J. COMBIN. MATH. COMBIN. COMPUT. 127b (2025) 2195--2212

Journal of Combinatorial Mathematics
and Combinatorial Computing
www.combinatorialpress.com/jcmcc

Combinatorial Press

A Practical Path of Digital Translation of Non-Heritage in Ethnic Graphic Design Based on Artificial Intelligence Algorithm

Feifei Li[1], Geli Zhu[2,✉], Lixuan Zhu[3], Yuxin Jiang[1]

[1] *School of Art and Design, Acacia Lake College of Guangxi University for Nationalities, Nanning, Guangxi, 530000, China*
[2] *College of Fine Arts and Design, Guangxi Preschool Teachers junior college, Nanning, Guangxi, 530000, China*
[3] *School of polytechnic, Acacia Lake College of Guangxi University for Nationalities, Nanning, 530000, Guangxi, China*

ABSTRACT

In this paper, the semantic description framework is used to standardize the extraction of semantic information of non-legacy images. The SIFT algorithm is chosen to calculate the key feature points of non-legacy images. The integrated semantic description framework and SIFT algorithm construct a model to extract the non-heritage image features globally and process them locally, and add the attention feature fusion module to fuse the features that are inconsistent in semantics and scale, so as to realize the accurate extraction of features. Use the algorithmic model of this paper to extract the color features of She ribbons. Develop a website for she color band design and verify its usability. Collect website evaluation data from target users to study the role of digital translation of non-heritage elements. The color feature extraction results are richest and most detailed when the number of She ribbon feature colors extracted is 21. The website usability scale score was 50.31, rating B+, with usability. 65% of the users thought that the website embodied the cultural characteristics of She ribbons. 71% of the users thought that the website was very helpful for understanding the ethnic graphic culture. 88.16% of the users thought that the digital design of She ribbons could effectively promote the dissemination of the ethnic graphic culture.

Keywords: non-heritage elements, digital translation, semantic description framework, SIFT algorithm, attention feature fusion

1. Introduction

Intangible cultural heritage (hereinafter referred to as “intangible heritage”) is passed on from fire to fire, is the living memory of the unique national spirit of the whole nation, and is an important symbol

✉ Corresponding author.
E-mail address: ffglz2008@163.com (G. Zhu).
Received 20 July 2024; Revised 10 October 2024; Accepted 05 February 2025; Published Online 16 April 2025.
DOI: 10.61091/jcmcc127b-124

of cultural identity [1]. Intangible heritage is not only the consensus of countries around the world, but also an important way for China to promote the great rejuvenation of the Chinese nation in a comprehensive way with Chinese-style modernization [2]. In the context of the rapid development of digital technology, all kinds of information are stored and presented in digital media in increasingly rich visual forms [3]. The proposal of visualization method makes the traditional meaning of non-genetic inheritance has undergone a fundamental change, for the inheritance and development of non-heritage provides an innovative inheritance path and broad space [4-5].

However, the current research on visualization inheritance is “heavy on theory, light on practice”, and it still remains in the theoretical research perspective of visual storage and visual design of non-heritage works, and it lacks the design practice corresponding to the proposed theory; on the other hand, the current commonly applied visualization method is “heavy on technology, light on inheritance”, and the method itself exists to a certain extent. On the other hand, the current commonly applied visualization methods “emphasize technology and neglect inheritance”, and the methods themselves have certain limitations, making it difficult to cover the actual needs of various categories of non-genetic inheritance [6-8]. Therefore, it often appears that visualization for the sake of applying technology, ignoring the subjectivity of the non-heritage itself in the visualization of inheritance [9]. Therefore, applying the translation method applied in the field of linguistics to the visual inheritance of non-heritage has a positive significance to optimize the shortcomings of the current visual inheritance method [10-11]. Using the translation method to visualize the inheritance of non-heritage provides a more in-depth and inclusive way of interpretation for Chinese non-heritage, and also provides a more effective inheritance path for Chinese non-heritage [12].

In the era of digital media, the dissemination of culture has changed from paper media to digital media, and how to protect and disseminate has become an important research topic [13]. The current audience of non-heritage culture has diverse needs, and with the change of the times also has more contemporary characteristics [14]. According to the living characteristics of non-heritage culture, digital motion graphics is a very suitable choice for recording and disseminating non-heritage culture [15]. The aesthetic principles of modern graphic and image design are reflected in the dynamic graphics, simplify many complex information, and have a unique superiority to the dissemination of non-heritage culture with diverse forms of expression and fast dissemination speed [16].

Based on the great application value of non-heritage elements in today's era, this paper proposes the realization paths of selection and extraction of non-heritage elements and modern design transformation. The semantic description framework is built through the description of eight types of codes, and the semantic information of non-heritage images is extracted in a standardized way. Using SIFT algorithm, the non-heritage images are arranged into a pyramid form after multi-scale segmentation, and the features and key points are extracted layer by layer and then locally represented on a specific scale. Combining the semantic description framework and the SIFT algorithm to construct the model, the attention feature fusion module is introduced to accurately extract the features of non-heritage images. Taking the she ribbon as an example, its color features are extracted using the algorithm model of this paper. And based on the algorithmic model and extracted non-heritage elements, etc., develop and apply the design website of She ribbons. By means of questionnaire survey, we study the value of the She ribbon design website in the embodiment of non-heritage culture and the promotion of national graphic culture.

2. Digital graphic design practice of non-heritage elements

Effectively selecting and extracting excellent non-heritage elements and transforming them into modern design is an important way to activate the vitality of non-heritage elements. This chapter analyzes the development possibilities of non-heritage elements in today's era from these two aspects.

2.1. Selection and extraction of non-heritage elements

The use of intangible cultural heritage elements in the digital era is a top priority, and digital graphic design based on intangible elements also gives new vitality to intangible elements. The first task of this process is to select and extract non-heritage elements, such as selecting and extracting representative and fashionable non-heritage elements, and integrating them into digital graphic design. Traditional patterns contain deep historical and cultural connotations and aesthetic values, which can be visually optimized by image processing software to enhance the clarity of non-heritage elements. This can not only enable the non-heritage traditional elements to be retained through the form of digitization, but also provide rich materials for digital graphic design. In the process of selecting and extracting the non-heritage elements, we should also pay attention to analyzing the composition and lines of the non-heritage elements, so as to ensure that the unique flavor and charm of the non-heritage elements can still be displayed after the digital processing. In addition, the color and material of non-heritage elements are also the focus of designers' attention in the selection and extraction, in which designers are required to use color management software to ensure that the traditional colors are accurately reproduced in the digital environment, and at the same time, they can use high-definition photographic technology to process the delicate texture and unique texture of the traditional materials that they have captured, so as to provide a richer and more textured material texture for the subsequent design to make the digital graphic design better.

