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Research on Regional Characteristic Art Image Recognition and Brand Building Strategy Based on Linear Discriminant Computational Analysis under Cultural and Tourism Resource Integration

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Abstract In order to take the advantage in the market competition under the integration of cultural and tourism resources, the only way to open the cultural and tourism market and increase the popularity is to study the regional characteristics in depth and shape a distinctive and unique art tourism image and brand. In this paper, the VGG19 network model is used as a benchmark, so as to extract the multi-scale features of regional characteristic art image, and then introduce linear discriminant analysis to downsize the data of tourists' comment images, and then construct a regional characteristic art image recognition model by combining the loss function. The validity of the model is analyzed by self-constructed dataset. Based on the identification results of the regional characteristic art image, the regional characteristic brand construction system is constructed by combining the regional brand culture, and the strategies related to the regional characteristic brand construction are proposed. Relying on policy leadership, planning guidance, technical empowerment and publicity optimization, it can provide new opportunities for regional characteristic art brand construction under the integration of cultural and tourism resources, thus helping the high-quality development of regional characteristic cultural and tourism industry.

Index Terms vgg19 network model, multi-scale features, linear discriminant analysis, regional characteristic image, recognition model

I. Introduction

With the rapid development of tourism, cultural tourism has gradually become an important choice for people's leisure and vacation [1], [2]. The integration of cultural and tourism resources is one of the important factors to promote regional economic development [3]. The integration of cultural and tourism resources not only brings tourism income, but also can drive the development of related industries and promote the development of the local economy, especially in the current economic situation, the development of cultural tourism industry has become one of the effective ways to improve economic growth [4]-[7].

In recent years, the rapid development of China's economy and the acceleration of urbanization, the development competition between regions has become increasingly fierce [8]. How to highlight one's own characteristics and advantages among many cities and build a city with a distinctive cultural brand has become a new issue for the development of each region [9], [10]. In this context, regional characteristic art image recognition and brand building has become an important idea [11]. Regional characteristic art image recognition is the foundation of regional brand [12]. Regional characteristic art image is not only a way of spiritual and cultural inheritance and development, but also an important embodiment of regional brand image [13], [14]. For example, the Pearl River Delta (PRD) region of Guangdong has a strong cultural atmosphere, and can rely on traditional cultural resources such as Lingnan culture and Cantonese opera culture to create a brand with the theme of “multiculturalism and innovative development” [15]-[17]. Xi'an, with its deep historical and cultural heritage, can combine the thousand-year-old culture with modern culture to build a brand with the theme of “tradition and innovation” [18], [19]. In the process of brand building, the sustainability of the brand is crucial [20]. With the development of modern society, the sustainability of regional brands has become an important consideration [21], [22]. The characteristics of the brand should promote the integration of regional culture and industry to create more economic and social benefits under the premise of enhancing regional image and resource utilization [23]-[25].

In the face of numerous tourist destinations, to gain an advantage in the market competition, how to set up a distinctive and unique tourism image and brand has become the key to occupy the heights of the tourism market in

tourist places. The article uses VGG19 network model to extract multi-scale features of regional characteristic art image, and in order to better improve the model recognition accuracy, linear discriminant analysis is introduced to downsize the features of tourists' comment image data, and the regional characteristic art image recognition model is constructed by combining the FocalLoss function. The validity of the recognition model is verified from multiple dimensions, such as network training, algorithm anti-noise performance and recognition performance, etc., and the characteristic brand construction system is established by combining the brand culture, etc., and the construction strategy of regional characteristic brand is proposed.

II. Artistic Image Recognition Model for Regional Characteristics

Under the background of deep integration of cultural and tourism resources, the development of regional cultural and tourism industry needs to fully grasp its regional characteristics in order to shape a distinctive and unique artistic image, which can help the regional cultural and tourism industry to expand the development channels and enhance the visibility of the regional cultural and tourism industry. Based on this, this paper proposes a regional characteristic art image recognition model combining deep learning and linear discriminant analysis, which aims to help the regional cultural tourism industry to better recognize its regional characteristic image, and provide support for the establishment of regional cultural tourism characteristic brand.

II. A.Relevant theoretical foundations

II. A. 1) The VGG19 network model

Convolutional neural network (CNN) has a wide range of applications in the field of image recognition, and its application in image recognition is mainly reflected in the powerful feature extraction and learning ability, which mainly consists of an input layer, convolutional layer, activation function layer, pooling layer, full connectivity layer, and output layer. Convolutional layer is the core of CNN is mainly used for feature extraction, multiple convolutional kernels on the input data convolution operation, so that each convolutional kernel is able to extract a kind of features of the input data, these features are retained in the feature map, used for subsequent processing. The activation function layer follows the convolutional layer and is used to nonlinearly transform the output of the convolutional layer to enhance the model expression ability, common activation functions are ReLU, Sigmoid, Tanh and so on. The pooling layer is mainly responsible for the downscaling operation of the feature map to reduce the data space size, reduce the computational complexity, while retaining the main features, common pooling operations include maximum pooling and average pooling. The fully connected layer is usually located in the last layers of the CNN, and its role is to integrate the features extracted from the previous layers and perform the final classification or regression task [26].

VGG19 is a deep convolutional neural network that benefits from the fact that it performs very well in a range of image tasks, such as image classification, object detection, and semantic segmentation, and consists mainly of a series of convolutional and pooling layers stacked on top of each other, with a total of nineteen layers.

Each of these convolutional layers uses a filter of the same size, first after two 3×3 convolutions and a pooling layer, then after two 3×3 convolutions and a pooling layer. Then it goes through three times four 3×3 convolutions and a pooling layer, and finally two fully connected layers and a SoftMax operation to output the result. Since a pooling layer is inserted between every two convolutional layers, it allows VGG19 to extract image features efficiently while maintaining the simplicity of the structure.

II. A. 2) Linear discriminant analysis

Linear discriminant analysis (FDA) is a type of supervised learning for feature extraction and dimensionality reduction, where the basic idea is to try to project the set of samples containing class labels onto a vector L, given a set of training samples, so that the projection values on that vector achieve the projection points of similar examples as close as possible to each other (with the minimum distance between the classes), and as far away from each other as possible (with the maximum distance between the classes) [27].

