dress, and presents a more natural and coordinated visual effect.

4. Innovative Development Path of Traditional Costume Culture Inheritance of Liangshan Yi Nationality

After the field research, factor screening and model experimental verification in Chapter 3, the article clarifies a modernization path for the inheritance and innovation of Liangshan Yi dress culture. In this chapter, we will integrate the conclusions of the previous chapter, i.e., the users' desire for practicality and fashion, the importance of the core factors such as “erwa cape” and “black tone”, as well as the practical role of the style migration technology in image generation, etc., into the proposed innovative development path. The path of innovative development is integrated into the proposed innovative development path. From design language, to education and inheritance, to cultural and tourism integration, a rich and diversified innovation path is designed to let the ancient Yi dress culture truly integrate into the contemporary life trend.

4.1. Design innovations

The artistic value of Liangshan Yi dress pattern is extremely high, but its complicated and detailed style has a certain distance from the fast pace and simple aesthetics of modern life. The key to realize innovation lies in refining and transforming. We can modernize and interpret the core patterns, for example, retaining the iconic horse cherry pattern in its divine outline, but simplifying its internal complex structure to make it more in line with modern aesthetics. These re-creations can then be skillfully applied to details such as collars, cuffs or hemlines of everyday garments. This kind of eye-catching application not only highlights the cultural identity of the ethnic group, but also greatly enhances the wearability and compatibility of the clothing, allowing the Yi aesthetics to return to modern life in a natural and elegant way.

4.2. Educational Transmission

The essence of preservation lies in the continuation of cultural vitality, and education is a key component. For the younger generation, forms of heritage should be developed that are entertaining and educational. For example, the myths and history behind Yi patterns can be transformed into illustrated stories, so that children can understand the cultural connotations of the patterns and stimulate their interest in and recognition of the national culture. In addition, Yi tattoos can also be introduced into the art courses or club activities of primary and secondary schools, so that young people can feel the charm of traditional crafts and sow the seeds of cultural inheritance in their hearts through interactive forms such as handicraft classes and tattoo design workshops.

4.3. Cultural and Tourism Integration

With the booming development of cultural tourism industry, Liangshan Yi culture has gained the opportunity to move to a broader stage. It is possible to plan and build a Yi pattern theme exhibition hall, and make full use of digital technology to create an immersive interactive experience. For example, a virtual pattern design platform can be set up, where visitors can freely choose and combine various patterns and colors on the touch screen to generate personalized design drawings. Subsequently, through holographic projection technology, this unique pattern will be projected directly onto the tourists dressed in white, so that they can instantly put on their own design of Yi Chinese dress. Further, a Yi embroidery simulation system can be developed to allow visitors to hold a sensor and follow the screen to guide the virtual needle threading, and deeply experience the exquisite skills and craftsmanship of the national non-heritage Liangshan Yi embroidery in the interesting interaction.

5. Conclusion

Taking the traditional costumes of the Yi ethnic group in Liangshan as a specific case, the study explores an innovative path that integrates cultural parsing with style image migration techniques.

Firstly, we go deep into the source, and through field research on 68 Yi people, we find out the cognition of different age groups of Yi natives. As many as 85.71% of the middle-aged group do not wear it due to inconvenience, and 76% of the young group think that traditional dress is not fashionable. It is clear that the dress innovation should be improved in convenience and fashion. Market research on 56 core target users found that as many as 69.64% of consumers expect to obtain modern daily styles that retain ethnic elements, again pointing the way to design innovation.

The style migration model is proved to be practicable, and the ReLU function, as the activation function, comprehensively outperforms the Sigmoid and Tanh functions in terms of the convergence speed and stability of the loss function. Its PSNR, SSIM and FID are all optimal, with 15.81, 0.6959 and 168.05 respectively, and the generated image is visually superior, achieving both form and spirit.

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