2.2. Modern design transformation of non-heritage elements

The integration of non-heritage elements and modern design requires designers to have strong innovative thinking and cross-border integration ability, on the basis of which the transformation of non-heritage elements into modern design can be realized. For example, the integration of traditional and modern design needs to find the point of convergence between the two, in this process can be extracted from the traditional pattern, and then these non-heritage patterns for simplification, reorganization or deformation, so that it can meet the needs of modern design, to achieve simple and clear patterns. After that, modernized design techniques can be applied on this basis, such as minimalist techniques, flat design techniques, etc., so that the non-heritage elements can be revitalized in modern design. In addition, in the modernized design transformation of non-heritage elements, designers should also carry out continuous innovation and practical exploration, such as advanced digital technology to explore the new application fields of non-heritage elements, such as through virtual reality technology to display and simulate the production process of non-heritage as well as non-heritage scenes, which can not only bring more intuitive and more realistic non-heritage experience to the audience, but also make the audience appreciate the charm and value of the non-heritage in the viewing and understanding of the non-heritage elements. This can not only bring more intuitive and real non-heritage experience to the audience groups, but also make the audience groups realize the charm and value of non-heritage in watching and understanding. In the modernization of non-heritage design transformation can also be combined with the hot issues and needs of society, such as non-heritage elements and environmental protection, sustainable development concepts, etc., which can not only create a sense of social responsibility and the significance of the times of the non-heritage works, but also spread the concept of environmental protection, inheritance and carry forward the excellent traditional Chinese culture.

3. Key Technologies for Digital Translation of Non-legacies

This part mainly discusses the key techniques and methods of digital translation of non-heritage images. First of all, a semantic description framework is built, based on the two-dimensional matrix model extended by Panofsky model, to standardize the annotation of NRL images from the dimensions of “generic-concrete-abstract” and “Who-What-Where-When”. Standardized Annotation. Secondly, the SIFT algorithm is introduced as the main computational method to extract key point features with scale invariance through Gaussian function for multi-scale segmentation of non-legacy images. Finally, the SIFT algorithm is used as the main method to construct the model by combining the semantic architecture. Specifically, the Transformer encoder and bidirectional multilevel aggregation decoder, etc. are utilized to globally sample and locally process the computed feature points, and the semantic and scale-invariant features are fused by using the multi-scale channel attention feature fusion module, etc., to realize accurate extraction and feature fusion of non-heritage images.

3.1. Semantic description framework

The idea of a three-layer model (i.e., Panofsky's model) of iconography, i.e., pre-image log description-image log analysis-image log interpretation, provides a path for the development of subsequent models. Extending the original one-dimensional model based on Panofsky, a two-dimensional matrix model that can be used to perform specific semantic annotations is designed. This paper applies the previous theoretical model and combines the characteristics of non-heritage image resources to propose a semantic description framework, which covers the multi-dimensional cognitive level of the user, tries to analyze the illustrated information according to a certain logical hierarchy, conveys more comprehensive and detailed information to the readers, and provides a standard specification for the annotation of non-heritage images.

The framework applies the Panofsky-Shatford model to design two dimensions of "generic-concrete-abstract" and "Who-What-Where-When" for the semantic objects in the images, and at the same time, modifies and integrates them according to the characteristics of non-heritage and digital images. At the same time, it was modified and integrated according to the characteristics of NRIs and digital images. The framework contains eight categories, which are coded using alphanumeric combinations. Field G represents generalized conceptual terms, field S represents conceptual terms with specific names, and field A represents abstract terms.

In the Who category, $G1$ represents the declaring and responsible organization associated with the NH item, and $S1$ represents the full name of the NH item in detail, as well as the people associated with the heritage mentioned in the image and its context (if any).

In the What-category, given that most of the objects in the NH digital images are static, and the activities that people are engaged in in the dynamic images are the NH items themselves, which are generally not very narrative, $G2$ represents the category, batch and level of the NH item, and $S2$ represents the specific way of carrying the NH item or the related event.

In the Where category, field $G3$ indicates a generalized location or internal building orientation to describe the environment in which an NRM item has grown up, while field $S3$ indicates a specific named geographical location, i.e. the geographic location associated with the NRM.

In the category of When, field $G4$ indicates a generic time period, and field $S4$ indicates a specific point or period of time, usually linked to the origin or transition time of the NRM. Given that the NRM digital image and its context contain more of field $S4$, and field $G4$ occurs less frequently, the two fields have been combined, and are uniformly referred to by G4/S4.

The A field is an abstract emotion field, which uniformly refers to the high-level semantic information such as emotion, style, theme, etc., contained in the NRL digital images. Through the description of the above eight types of codes, this paper tries to construct a semantic description framework for non-heritage digital images.

The theoretical innovation of this paper's framework lies in proposing a new semantic description model to specifically target the existing non-heritage image cataloging system; in terms of methodological innovation, this paper designs a complete and novel three-step keyword extraction process based on the existing mature technology, and through comparative validation, it is proved that the results obtained from the extraction process used in this paper are better than that of the existing system in terms of checking accuracy and completeness.

3.2. Principles of the SIFT algorithm

The main idea of the Scale Invariant Feature Transformation (SIFT) algorithm is to use a 2D Gaussian function for multi-scale segmentation of the picture, arrange the segmented image in the form of a pyramid, and then carry out the feature and key point extraction from the different layers of the pyramid (at different scales), and finally, the extracted feature points will be locally represented at a particular scale. The description of all these key points then belongs to the object features in the picture.