Assuming a data set of $D=\{(x_1,y_1),(x_2,y_2),\cdots,(x_m,y_m)\}$, any sample x_i is represented as a n vector, $y_i\in\{0,1\}$. The number of samples in category j is represented by $N_j(j=0,1)$, the sum of the number of samples in category j is represented by $X_j(j=0,1)$, and the covariance matrix with samples missing the denominator is represented by $\sum_j(j=0,1)$. Then:

$$\mu_j=\frac{1}{N_J}\sum_{x\in X_j}x,\quad \text{among}(j=0,1) \tag{1}$$

where the vector of mean values of the samples of category j is denoted by $\mu_j (j=0,1)$. $\sum j$ is denoted by:

$$\sum_j = \sum_{x \in X_j} (x-\mu_j)(x-\mu_j)^T, \text{among}(j=0,1) \tag{2}$$

Since the idea of linear discriminant analysis is to maximize the out-of-class spacing, the maximization is expressed by $\| w^T \mu_0 - w^T \mu_1 \|_2^2$, where $w^T \mu_0$ and $w^T \mu_1$ represent the two category centroids that μ_0 and μ_1 pass through in the projection process, respectively; and the in-class spacing is minimized, the covariance of the projection points of the same kind of samples is minimized by $w^\tau \sum_0 w$ and $w^T \sum_1 w$, which is finally transformed into $w^T \sum_0 w + w^T \sum_1 w$. Based on the above analysis, the optimization objective is finally expressed as:

$$\underbrace{\arg\max}_{w} J(w) = \frac{\| w^T \mu_0 - w^T \mu_1 \|_2^2}{w^T \sum_0 w + w^T \sum_1 w} = \frac{w^T (\mu_0 - \mu_1)(\mu_0 - \mu_1)^T w}{w^T (\sum_0 + \sum_1)^T w} \tag{3}$$

The intra-class scatter matrix is denoted by s_w. Then:

$$S_w = \sum_0 + \sum_1 = \sum_{x \in X_0} (x-\mu_0)(x-\mu_0)^T + \sum_{x \in X_1} (x-\mu_1)(x-\mu_1)^T \tag{4}$$

The inter-class scatter matrix is denoted by s_b. Then:

$$S_b = (\mu_0 - \mu_1)(\mu_0 - \mu_1)^T \tag{5}$$

According to the matrix formulation of intra-class scatter and inter-class scatter, the optimization objective can be obtained as:

$$\underbrace{\arg\max}_{w} J(w) = \frac{\prod_{diag} w^T S_b w}{\prod_{diag} w^T S_w w} \tag{6}$$

The generalized Rayleigh quotient is needed to deal with the optimization objective, which is a matrix consisting of the conjugate transpose matrix of the Ermitian matrix with non-zero vectors equal to itself, i.e., the function is denoted by $R(A,x)$. i.e:

$$R(A,x) = \frac{x^H A x}{x^T x} \tag{7}$$

where if matrix A is a real matrix, then the matrix satisfying $A^T = A$ is an Ermitian matrix. i.e:

$$\lambda_{\min} \le \frac{x^H A x}{x^T x} \le \lambda_{\max} \tag{8}$$

The maximum and minimum eigenvalues are denoted by $\lambda_{\max}, \lambda_{\min}$ when vector x is a standard orthogonal basis, $x^H x = 1$, $R(A,x)$ respectively:

$$R(A,x) = x^H A x \tag{9}$$

The generalized Rayleigh quotient $R(A,B,x)$ is derived from the above equation as:

$$R(A,x) = \frac{x^H A x}{x^H B x} \tag{10}$$

where B is a positive definite matrix, when $x = B^{-\frac{1}{2}} x'$, the numerator and denominator of the above equation are denoted respectively:

$$x^H A x = x'^H B^{-\frac{1}{2}} A B^{-\frac{1}{2}} x' \tag{11}$$

$$x^H B x = x^H (B^{-\frac{1}{2}H}) B B^{-\frac{1}{2}} x' = x^H B^{-\frac{1}{2}H} B B^{-\frac{1}{2}} x' = x'^H x' \tag{12}$$

Converting $R(A,B,x)$ into $R(A,B,x')$, then:

$$R(A,B,x^{'}) = \frac{x^{'H} B^{\frac{1}{2}} A B^{\frac{1}{2}} x^{'}}{x^{'H} x^{'}} \tag{13}$$

where the largest eigenvalue of matrix $S_w^{\frac{1}{2}} S_b S_w^{\frac{1}{2}}$ is the largest vector represented by w. The two eigenvalues of $S_w^{\frac{1}{2}} S_b S_w^{\frac{1}{2}}$ and $S_w^{-1} S_b$ are the same, and the resulting eigenvectors of $S_w^{-1} S_b$ and $S_w^{-\frac{1}{2}} S_b S_w^{-\frac{1}{2}}$ are satisfied:

$$w = S_w^{-\frac{1}{2}} w^{'} \tag{14}$$

In the case of dichotomous classification $S_b w$ is oriented parallel to $(\mu_0 - \mu_1)$. It is better to make $S_b w = \lambda(\mu_0 - \mu_1)$ and then bring in the following formula:

$$(S_w^{-1} S_b) w = \lambda w \tag{15}$$

Eventually available:

$$w = S_w^{-1}(\mu_0 - \mu_1) \tag{16}$$

Based on the above conclusion, it is found that when the dichotomous sample set is obtained only the mean and variance of the dichotomous sample set need to be obtained to determine the optimal projection direction w [28].

II. B.Recognition model construction

In order to be able to realize the effective identification of regional characteristic art image, this paper takes the VGG19 network structure as the basis, introduces the linear discriminant computation to reduce the dimensionality of the data of the regional characteristic art image, and obtains the framework of the regional characteristic art image identification model as shown in Figure 1.