The two-dimensional symmetric Gaussian function is represented as

$$G(x,y)=\frac{1}{2\pi\sigma^2}e^{-\frac{x^2+y^2}{2\sigma^2}} \tag{1}$$

where: σ^2 is the variance. In practice, the Gaussian function is mainly used as a blurring template to blur an image by obtaining different degrees of blurred images with different σ values. These different blurred images constitute the scale space of an image. In fact, the SIFT algorithm uses these different degrees of blurred images to simulate the actual situation of the human eye seeing things from different distances. Therefore, the formula corresponding to the point (x,y) on the Gaussian blur $m\times n$ size template becomes

$$G(x,y)=\frac{1}{2\pi\sigma^2}e^{-\frac{(x-m/2)2+(y-n/2)2}{2\sigma^2}} \tag{2}$$

Thus, the scale space L of the image is denoted as

$$L(x,y,\sigma)=G(x,y,\sigma)*I(x,y) \tag{3}$$

where:* is the convolution operation. The images that arrive at different σ values are the images at different scales.

Fig. 1 Gaussian pyramid model. The images under different scales obtained by different σ values and the original images are continuously downsampled to obtain a series of unequal sized images, which constitute the pyramid model shown in Fig. 1. In fact the number of layers of the pyramid is jointly determined by the size of the original image and the top image, which is expressed as

$$n=\log_2\{\min(M,N)\}-t \tag{4}$$

where: M, N are the width and height of the original image; t is the logarithm of the minimum dimension of the top image. After obtaining the Gaussian pyramid, the scale normalized Laplace function needs to be used to locate the feature points at different scales with the following equation:

$$\frac{\partial G}{\partial\sigma}=\sigma\nabla^2 G \tag{5}$$

Eq. (5) can be computed by difference in discrete images, i.e.

$$\sigma\nabla^2 G=\frac{\partial G}{\partial\sigma}\approx\frac{G(x,y,k\sigma)-G(x,y,\sigma)}{k\sigma-\sigma} \tag{6}$$

Therefore, it can be concluded that

$$G(x,y,k\sigma)-G(x,y,\sigma)\approx(k-1)\sigma^2\nabla^2 G \tag{7}$$

To simplify the calculation, the difference operator is used to replace the Laplace operator, i.e.

$$\begin{aligned}D(x,y,\sigma)&=[G(x,y,k\sigma)-G(x,y,\sigma)]\\&\quad *I(x,y)L(x,y,k\sigma)-L(x,y,\sigma)\end{aligned} \tag{8}$$

where: L represents the convolution of the Gaussian fuzzy template with the original image at a certain scale; D is the Difference of Gaussian (DoG) image, characterizing the DoG contour image at that scale. In fact after this process is computed, the scale model of the Gaussian pyramid becomes the DoG Gaussian difference pyramid.

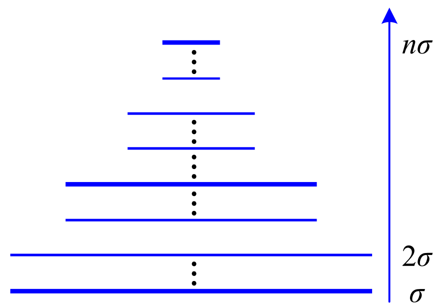

Fig. 1. Gauss pyramid model

In order to extract the feature points, the extreme points in the DoG space need to be found, and these extreme points are also mixed with some unstable edge response points, which need to be eliminated. Finally, the SIFT feature points (descriptors) are generated by using the gradient direction of the extracted feature points, after correction, rotation and other operations.

3.3. Model Network Architecture

For global sampling in the first stage, given sample position P_t and feature map F in each iteration, the initial markers T_t' are then sampled at P_t on F. The position encoding P_t is summed with the elements of the output markers T_{t-1} from the previous iteration and fed into a Transformer encoder layer to predict the markers for the current iteration T_t. The offset matrix O_t is predicted based on the T_t through a fully-connected layer. T_t is summed with P_t to obtain the sampling position P_{t+1} for the next iteration. And the above process is repeated N times.

$$P_{t+1} = P_t + O_t, t \in \{1, \cdots, N-1\} \tag{9}$$

where: P_t and O_t denote the predicted sampling position matrix and offset matrix at iteration t.

In the first iteration, P_1 is initialized as a regular interval position in ViT and P_t^i at the i th position is computed as follows:

$$P_t^i = \left[\pi_t^i S_h + \frac{S_h}{2}, \pi_w^i S_w + \frac{S_w}{2} \right] \tag{10}$$

$$\pi_i^y = \left[\frac{i}{n} \right] \tag{11}$$

$$\pi_i^x = i - \pi_i^y \times n \tag{12}$$

$$S_h = \frac{H}{n} \tag{13}$$

$$S_w = \frac{W}{n} \tag{14}$$

where: π_y^i and π_x^i denote the mapping of position index i to rows and columns, [] denotes the layer operation, S_h and S_w are the step sizes in the y-axis and x-axis directions, respectively, and

H and W denote the height and width.

The input feature map samples the initial markers:

$$T_t' = F\left(P_t\right), t \in (1, \cdots, N) \tag{15}$$

The position encoding of the current sampled position is summed with the offset vector of the previous iteration before being fed to a Transformer encoder layer to obtain the output marker for the current iteration:

$$P_t = W_t P_t \tag{16}$$

$$X_t = T' \oplus \oplus P_t \oplus T_{t-1} \tag{17}$$

$$T_t = Transformer\left(X_t\right), t \in \{1, \cdots, N\} \tag{18}$$

where: W_t is a linear transformation that projects the sampled position P_t to a coding matrix P_t of size, all iterations share the same W_t, $\oplus$ denotes element summation, and Transformer() is a Transformer encoder layer based on multi-head self-attention.

The normalized absolute coordinates of the sampled positions are projected into an embedding space as position embedding. The projected sampled position offset is computed as follows:

$$O_t = M_t T_t, t \in \{1, \cdots, N-1\} \tag{19}$$

where: M_t is a learnable linear transform used to predict the sampling offset matrix.

Using a progressive sampling strategy, the sampling positions gradually converge to the high attention region of the image. The latest sampling position is obtained as input Z_g^0, and the global attention is computed by the global Transformer encoder G_E on Z_g^0:

$$Z_g = \left\{Z_g^1, Z_g^2, \cdots, Z_g^{L_g}\right\} = G_E\left(Z_g^0\right) \tag{20}$$

where: Z_g^1, Z_g^2, etc. denote G_E the consecutive output blocks, and L_g denotes the number of Transformer blocks in G_E.

In the experiment, G_E is set to 25, after which the global decoder G_D will come up to sample on the global context feature sequence Z_g to obtain the global context. According to a new bi-directional multilevel aggregation decoder (BiMLA), this paper utilizes a bi-directional feature aggregation strategy designed by BiMLA, including top-down paths and bottom-up paths, to enhance the information flow in the Transformer encoder. Eight sampled features from the bidirectional paths are concatenated into a tensor and smoothly connected using a convolutional stack consisting of three 3×3 convolutional layers and one 1×1 convolutional layer with BN and ReLU, f_g which are pixel-level global features.The BiMLA decoder is as follows:

$$f_g = G_D\left(Z_g^6, Z_g^{12}, Z_g^{18}, Z_g^{24}\right) \tag{21}$$

After the first stage of global sampling, the second stage of the model segments the NRM image into a series of less dense image sequences with progressive sampling iterations N and computes the attention level Z_r by the local encoder R_E:

$$Z_r = \left\{Z_r^1, Z_r^2, \cdots, Z_r^{L_r}\right\} \tag{22}$$

Setting $L_r = 15$ in Eq. (22) represents the local encoder, which is selected Z_r^1, Z_r^5, Z_r^{10}, Z_r^{15} and fed into the R_D of the local BiMLA to generate f_r local high-resolution features:

$$f_r = R_D\left(Z_r^1, Z_r^5, Z_r^{10}, Z_r^{15}\right) \tag{23}$$

After that all localized attentions are connected. Finally using multi-scale channel attention feature fusion module to merge f_g and f_r as feature inputs X and Y to merge the contextual cues of the two phases to obtain the edges of the NRI image. Attention Feature Fusion (AFF), can better fuse semantic and scale inconsistent features. Fig. 2 shows the MS-CAM module structure. Fig. 3 shows the Attention Feature Fusion module structure. In it, the Multi-scale Channel Attention Module (MS-CAM) is added, which solves the problem that occurs when fusing features of different scales.The MS-CAM module adds the local context to the global context within the Attention Module, and chooses the Point-by-Point Convolution (PWConv) as the Local Channel Context Aggregator, which utilizes only the point-by-point channel interactions at each spatial location, and is implemented in the following way:

$$L(X) = B\left(PWConv_2\left(\delta\left(B\left(PWConv_1(X)\right)\right)\right)\right) \tag{24}$$

The pair Eq. (24) is given an intermediate feature value X in the C-channel and a feature map of size $H \times W$. $L(X)$ is the local channel context that preserves and highlights fine details in low-level features.

B denotes the batch normalization (BN), δ is a linear rectification function, and $PWConv_1$ and $PWConv_2$ point-by-point convolution kernels of size $C \times C / r \times 1 \times 1$. More detailed features X' can be obtained through the global channel context $g(X)$ and the local channel context $L(X)$:

$$X' = X \otimes M(X) = X \otimes \sigma(L(X) \oplus g(X)) \tag{25}$$

$$g(X) = \frac{1}{H \times W} \sum_{i=1} H \sum_{j=1} W X_{[:,i,i]} \tag{26}$$

where: $M(X)$ denotes the attentional weights generated by MS-CAM, $\oplus$ denotes broadcast summation, and $\otimes$ denotes multiplication by elements.

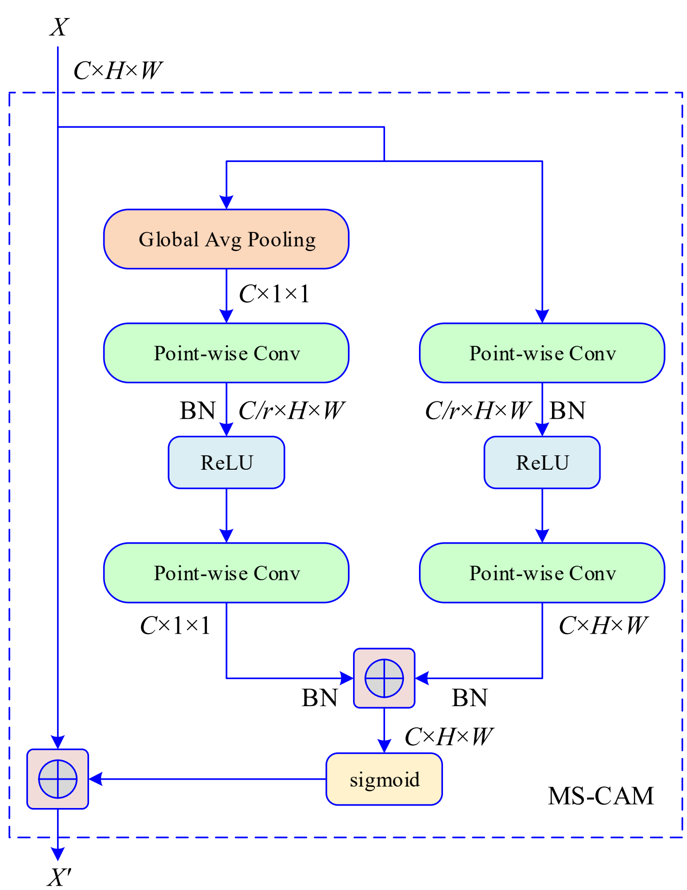

Fig. 2. MS-CAM module

Given two feature maps X , Y, and assuming that Y is a feature map with a large receptive field. Based on the multi-scale channel attention module, Attention Feature Fusion (AFF) can be expressed as:

$$Z = M(X \cup Y) \otimes X + (1 - M(X \cup Y)) \otimes Y \tag{27}$$

where: Z is the fusion feature, $\cup$ denotes the initial feature ensemble, and the fusion weights $M(X \cup Y)$ and $1 - M(X \cup Y)$ consist of real numbers of $0 \sim 1$ so that the network is able to perform a weighted average between X and Y.