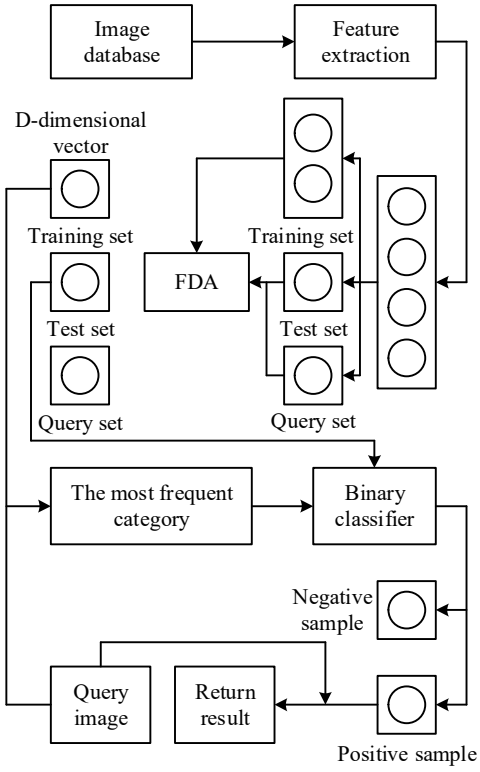


Figure 1: Regional characteristics art image recognition model

II. B. 1) Multi-layer feature extraction

In the regional characteristic art image recognition model established in this paper, the VGG19 network is mainly used to extract the features related to regional characteristic art image.The VGG19 network replaces the convolution kernel of large size with the convolution kernel of small size, and makes the network reach the same sensory field

as the larger convolution kernel such as 5*5, 7*7 by repeatedly stacking the 3*3 convolution kernel, which not only reduces the parameters of the network but also produces more nonlinear mappings, which enhances the expressive ability of the network.The convolutional layer structure of the VGG19 network is shown in Table 1, with a total of 19 layers, including 5 sets of convolutional layers, 5 pooling layers and 3 fully connected layers.

Table 1: VGG19 network convolution structure

Layer name	Convolution kernel/step size	Output size
Conv1_1	3*3/stride=1	256*256*64
Conv1_2	3*3/stride=1	256*256*64
Maxpool1	2*2/stride=2	128*128*64
Conv2_1	3*3/stride=1	128*128*128
Conv2_1	3*3/stride=1	128*128*128
Maxpool2	2*2/stride=2	64*64*128
Conv3_1	3*3/stride=1	64*64*256
Conv3_2	3*3/stride=1	64*64*256
Conv3_3	3*3/stride=1	64*64*256
Conv3_4	3*3/stride=1	64*64*256
Maxpool3	2*2/stride=2	64*64*256
Conv4_1	3*3/stride=1	32*32*512
Conv4_2	3*3/stride=1	32*32*512
Conv4_3	3*3/stride=1	32*32*512
Conv4_4	3*3/stride=1	32*32*512
Maxpool4	2*2/stride=2	16*16*512
Conv5_1	3*3/stride=1	16*16*512
Conv5_2	3*3/stride=1	16*16*512
Conv5_3	3*3/stride=1	16*16*512
Conv5_4	3*3/stride=1	16*16*512
Maxpool5	2*2/stride=2	8*8*512

Different convolutional layers in the VGG19 network learn to express different features, and the convolution of regional featured art images is to continuously filter and screen the features of regional featured art images to get useful information. The high-level features obtained after many convolutions lose more detailed information and obtain richer semantic information, while the low-level features undergo fewer convolutions and still retain much of the detailed information in the regional featured art image. The semantic information of the high-level features has a strong feature expression ability, and the low-level features contain more detailed features of regional characteristic art images, which can be used as a supplement to the high-level features. Therefore, in this paper, based on the idea of multi-layer fusion, the high-level features in the VGG19 network are fused with the low-level features to get the global features, in order to secondly improve the feature expression ability. The details are as follows:

(1) Preprocess the image. Set the input image as $I \in R^{(H \times W \times C)}$, I scaled to 512 × 512 size, normalization, de-mean operation.

(2) Multi-layer feature fusion is utilized to extract global features. The preprocessed image is first passed through the first two groups of convolutional layers convl(convl_1, convl_2), conv2(conv2_1, conv2_2) for feature extraction, and then the conv3_1 and conv3_4, conv4_1 and conv4_4, conv5_1 and conv5_1 within the convolutional layers of groups 3, 4 and 5 are fused in turn and input to the next layer. conv5_4 are fused and input to the next layer respectively, and the final result is the global feature $F \in R^{(H \times W \times D)}$, D is the number of channels of the feature map, and F is the global feature.

II. B. 2) FDA data downscaling

In order to better realize the effective recognition of regional characteristic art images, this paper introduces FDA to downscale the regional characteristic art image data, so as to ensure that VGG19 can accurately extract its features.

First, we use the nonlinear mapping function $f(x) = \omega^r x$ to map the data samples to a feature space, and then we use linear discriminant analysis to calculate the mean values of the data samples of the two categories in the

mapping space $m_{s_1}=\frac{1}{N_1}\sum_{x_j\in X_1}x_i$, $m_{s_2}=\frac{1}{N_2}\sum_{x_j\in X_2}x_j$ and the sample centers of the data samples in the mapping space $M_{s_1}=\frac{1}{N_1}\sum_{x_i\in X_1}f(x_i)=\omega_1^T m_{s_1}$ and $M_{s_2}=\frac{1}{N_2}\sum_{x_j\in X_2}f(x_j)=\omega_1^T m_{s_2}$, respectively.

From the above equation, we define m as the mean of the data samples in the mapping space and M as the sample center of the data samples in the mapping space. By calculating, we can get the mean value of the data sample points in the mapping space and the sample center of the data samples in the mapping space, and by using the obtained results, we can further calculate the data sample discretization of two different categories of data sample points in the mapping space as respectively:

$$SC_{S_1}=\sum_{x_i\in X_1}\omega_1^T(x_i-m_1)(x_i-m_1)^T\omega_1 \tag{17}$$

$$SC_{S_2}=\sum_{x_j\in X_2}\omega_2^T(x_j-m_{S_2})(x_j-m_{S_2})^T\omega_1 \tag{18}$$

We define SC in the above equation as the dispersion of the data samples in the mapping space. In the nonlinear mapping feature space, in order to be able to well separate the two different categories of data samples, so we hope that the sample center of the mapped two different categories of data sample points to do the maximum away from the data samples in the mapping space of the same category of data samples in the mapping space as far as possible together, that is, data samples of the degree of dispersion is small. Only by doing so can the two different categories of data samples in the source domain be categorized. When we use linear discriminant analysis to do the operation, we want to be able to maximize $|M_{s_1}-M_{s_2}|^2$ and minimize $SC_{S_1}+SC_{S_2}$ at the same time, according to the theoretical knowledge of linear discriminant analysis, we can get an optimization objective framework as follows:

$$MaxJ_1(\omega_1)=\frac{|M_{S_1}-M_{S_2}|^2}{SC_{S_1}+SC_{S_2}} \tag{19}$$

From the above equation, we can know that $|M_{S_1}-M_{S_2}|^2$ is the interclass distance between two different data sample categories, and we can write the interclass distance $|M_{S_1}-M_{S_2}|^2$ as $|M_{S_1}-M_{S_2}|^2=\alpha_1^T SC_{B_1}\omega_3$, where SC_{B_1} in Eq. is the interclass discretization matrix, and the specific calculation of SC_{B_1} is given in the following equation:

$$SC_{B_1}=(m_{S_1}-m_{S_2})(m_{S_1}-m_{S_2})^T \tag{20}$$

Using the data sample mean and the center of the mapped data sample above, and the dispersion of the mapped data sample, we can write $SC_{S_1}+SC_{S_2}$ in the following form:

$$\begin{aligned}SC_{S_1}+SC_{S_2}&=\sum_{s_1\in X_1}\omega_1^T(x_j-m_{S_1})(x_j-m_{S_1})^T\omega_1\\&+\sum_{s_1\in X_2}\omega_1^T(x_j-m_{S_2})(x_j-m_{S_2})^T\omega_1=\omega_1^T SC_{W_1}\omega_1\end{aligned} \tag{21}$$

Using the above analysis as well as calculations, we can rewrite the form of Eq. $Max\ J_1(\omega_1)=\frac{|M_{S_1}-M_{S_2}|^2}{SC_{S_1}+SC_{S_2}}$ into the final optimization objective framework, viz:

$$Max\ J_1(\omega_1)=\frac{\omega_1^T SC_{B_1}\omega_1}{\omega_1^T SC_{W_1}\omega_1} \tag{22}$$

For Eq. More or less, we introduce the optimization method of Lagrange multiplier method to solve the above equation, and one eigenvector ω_1 obtained from the solution is our optimal mapping direction. Namely:

$$L(\omega_1,\lambda_1)=\omega_1^T SC_{B_1}\omega_1-\lambda_1\omega_1^T SC_{W_1}\omega_1 \tag{23}$$

$$\omega_1=SC_{W_1}^{-1}(m_{S_1}-m_{S_2}) \tag{24}$$

II. B. 3) Loss function construction

In order to minimize the effect of data imbalance, this chapter not only expands the amount of data by data augmentation, but also uses the FocalLoss function as the loss function. The loss function formula is as follows:

$$L(p_t) = -\alpha_t (1-p_t)^{\gamma} \log(p_t) \tag{25}$$

where p_t is the probability of predicting the true label and $\gamma(\gamma \geq 0)$ is an adjustable focusing parameter. α_t is a weight factor whose value is determined by the number of categories, and the effect of unbalanced data is minimized by varying the size of the weight factor. When a sample is misclassified and p_t is very small, $(1-p_t)$ close to 1, the total loss is almost unaffected. On the contrary, easier to categorize samples with p_t close to 1 and $(1-p_t)$ close to 0, the weight of the loss decreases and the total loss is reduced. This loss function ameliorates the problem of data imbalance by taking into account the number of categories and the difficulty of the samples.

II. B. 4) Model Identification Process

The process of regional characteristic art image recognition based on VGG19 and linear discriminant analysis is as follows:

(1) Put all the images into the VGG19 model that has been trained, and extract the features of five pooling layers and one fully connected layer. Then the HSV color features of the images are extracted and the three extracted features are fused.

(2) Divide the features into three parts: training set, test set and query set. Using the FDA algorithm, the training set is used to train the FDA model, and then all the image features of the regional featured art images are downscaled to d -dimensional, and the features are stored locally. When reading again, there is no need to load the image, but only need to read the d -dimensional features of the corresponding image according to the stored list.

(3) Given a recognition image, calculate the distance between the downsized recognition image features and the downsized training set image features and sort them. Take the first r returned results, count the frequency of occurrence of each category in the first r returned results, and mark the category with the highest frequency of occurrence as L_h.

(4) The features in the training set belonging to L_h are taken as positive samples and the number of samples is P, the samples not belonging to L_h are randomly drawn as negative samples, and the number of negative samples is taken as $3P$ according to the ratio of positive and negative samples of 1:3. The positive and negative samples are fed into the FDA classifiers for training.

(5) The dimensionality reduced test set is fed into the already trained FDA classifier, which predicts the test data into positive and negative samples, where a positive sample is one that belongs to the same category as the recognized image. The purpose of this is to filter some of the images in the test set before retrieval, because many images are not related to the query image, but they will be more similar to the query image in terms of features, and they may be ranked in the top position after the distance metric sorting, affecting the average accuracy.

(6) The similarity measure is performed between the recognized image and the positive samples in the test set, and the first r_0 result is taken as the final return result. No processing is done for negative samples, because the retrieval results of negative samples will reduce the retrieval accuracy in the experiment.

III. Validation of the artistic identity of regional features

Regional characteristic art image under the integration of cultural and tourism resources is the public's evaluation of a region in the eyes of a potential tourist or a real tourist, and it is the sum of the tourist's beliefs, impressions and ideas about a region, and the study of regional characteristic art image is one of the hotspots of tourism research in recent years. Regional characteristic art image has highly subjective characteristics, which influences people's choice of tourist places and tourists' behaviors, and has a greater impact on the integration of regional cultural and tourism resources. Therefore, this chapter mainly focuses on the validation analysis of the effectiveness of the regional characteristic art image recognition model based on VGG19 and linear discriminant analysis, aiming at further clarifying the key features of the regional characteristic art image and providing reference for the construction of regional characteristic brand strategy.

III. A. Data Acquisition and Preprocessing

III. A. 1) Data acquisition

The object of research in this paper is the comment information published by tourists in the tourism software related to the regional characteristics of the artistic image, so it is necessary to obtain the comment text and pictures by using web crawler technology, the specific steps are as follows:

(1) Initiate a request to the website, use the http library to initiate a request to the desired tourism website, the request includes the request header, request body, etc.. Wait for the response from the travel website server.

(2) Obtain the corresponding content needed for the study, such as URL, comment text, comment image and other content.

(3) Analyze the acquired content. That is, to parse the acquired response, the content such as strings and URLs are parsed using the parsing library to generate the graphic content needed for analysis.

(4) Data saving to save the required data generated by parsing. In this paper, we obtain the text and image data of users' comments on attractions by calling Python related functions. By crawling the graphic data of the relevant comments under each tourism website, the text of the tourists' comments on the tourist destination is finally obtained.