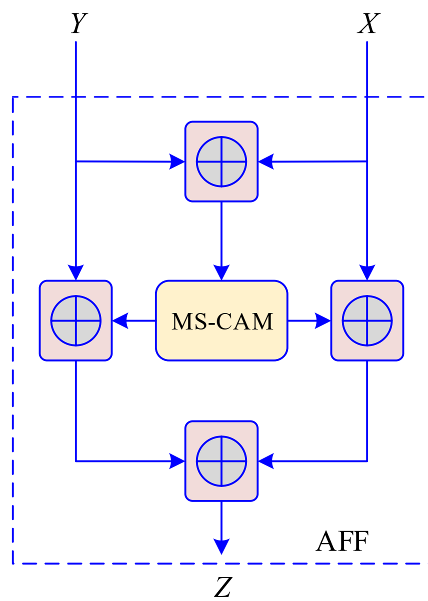

Fig. 3. AFF module

4. The application of algorithmic model in the design of she ribbons

Taking the color feature extraction of She ribbons and the digitized design of She ribbons as an example, we study the application of the algorithmic model of this paper in the digitization of non-heritage and the importance of digitization of non-heritage in the dissemination of national graphic culture. The chapter uses the algorithmic model of this paper to extract the colors in the pictures of She ribbons, compares the changes in the primary and secondary relationships between the colors caused by different numbers of feature colors extracted, and determines the optimal feature color extraction values. Using the algorithmic model of this paper and the extracted color features and other non-heritage elements, the She ribbon design website is designed and users are invited to conduct website usability experiments. Put the website to the target users, collect the evaluation data of the target users for the website, and analyze the effect of the digital website in spreading the non-heritage culture.

4.1. Color Extraction and Analysis

Before the formal color extraction, the number of extracted colors is determined. After research, it is found that the color types of the warp used in she ribbons are generally within five, and also after testing, more than 95% of the color types of she ribbons are within this range, so the number of extracted colors is determined to be 5. If the number of color types in the graph is less than 5, the extraction result is the number of color types in the actual graph; if the number of color types in the graph is greater than 5, the algorithm determines the color types based on the clustering calculation to 5.

Next, the algorithmic model of this paper is used to extract colors from 230 pictures of she ribbons. Four of the case pictures are taken as examples to test whether the extraction results are accurate. Firstly the main color extraction results shown on the color card are roughly the same as people's subjective feelings. Secondly, the RGB values of the colors on the color card are checked using the color absorption tool of the image processing software, and the results are consistent with the RGB of the extracted output. From this, it is judged that the extracted color of the sheer ribbon is basically accurate.

4.1.1. Ribbon extraction color results. All 230 She ribbon images were color extracted using the algorithmic model of this paper, and the five colors extracted from each image, a total of 1,150 colors, were labeled in an Excel table with all the colors, the corresponding RGB values, and the proportion of them. Table 1 shows the obtained color extraction results (partially) for the colored ribbons. The extraction of each she ribbon in Table 1 is sorted according to the proportion it occupies, and the extraction is also numbered from 1 to 5, with a decreasing proportion. The five colors contained in each picture of she ribbons are different, and the color that accounts for the most can reach 41.84%, i.e., two-fifths of the ribbons are of that color. The color that accounts for less is also around 10%, close to one-fifth of the ribbon.

Table 1. RGB value and ratio(partial)

ID	Extraction color number	Colour	RGB value	Ratio
1	1	Dark Slate Blue	66 24 80	26.09%
	2	Dark Orchid	122 27 136	22.95%
	3	Deep Pink	184 22 198	20.38%
	4	Hot Pink	233 84 244	16.52%
	5	Lavender	207 206 238	14.06%
2	1	Dark Blue	31 55 135	24.97%
	2	Indigo	82 98 179	21.86%
	3	Light Blue	206 221 237	19.56%
	4	Light Steel Blue	153 166 196	17.34%
	5	Light Goldenrod	211 188 102	16.27%
3	1	Dark Navy Blue	5 7 18	41.84%
	2	Dark Blue Gray	23 37 79	23.58%
	3	Medium Blue	40 69 156	15.59%
	4	Sky Blue	101 139 198	10.15%
	5	Light Cyan	191 219 240	8.84%
4	1	Dark Olive Green	52 48 32	25.96%
	2	Olive Brown	163 128 53	21.52%
	3	Coffee Brown	121 84 27	20.84%
	4	Dark Olive	59 83 69	18.07%
	5	Medium Aquamarine	36 162 114	13.61%

4.1.2. Ribbon feature color extraction. How to realize the extraction of characteristic colors of she ribbon? The idea of this paper is to use the algorithm model of this paper to extract 1150 colors from 230 pictures of She ribbons for secondary color extraction, and then use the color adjacency matrix to show the collocation relationship between each feature color, which results in the feature color of She ribbons. How to determine the number of feature colors? In this paper, we use the algorithm model to validate the number of extracted feature colors of 5, 9, 13, 17, 21 and 25 respectively, and compare the five results to find out the best scheme that can represent the actual color of the she ribbon and express the clear primary and secondary relationships, and finally determine the best number of extracted feature colors of the she ribbon.

When the number of extracted feature colors is set to 5 and 9, the main color imagery of the feature colors of the she ribbon is summarized to include several colors such as black, red, blue, yellow and reddish brown. There are some primary and secondary differences in the proportions of various feature colors, but these differences cannot make a judgment on the primary and secondary colors of the she ribbon. It is necessary to further increase the number of extracted feature colors.

When the number of extracted feature colors is set to 13 and 17, two feature colors, green and pink, are added, and the brightness and saturation between various feature colors are somewhat increased. These two extraction quantity schemes enrich some detail colors. To know whether 13 and 17 are the optimal schemes, further analysis and comparison are still needed.

When the number of feature colors extracted is 21, no new hue is added relative to the 17 feature colors. Compared to the occupancy diagram, 21 kinds of feature extraction results such as blue which is an auxiliary color began to appear brightness distinction, indicating that at this time the extraction results of the features are more accurate, basically each hue includes 3-4 different colors.

When the number of extracted colors is 25, there is no increase in other colors, although the feature color is richer, but for the overall feature color results bring little change. The difference between the main color and the auxiliary color with the smallest percentage increases significantly, and the difference in the percentage of colors is up to 18.7 times, so it is obvious that the last few colors have very little influence on the overall feature color.

In summary, when the number of feature colors is 21, the extracted color results are richer in color details compared to other schemes, and there is no excessive introduction of some colors with very small influence, which is overall more appropriate as the number of feature colors of the She ribbon. In order to visualize the various color brightness and saturation characteristics, the points of the 21 colors on the color picker are concentrated on one graph. Figure 4 shows the color brightness and saturation characteristics of the 21 feature colors. The horizontal coordinate axis of the graph indicates the saturation, the long vertical coordinate axis indicates the brightness, and the position of the points in the graph indicates their saturation and brightness, and the points numbered from 1 to 21 indicate the characteristic colors of the she-color bands with the largest to the smallest percentage, respectively. According to FIG. 4, the saturation values of the top 6 feature colors of the She Clan ribbon are all below 50, the main colors that account for a larger percentage have lower values of brightness and saturation, such as the 1st, 3rd, and 6th feature colors, and the auxiliary colors that account for a smaller percentage have relatively larger values of saturation and brightness, such as the 18th, 19th, and 20th feature colors.