By using the crawler technology to crawl the text and pictures of all the 4A level and above user comments on TJ city on the popular Dianping. there are 40 4A level and above scenic spots in TJ city, after comprehensive analysis of which 10 scenic spots include too few evaluations, indicating that tourists do not pay much attention to these scenic spots, which does not have much impact on the overall research of the regional characteristics of the artistic image of TJ city, and there are 5 attractions that belong to the Memorial Scenic Spots Evaluations are not included and they are not considered. Therefore, the remaining 30 scenic spots' tourist comment texts and pictures are obtained as the research object of TJ city's regional characteristic art image. In order to ensure that the content of the tourists' comments can better reflect the development status of the scenic spots, this study selects the user comment data of each scenic spot in the past three years, and obtains a total of 78,542 comment texts and pictures contained in each comment as the dataset for the study, with a time span of 2021~2024.

III. A. 2) Data pre-processing

(1) Data cleaning

In the phase of processing missing values, special attention was paid to possible missing cases in the comment data and the following measures were taken.

Missing user nicknames: for the missing user nicknames, it was found that this situation is relatively rare and the user nicknames are not absolutely necessary key information for analysis. Therefore, it was chosen to keep this part of the record and not to perform a deletion operation on it.

Missing comment publication time: Comment publication time is crucial for time-series analysis, and records with this information missing were deleted to ensure that the subsequent analysis is based on accurate time information.

By comprehensively processing the duplicates, the cleanliness and accuracy of the comment data are ensured, which provides a more reliable data base for the subsequent identification of the regional characteristics of the art image.

When processing the comment text, in-depth text cleaning is required, including special characters and link processing. In order to avoid the interference of links to the subsequent analysis and maintain the purity of the text, URL links and special characters in the comment text are identified by regular expressions and replaced or deleted. In addition, to reduce the impact of non-textual information on the model and ensure the regularity of the text, regular expressions are used to match and clean up emoticons in the comment text.

(2) Participles and de-duplicated words

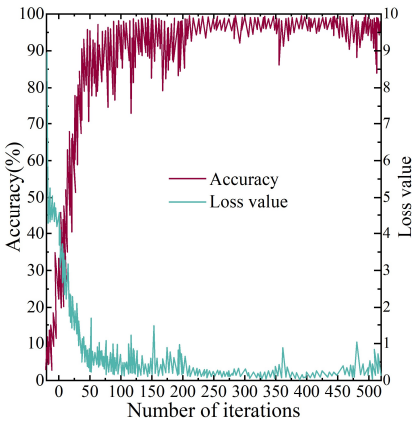
In the word separation stage of data preprocessing, Jieba word separation was chosen as the Chinese word separation tool. In the text after word separation, the deactivation operation is carried out. Deactivation words refer to the common words that frequently appear in text analysis but do not carry actual semantic information, such as “the”, “is”, “has”, etc. In the selected text data, some words are also used due to the high repetition rate and do not carry more information. “In the selected text data, some words are also added to the deactivated word list for removal due to their high repetition rate and the fact that they do not carry more information. Removing these deactivated words helps to reduce the data dimensions, improve the running efficiency of the model, reduce noise interference, improve the model's ability to understand the text, and ensure that the focus is on the truly meaningful keywords in the text. In this experiment, customized deactivated word lists and the NLTK library are used.

Through the above detailed standardization steps, the consistency and standardization of comment publication time and comment content were ensured, and a total of 57,958 relevant comment data about TJ city's regional characteristic art image were obtained, which will be used in the identification of regional characteristic art image later.

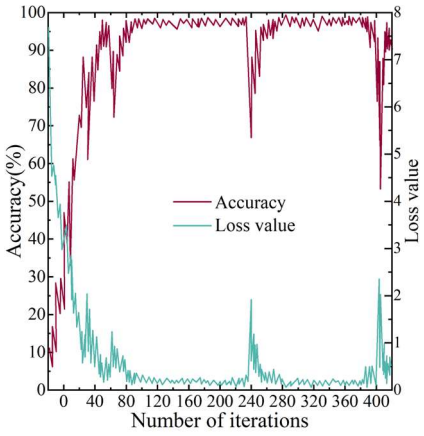
III. B. Regional Characteristic Image Recognition

III. B. 1) Effectiveness of training on various types of networks

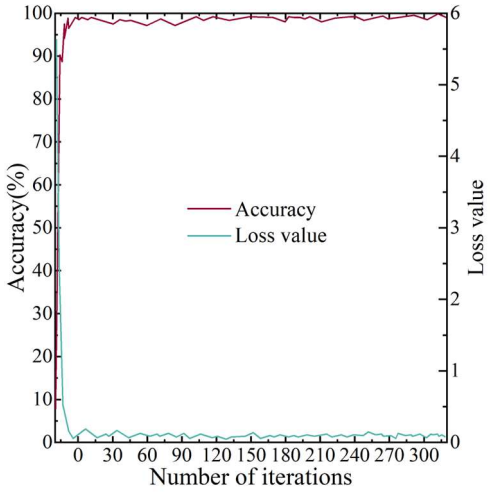
The regional characteristic image recognition model designed in this paper is constructed on the basis of VGG19 network, which aims to enhance the recognition effect of regional characteristic art image, and lay the foundation for promoting the construction of regional characteristic image under the integration of cultural and tourism resources. In order to verify the effectiveness of the VGG19 network, ZFNet and ResNet are selected as the comparison networks, and the network is trained based on the data collected in this paper and its training accuracy is compared. Figure 2 shows the training effect of different networks, where Figure 2(a)~(c) shows the training results of ZFNet, ResNet and VGG19, respectively.



(a) ZFNet



(b) ResNet



(c) VGG19

Figure 2: Training effects of different networks

As shown in the figure, we observe that there is a significant difference in the performance of each model in the task of recognizing regional characteristic art images.The ZFNet network achieves 92.48% accuracy in recognizing multiple categories by virtue of its deep structure and reuse of small convolution kernels strategy, which demonstrates the ability of the ZFNet network in extracting complex features. In contrast, the ResNet network, despite the introduction of the residual learning mechanism to avoid the gradient vanishing problem in deep network training, achieves a recognition accuracy of approximately 92.17%, which is slightly lower than that of the ZFNet network, probably because some of the features of ResNet fail to fully take advantage of the task of recognizing specific regionally distinctive artistic images. It is worth noting that the VGG19 network performs well in terms of training accuracy, at about 98.42%, which indicates that the VGG19 network, through its adapted network structure,

is able to better extract image features in the specific regional featured art recognition task, and thus obtains a higher classification accuracy. According to the comparison data, the model based on the VGG19 network can significantly improve the average recognition accuracy. This significant improvement is attributed to the customized design of the self-built model, which may capture deeper and subtle feature differences through finer structural adjustments, optimization for region-specific featured art images in particular, and more efficient training strategies.

III. B. 2) Anti-noise performance of FDA algorithm

In the VGG19-FDA model designed in this paper for the recognition of artistic images of regional characteristics, the FDA algorithm is mainly used to reduce the dimensionality of the text image data of tourists about regional characteristics, so as to ensure the recognition accuracy of the model. For the text image data of tourists' artistic images of regional characteristics, some noise will inevitably be mixed in the acquisition process, and the reliability of the anti-noise performance of the FDA algorithm needs to be verified. In this paper, SVM and PCA are chosen as comparison algorithms to verify the anti-noise performance of different data dimensionality reduction algorithms. Figure 3 shows the anti-noise performance comparison results of different algorithms.

Since the dataset used in this paper is acquired in real environment, its real signal-to-noise ratio cannot be accurately obtained. So the real data is processed using wavelet denoising method, and the processing result is used as the estimated pure signal, and then Gaussian white noise with different intensity is added to construct text image data with different signal-to-noise ratios, so the real signal-to-noise ratio should be slightly lower than the estimated signal-to-noise ratio. As can be seen from the figure, when the signal-to-noise ratio is 0dB, the algorithm in this paper can achieve close to 100% recognition accuracy. With the continuous improvement of the signal-to-noise ratio, the recognition accuracy is also gradually reduced, and the two show a nearly linear relationship. When the signal-to-noise ratio is greater than 36dB, for the image dataset containing different reviews of tourists, its recognition and classification accuracy can still be maintained at more than 90%, in contrast, the other two comparison algorithms show a significant decline in recognition accuracy. This can show that this paper uses the FDA algorithm to reduce the dimensionality of regional featured art images is feasible, to improve the classification and recognition effect of regional featured art images to provide a guarantee.

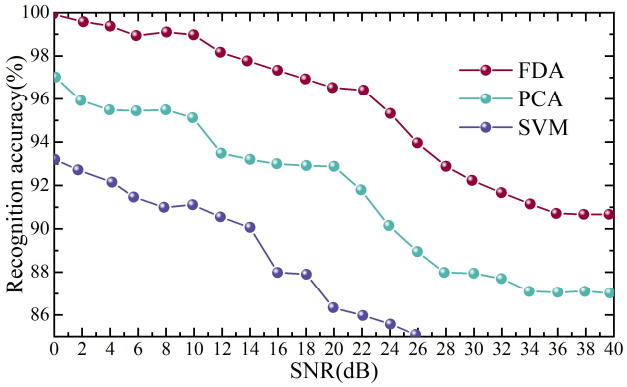


Figure 3: Anti-noise performance of different algorithms

III. B. 3) Comparison results of recognition performance

(1) Recognition speed and accuracy

In terms of network model training, the model in this paper is implemented using the Flying Paddle deep learning framework. The experimental dataset is a self-constructed image dataset of tourists' comments on regional features in TJ city, and each image is cropped by 4 pixels through random edge filling, and data enhancement is performed through random horizontal flipping, and finally mean normalization is performed. The training environment is Baidu's AI Studio, and the GPU is Tesla V100.The network model is trained using backpropagation with stochastic gradient descent with momentum.The self-constructed dataset is divided into the training set and validation set in accordance with 8:2, and a total of 500 rounds are trained on the training set. The initial learning rate is set to 0.001, and 50 rounds of linear warm-up training are performed. On this basis, 450 rounds of cosine decay training are started with a learning rate of 0.01. The weight parameters of the convolutional kernel were initialized using MSRA, the weight decay coefficient was set to 0.005, the size of each batch of data was set to 128, and a label smoothing strategy with a coefficient of 0.02 was also used.

SSRNet, ResNet and ZFNet are selected as comparisons, and the same training parameters are used to obtain the comparison results of recognition speed and recognition accuracy obtained by different models trained on the dataset as shown in Fig. 4. Under the same recognition time, the model based on VGG19 network has a higher

recognition accuracy, and it has a faster recognition speed under the premise of retaining the recognition accuracy of regional characteristic art images. Comparatively speaking, SSRNet and ZFNet need to spend more time to ensure their recognition accuracy. Therefore, the model designed in this paper has higher recognition accuracy and faster recognition speed.

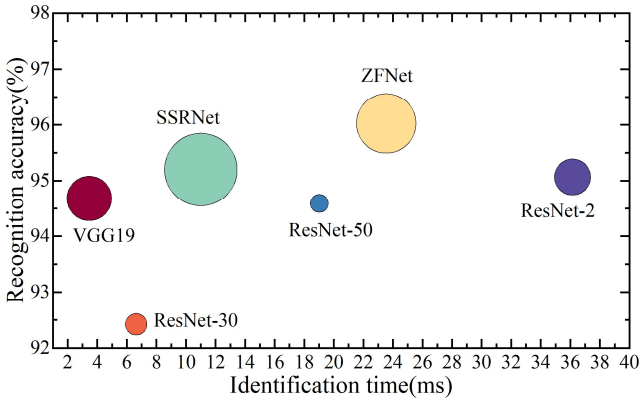


Figure 4: Recognition speed and recognition accuracy

(2) Comparison of Recognition Performance

In order to verify the accuracy of the proposed method for the recognition of regional characteristic art images, this paper selected a variety of models on the self-constructed dataset to carry out comparative verification. In the experiment, OHEM++ and Faster are two-step image recognition methods, and all other methods are single-step image recognition methods. In image recognition, the finer the image, i.e., the larger the size of the original input image, and the relatively more information in the image, the relatively better the image recognition results. In the single-step control method, this paper sets the image input size to 1024×1024 for both the latest SSD and RefineDet, as well as the BFFD algorithms to carry out the comparison of experimental results. IoU and accuracy are chosen as evaluation indexes, and the experimental results of different methods on the self-built dataset are obtained as shown in Table 2.