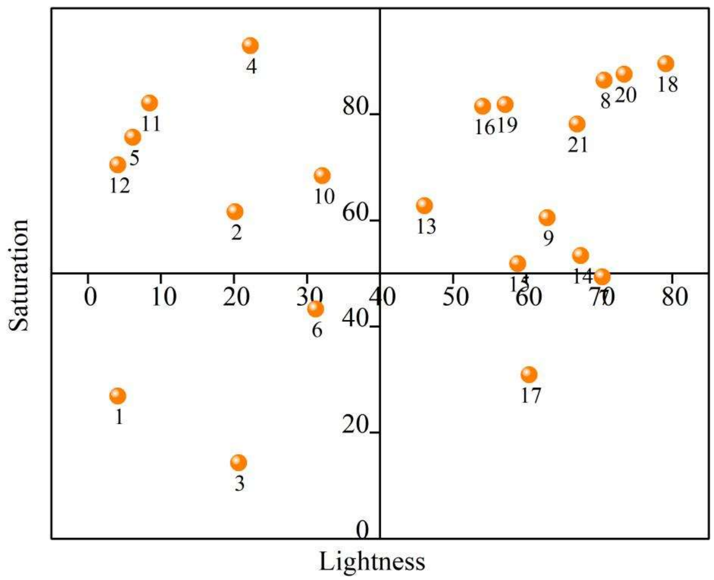

Fig. 4. Coordinates of lightness and saturation of 21 characteristic color

The 21 groups of characteristic colors of the she-band are grouped according to how much they account for, and the colors that account for more than 9% are grouped into 1 group, and the rest are the other 2 groups. Table 2 shows the brightness and saturation values of each feature color and the grouping. By performing an independent sample t-test on the saturation and brightness of the two groups of colors, it was found that there was a significant difference in the saturation factor between the features that accounted for more than 9% and the feature colors that accounted for less than 9% (sig<0.05). To summarize, the main characteristic hues of she ribbons include black, blue, yellow and red, with an overall trend of low saturation and low brightness of the main color and high saturation and high brightness of the secondary colors, and there is a significant difference in saturation between the characteristic colors that account for more than 9% of the features and those that account for less than 9% of the features of she ribbons.

Table 2. Characteristic color saturation and lightness are grouped

ID	Saturation	Lightness	Group
1	4	26	1
2	20	61	1
3	20	14	1
4	22	92	1
5	6	75	1
6	31	43	2
7	70	49	2
8	70	86	2
9	62	60	2
10	32	68	2
11	8	82	2
12	4	70	2
13	46	62	2
14	67	53	2
15	58	51	2
16	54	81	2
17	60	30	2

18	79	89	2
19	57	81	2
20	73	87	2
21	67	78	2

4.2. Designing Website Usability Validation

Using the algorithmic model of this paper and the extracted 21 characteristic colors of She ribbons and other non-heritage elements, the She ribbon design website is developed as a non-heritage digital experience product, which allows users to complete a typical She ribbon design task, and then conducts a structured interview with the users to find out the potential problems of the ethnic graphic digital design and improve it. Two main aspects were verified: on the one hand, the effect of use was verified, including whether or not the cultural connotation of the ribbon could be felt and whether or not a personalized NRL experience could be gained; on the other hand, the effect of experience was verified, whether or not it could stimulate the users' interest in exploring the NRL, and whether or not there was a willingness to use the website on a continuous basis.

Eight subjects recruited from the target user group were selected to cover the complete experience process of the users' digital design of She ribbons by completing five representative typical tasks in the test. Task 1 was to learn a common ideogram text on a She ribbon, and the completion criteria were to browse the knowledge cards and complete the mini game. Task 2 is to generate a personalized ribbon using digital resources on the website, and the completion criteria is to complete the ribbon generation process. Task 3 is to watch the teaching course on colored ribbons in the website, and the completion standard is to successfully realize the search and learning of the teaching course. Task 4 is to obtain the beginner's weaving drawings of she ribbons, the completion standard is to select the beginner's difficulty first and then download the drawings. Task 5 is to order the required she ribbons, the completion criterion is to successfully select the wire package generated according to the color scheme of the drawings.

After all eight subjects successfully completed the task of digitizing the design of the She ribbons using the website's non-heritage resources, we interviewed the subjects individually and included a system usability scale in the interview process to understand how the subjects evaluated the She ribbons design website. The system usability scale for this experiment included 10 questions. Question 1 was I would like to use the She Ribbon Design website regularly; Question 2 was I find the She Ribbon Design website too complicated to operate; Question 3 was I can learn about She Ribbon; Question 4 was I need professional help to use the She Ribbon Design website; Question 5 was I think I can use the She Ribbon Design website to increase my interest in learning; Question 6 was I don't like the functions provided by the She Ribbon Design website; Question 7 was I think that the She Ribbon Design website offers features; Q7 is that I think most people can learn to use the She Ribbon Design website quickly; Q8 is that I think the process of using the She Ribbon Design website is cumbersome; Q9 is that I am comfortable using the She Ribbon Design website; Q10 is that I need to prepare a lot of knowledge in order to be able to use the She Ribbon Design website. When answering questions 1-10, users need to score between "strongly agree" and "strongly disagree", with "strongly agree" being 5 points and "strongly disagreeing" being 1 point, for a total of 1-5 points.

Figure 5 shows the results of the statistical data of the questionnaire completed by 8 users. Vertical coordinates 1-10 are questions 1-10, horizontal coordinates 1-8 are the numbers of the 8 subjects, and horizontal coordinate 9 is the value of the average score for each question.The lowest average value of the 10 questions is 1.9, and the highest average value is 4.6, which indicates that overall there is no situation in which users are very dissatisfied with the She Ribbons Design website, and at the same time, the website has a certain amount of value in terms of application. The score of the system usability scale was calculated as 50.31, with a rating of B+, indicating that the usability of the website is good, users can get a good design experience, and users have the will to use it continuously, and they can improve their understanding of the she ribbons by participating in the experience, and the she ribbons design website can realize the function of popular non-heritage experience well, and help the digital promotion of the ribbons and the cultural inheritance.