Table 2: Experimental results of different methods

Model	Input	FPS	IoU			Scale		
			0.5	0.7	0.9	S	M	L
OHEM++	800*400	8.27	44.38	26.15	24.15	7.42	28.17	40.35
Faster	800*400	8.35	41.72	-	21.04	-	-	-
RON385	360*360	16.48	48.95	27.18	27.39	-	-	-
SSD300	256*256	42.16	43.17	25.83	25.27	6.65	26.05	42.03
SSD512	1024*1024	21.09	48.24	30.35	28.86	10.94	31.24	43.59
RefineDet	1024*1024	22.52	55.06	35.92	32.03	16.37	36.48	44.27
Ours	1024*1024	**18.61**	**60.49**	**40.27**	**35.48**	**18.21**	**39.51**	**46.74**

As can be seen from the table, under the same input conditions, the model developed in this paper has a lower FPS value than both the SSD512 model and the RefineDet model. That is, the computational efficiency of the model in this paper is better than the SSD512 model and RefineDet model. In the experiments, the IoU was set to 0.5, 0.7, and 0.9. It is easy to see that the average accuracy values of all the models decrease as the IoU values increase. However, in all three different IoU experiments, the regional featured art recognition model developed in this paper achieved the best average accuracy for multi-scale image recognition. Since RefineDet is the better model for image recognition, for this reason, this section focuses on comparing the model proposed in this paper with the RefineDet model. Obviously, the average accuracies of this paper's model are 60.49%, 40.27%, and 35.48% at IoUs of 0.5, 0.7, and 0.9, respectively, which are 5.43, 4.35, and 3.45 percentage points better than the RefineDet model, respectively. Finally, the experiment also verifies the recognition accuracy of objects at different scales when the IoU is 0.7. As can be seen from the table, the recognition accuracies of this paper's model are 18.21%, 39.51%, and 46.74% for small-scale, medium-scale, and large-scale objects, respectively, which are 11.24%, 8.31%, and 5.58% better than the RefineDet model, respectively. The experimental results show that the model proposed in this paper can effectively improve the recognition accuracy of multi-scale objects, fully identify their specific features

for different types of tourist review images, and lay a solid data foundation for optimizing the regional characteristic art image and establishing the cultural tourism image.

IV. Branding strategies for regional specialty arts

Under the background of cultural and tourism resources integration, the regional characteristic art image occupies an important position in brand building, and has also become an important direction of cultural and tourism industry development research, and how to realize the regional characteristic brand building has become the core field in the current cultural and tourism industry high-quality development practice. As a major brand type of cultural tourism industry brand, regional characteristic brand also plays a leading role in brand development. Therefore, the promotion of regional characteristic brand construction helps to further enhance the vitality of the cultural tourism industry, to play the regional cultural tourism characteristic brand and image, and has special theoretical and practical significance for the development of the regional cultural tourism industry.

IV. A. Framework for Regional Specialty Branding

IV. A. 1) Characteristic Brand Building System

Regional characteristic brand image belongs to the part of cultural and tourism branding construction, which refers to the name and logo of cultural and tourism resource products used to distinguish them from other similar products after a series of visual design. It is an effective interpretation of the various elements of the brand of cultural and tourism products and the extraction of design elements, combined with modern aesthetic needs to integrate the elements to form a brand visual symbol that can express the personality of the brand.

Based on the results of the regional characteristic art image recognition, this paper establishes a systematic planning based on various aspects such as brand positioning, brand culture excavation, image design planning and marketing, brand promotion, etc., combining with the characteristics of the regional cultural and tourism resources in TJ City, whose specific framework is shown in Figure 5. Relying on the regional characteristics of the brand building system, as a way to promote the brand benefits, to enhance the efficiency of regional cultural and tourism resources integration to provide reliable support, and further promote the high-speed development of the regional cultural and tourism economy.

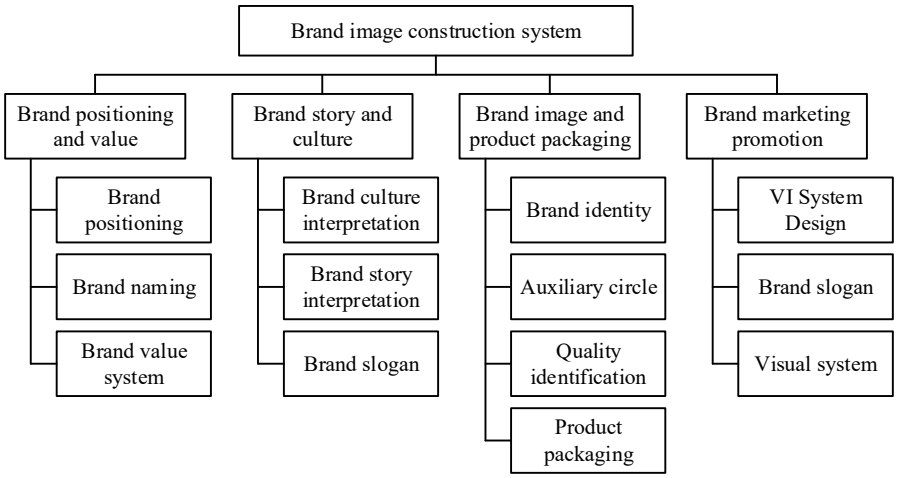


Figure 5: Characteristic brand construction system

(1) Brand Positioning and Value

Brand positioning is the enterprise through the brand's product and corporate image design, to obtain the identity of the target consumers of the brand / product. Brand positioning from the brand image, product positioning and consumer use perspective of the three aspects of the joint development of the brand image and product features, brand positioning needs to be based on regional characteristics of the development of the concept as well as product positioning. The value created by the brand not only lies in the promotion and publicity to increase brand awareness, but also in the brand in the growth process gradually become a brand of intangible assets, with unlimited vitality.

(2) Brand culture performance

Brand culture is the material and spiritual culture of the brand gradually condensed in the process of operation, representing the brand's cognition and emotional belonging, is the core content of the brand. Brand culture shaping through the product's emotional connotation and functionality of the perfect blend of consumer comfort, to meet the

spiritual pursuit. Inspire consumers to identify with the brand's culture and philosophy, and ultimately become loyal fans of the brand.

(3) Brand image design

Brand image is the visual expression of brand culture and story, as the cultural expression carrier of the brand, reflecting the value of brand culture in communication, the brand image not only includes the name, logo, product packaging, advertising and marketing image design, but also is a kind of visual work with rich connotation. The brand cultural value, product quality, brand service concepts and other brand culture into the image design, and ultimately form a unified standardized visual communication system.

(4) Brand marketing communication visual system

Build a complete brand marketing communication visual system is crucial to the long-term development of the brand, brand communication is multi-directional, including the brand image and cultural concepts and other information from the enterprise to consumers, but also includes the consumer according to say that the information received to give the brand perception and brand concept of feedback. The direction and content of brand communication information to a certain extent controlled by the enterprise, but it is more dependent on the market and consumer acceptance of its degree.

IV. A. 2) Branding influencing elements

Figure 6 shows the influencing elements of regional characteristic brand construction, which is based on the tangible material of regional characteristic cultural and tourism resources, the business activities with enterprises as the main business, and consumers as the recipients, which just constitute the interrelated and interacting stakeholders. The successful implementation of regional characteristic brand building activities can not be separated from the influencing elements among the stakeholders.

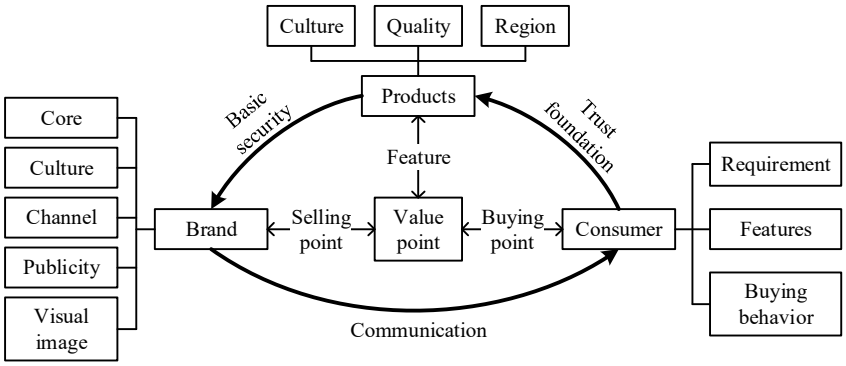


Figure 6: Influencing factors of brand building

Through the analysis of consumers, it is learned that consumers pay the most attention to the quality and experience sense of cultural tourism brand products, and these concerns end up as the consumer's buying point. Through the exploration of the brand, it is concluded that the brand structure of the regional characteristics of cultural tourism products should be based on the quality of the product as the cornerstone, using the brand image to communicate with consumers, and through the understanding of the consumer's buying point, the product is the core of the functional points, converted into selling points. Through the understanding of the product found that the quality of the product can not be separated from the technical support and training of professionals. Finally, consumer buying points, brand selling points, product functional value points of the common convergence of where the value point is located. But in any case, products and brands are ultimately oriented to consumers, and consumers have a guiding role in the construction of regional characteristics of cultural tourism brand.

IV. B. Brand building strategy for regional specialties

IV. B. 1) Policy-led planning first

The identification of regional characteristics of culture and tourism art image and brand building, need to dig deep into the regional characteristics of tourism resources, around the supply and demand end of the force, the introduction of a number of policies, to create a diversified thematic activities brand, so as to form a “boutique-driven, multi-point support, industrial integration” of the tourism development of the new pattern. In order to create regional characteristics of tourism brand, shaping the image of regional characteristics of tourism destinations, we must further release the policy dividends, integration of tourism resources, focus on efficiency, tourism development planning into the overall situation of regional economic and social development, in promoting urban and rural

integration, rural revitalization, structural adjustment, industrial integration, and coordinated development of the process of systematic planning of tourism projects. In response to the imbalance in tourism development between regions, we will improve the coordination and promotion mechanism, plan boutique tourism routes, and provide a strong guarantee for synergistic construction.

The brand image construction of regional characteristic tourism destinations should be combined with the tourism demand of tourists, use tourism big data to carry out the analysis of tourists' demand and perception, provide tourists with personalized tourism services, enhance the experience of tourists, and improve the satisfaction of tourists. At the same time, we should condense the consensus on the deep integration and development of culture and tourism, continue to promote the construction of intelligent system, and expand the spillover effect of industrial integration with the concept of common construction, common governance and sharing, so as to promote the high-quality development of the regional characteristic culture and tourism industry.

IV. B. 2) Optimizing brand promotion channels

With the accelerated development of the Internet, new media are gradually integrated into people's lives. Compared with traditional media, new media marketing and publicity has the advantage of more convenient and wider dissemination. Through the publicity of the new media platform, it can help tourist attractions to better establish their image. New media bring tourists a vivid image of tourism information display, which will allow tourists to produce a cognitive response to echo, thus affecting their travel intentions. New media marketing is not simply send copy to do publicity, but need to plan publicity strategy, to do publicity to be comprehensive three-dimensional, full coverage.

First of all, when carrying out network publicity can not be limited to short videos of this type of new media, but to actively use new media platforms, create microblogging, WeChat public official account, all-round publicity of tourist places. It is necessary to open columns in various new media communities such as Zhihu and Ma's Nest to help potential tourists better understand the information and evaluation, and realize information sharing. Secondly, tourism enterprises can organize netizens and opinion leaders to carry out the picking activities of special tourism routes, and make use of live broadcasts, short videos, travelogues and other forms to attract tourists to pay attention to tourism scenic spots and participate in interactions. For example, to create information hotspots of tourist destinations through netroots topics, and to improve the exposure of tourist destinations through the extension of hot topics in order to make tourist destinations establish a good image in the minds of potential tourists beforehand. Finally, it is necessary to speed up the construction of cultural and tourism websites and implement modernized service systems such as online booking and online travel route guidance, so as to make tourism services more fashionable, convenient and fast, so that tourists can feel a high-quality tourism service experience.

V. Conclusion

The article establishes a regional characteristic art image recognition model based on VGG19, combined with linear discriminant analysis algorithm, and verifies the validity of the model through self-constructed dataset. In addition, a framework of regional characteristic brand building is established based on the results of the identification of regional characteristic art image, and relevant strategies for the construction of regional characteristic brand image are proposed. The identification of regional characteristic art image needs to fully explore the tourists' comment image data, and through the aggregation to clarify the characteristic composition of regional characteristic art image, combined with the policy leadership and new media publicity channels, so as to promote the construction of regional characteristic brand. In the context of cultural and tourism resources integration, it is necessary to fully combine big data technology to deeply analyze different types of data, in order to give more diversified characteristics of regional special art imagery, and to lay the foundation for promoting the efficiency of regional special cultural and tourism resources integration, and boosting the vitality of the regional cultural and tourism economy.

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