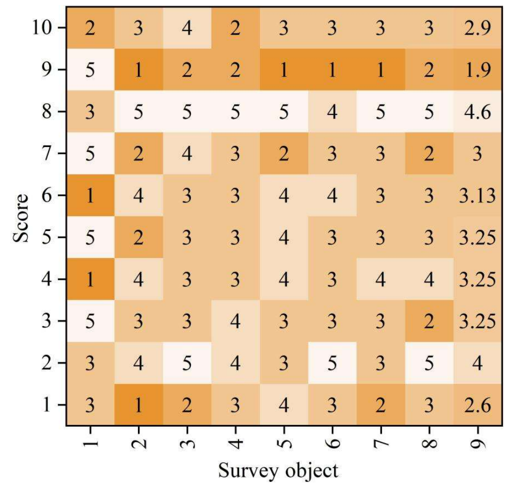

Fig. 5. Questionnaire survey

4.3. Analysis of user experience satisfaction

Comprehensive 4.2 practical research verifies that the She ribbon design website combining the algorithmic model and the non-heritage elements of She ribbons has usability, which enables the public to make use of the digital resources of non-heritages, design ethnic graphics in person, and experience the charm of non-heritages cultural inheritance. User satisfaction analysis is a way to test the results of practice, the author put the constructed She Ribbon Design website to test in a small range, a total of 200 users were invited to experience online, and filled out a user satisfaction questionnaire to analyze and test the dissemination effect, experience satisfaction and the effectiveness of the cultural information transmission of the digital design of the She Ribbon. To ensure the validity of the data, the experiencers were selected at all ages according to the age distribution in the demand analysis.

Figure 6 shows the results of the analysis of the degree of coordination between the style of the digital website and the She ribbon culture. Among them, 65% of the users think that the digital resources related to the She ribbon design website reflect the cultural characteristics of the She ribbon, 31% think that the overall style of the website is more consistent with the style of the She ribbon, 3% think that some areas of the website are not quite coordinated with the style of the She ribbon, and 1% think that the style of the website does not match the culture of the She ribbon. This result proves that practicing part of the She ribbon culture is better reflected in the digital website.

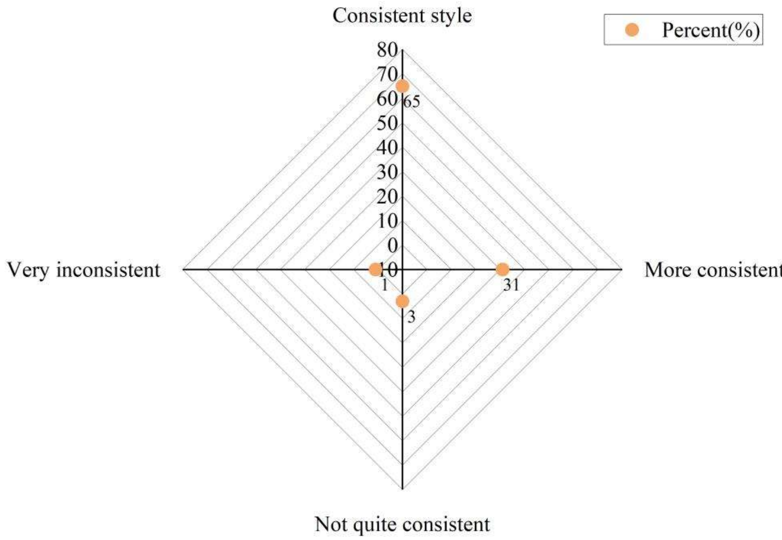

Fig. 6. Coordination degree between website style and ribbon culture

Figure 7 shows the analysis of the effectiveness of the information transfer of the digital design of the She ribbon. In the question "Do you think that the digital design of the She ribbon is helpful for you to understand ethnic graphic culture?" question, 71% of the users thought it was very helpful, 17% thought it was somewhat helpful, 10% thought it was less helpful, and 2% thought it was not helpful. This item examines the effectiveness of the information transfer of the digital design of the She Ribbon and shows that the digital design is useful in understanding the ethnic graphic culture quickly.

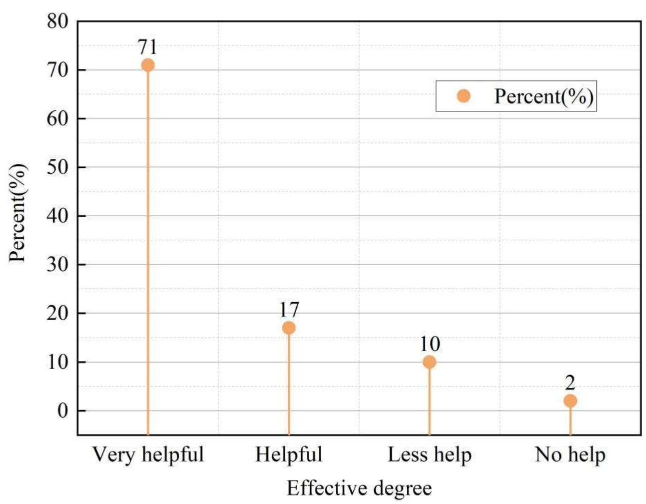

Fig. 7. Effectiveness of information transmission in ribbon digital design

Figure 8 shows the analysis of the dissemination effect of the digital design of She ribbons on the national graphic culture. In the question "Do you think that the digital design of She ribbons can effectively promote the dissemination of ethnic graphic culture?" In the question 58.44% of users think it is very effective, 29.72% of users think it is quite effective, 6.91% of users think it is generally effective, and 4.93% of users think it is not effective. According to the detailed analysis of the questionnaire, the age stage of the users who think it is not effective and generally effective is concentrated in the age group of 45-65 years old and over 65 years old, and the proficiency of the website is low, so they think that the dissemination effect is not good. However, the majority of users believe that there is a certain dissemination effect, so this test of the digital design approach to the dissemination of national graphic culture has a certain role in promoting.

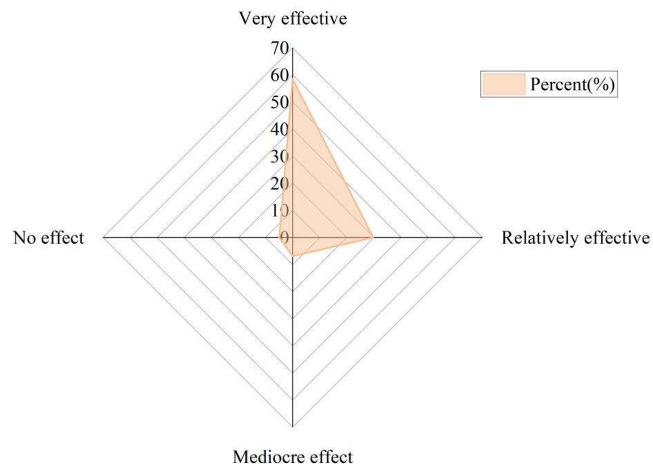

Fig. 8. Effect of ribbon digital design on the dissemination of ethnic graphics

An overall analysis of evaluation data from 200 users using the She Ribbon Design website. The website provides digital resources for users to design She ribbons according to their own preferences, and in this interactive process, the website shows the style of She ribbons well to users, and it can effectively convey the graphic culture related to She ribbons, promote the dissemination of national graphic culture, and increase the users' desire to explore and recognize the non-heritage culture.

5. Conclusion

In this paper, based on the cultural value of non-heritage elements, we design a feature extraction model for non-heritage images using techniques such as semantic description framework and SIFT algorithm to realize the digital translation of non-heritage images and ethnic graphic design. Extracting 1150 colors from 230 She ribbon images and arranging them in proportion to their size, it is found that each She ribbon image contains five different colors. The maximum percentage of colors is more than 40% and the minimum is only about 10%. When the number of feature colors extracted was set to 21, the brightness and saturation of the extracted colors appeared to have obvious primary and secondary relationships. The 21 feature colors are proportionally divided into 2 groups and subjected to independent sample t-test. sig<0.05, there is a significant difference between the 2 groups of feature colors in terms of saturation, and the primary and auxiliary colors are clearly divided into primary and secondary.

Using the algorithmic model of this paper and the extracted non-heritage elements such as the characteristic colors of she ribbons, a website for she ribbon design was developed. 8 users completed 5 design tasks and then evaluated and scored the usability of the website through the 10 questions of the usability scale. The final score on the Usability Scale was over 50 with a rating of B+. Verify that the website is usable. After putting the site to promotional testing, evaluation data from 200 target users was collected through a questionnaire. Among the valid evaluation data, 96% of the users thought that the website showed the cultural characteristics of She ribbons, 88% of the users thought that the digital design of She ribbons was helpful to their understanding of ethnic graphic culture, and more than 88% of the users thought that the digital design of She ribbons could effectively promote the dissemination of ethnic graphic culture. The practice of combining algorithms to extract the characteristics of non-heritage elements and developing digital design websites is of great help to the application of non-heritage elements and the promotion of ethnic graphic culture. When implementing their work, relevant NRL protection workers can use AI algorithms to digitally translate NRL elements, provide the public with more digital NRL experience products with participatory value, mobilize the public's interest in NRL protection, and truly enter into NRL protection practice.

Funding

This work was supported by the key project of the university-level teaching Reform Project of Acacia Lake College of Guangxi University for Nationalities in 2024. The project name is teaching innovation and practice of AI-enabled National Graphic Design course (project number: 2024JGZD07).

References

[1] Severo, M., & Venturini, T. (2016). Intangible cultural heritage webs: Comparing national networks with digital methods. New Media & Society, 18(8), 1616-1635.

[2] Borissova, V. (2018). Cultural heritage digitization and related intellectual property issues. Journal of Cultural Heritage, 34, 145-150.

[3] Zhu, Y., & bin Azahari, M. H. (2024). Research on the Branding of Intangible Cultural Heritage Enabled by Digital Technology. International Journal of Education and Humanities, 13(2), 104-107.

[4] Shuai, H., & Yu, W. (2021, May). Discussion on the application of computer digital technology in the protection of intangible cultural heritage. In Journal of Physics: Conference Series (Vol. 1915, No. 3, p. 032048). IOP Publishing.

[5] Yin, J. (2024). Application of Intelligent Image Recognition and Digital Media Art in the Inheritance of Black Pottery Intangible Cultural Heritage. ACM Transactions on Asian and Low-Resource Language Information Processing, 23(6), 1-15.

[6] Gou, Y. (2021, October). Computer digital technology in the design of intangible cultural heritage protection platform. In 2021 3rd International Conference on Artificial Intelligence and Advanced Manufacture (pp. 1524-1528).

[7] Wang, Q. (2022). The digitisation of intangible cultural heritage oriented to inheritance and dissemination under the threshold of Neural Network Vision. Mobile Information Systems, 2022(1), 6323811.

[8] Xie, R. (2021). Intangible Cultural Heritage High-Definition Digital Mobile Display Technology Based on VR Virtual Visualization. Mobile Information Systems, 2021(1), 4034729.

[9] Wu, S. (2023). Digital transmission of intangible cultural heritage based on empirical modal analysis in a multicultural perspective. Applied Mathematics and Nonlinear Sciences.

[10] Erturk, N. (2020). Preservation of digitized intangible cultural heritage in museum storage. Milli Folklor, 16(128), 100-110.

[11] Hariri, A. (2021). Digitalization of Intangible Cultural Heritage (ICH) Archives As Legal Protection of Intellectual Property Rights. Khizanah al-Hikmah: Jurnal Ilmu Perpustakaan, Informasi, dan Kearsipan, 9(2), 145-156.

[12] Wang, X. (2023). Research on the Protection and Dissemination of Intangible Cultural Heritage with Regional Cultural Characteristics in Shaanxi under the Background of Big Data. Applied Mathematics and Nonlinear Sciences, 9(1).

[13] Feng, H. (2024, December). The application of digital technology in the protection and inheritance of intangible cultural heritage. In Proceeding of the International Conference on Arts and Humanities (Vol. 11, No. 1, pp. 1-13).

[14] Lim, C. K., Tan, K. L., & Hambira, N. (2019). A basis of cultural education: safeguarding intangible heritage through a web-based digital photographic collection. Comput. Sci. Inf. Technol.

[15] Fan, J. (2018, April). Digital design and application strategy of intangible cultural heritage presentation. In 2018 International Conference on Management and Education, Humanities and Social Sciences (MEHSS 2018) (pp. 279-283). Atlantis Press.

[16] Tong, C., & Hee-Gyun, K. (2022). Intangible Cultural Heritage Based on AR Technology. Journal of Applied Data Sciences, 3(3), 118-127.