International Journal for Housing Science and Its Applications
Publish August 6, 2025. Volume 46, Issue 3 Pages 7336-7348

https://doi.org/10.70517/ijhsa463629

Computer-Assisted Regional Cultural Translation in Xi'an Metro Line 4 Spatial Design Practice

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Abstract As an urban cultural communication carrier, metro space is characterized by dense flow of people and closed space, which is an excellent medium for displaying regional culture. Computer-aided technology provides a scientific method for the extraction and translation of regional cultural elements, which makes the subway space design more local characteristics. In this study, K-Means clustering algorithm and LBP (Local Binary Pattern) algorithm are used to extract the color and texture features of the Shaanxi folk art element-horse spoon, construct a color network model to analyze the color matching law, and convert the cultural elements into design elements through the regional culture translation model, which is applied to the spatial design of Xi'an Metro Line 4. The results show that the K-Means algorithm has high accuracy in color extraction; the LBP algorithm outperforms the five algorithms of GLCM, EOG, SGS, CS and SOP in four texture dataset tests, and at the same time has the shortest feature extraction time. The practical design effect survey shows that 72%~76% of the 500 passengers are satisfied with the spatial design of Xi'an Metro Line 4 that incorporates regional culture. This study provides new ideas for the scientific extraction and artistic translation of regional culture in urban public space, effectively solves the problem of “a thousand stations in one place” in metro space, and realizes the harmonious unity of regional culture and modern design.

Index Terms regional culture translation, computer-aided, K-Means algorithm, LBP algorithm, color network, subway space design

I. Introduction

With the continuous construction of subway transportation network, the underground space of subway station has become an important part of urban public space, and its basic function has gradually expanded and sublimated from carrying transportation to art appreciation, cultural heritage and other levels [1], [2]. In this process, the subway not only profoundly affects people's travel mode, work rhythm and quality of life, but also infiltrates people's thinking, aesthetic interest and cultural taste [3], [4]. Due to the dense passenger density in subway stations, the space is relatively closed, and the passing people are not easy to be disturbed by external things, and their vision and attention are relatively concentrated, which determines that the public space of the subway is very suitable for acting as a medium for spreading urban regional culture [5]-[7].

Regional culture refers to the humanistic spirit that plays the role of cultivating, educating and value leading in the process of social development of a certain region, which is condensed and precipitated by the region as the spatial carrier, history as the main line of time, scenes and objects as the tangible carrier, and reality as the appearance [8]. It is mainly manifested in historical and cultural heritage, modern civilization display, urban landmark building, tourism information guidance, humanistic spirit convergence, cultural integration and innovation, etc. [9], [10]. How to translate a city's historical and cultural heritage, natural and humanistic style through the innovative artistic design of subway space, so as to enhance the city's public image and cultural soft power, is the goal that designers and artists have been painstakingly exploring and diligently pursuing for more than a hundred years [11]-[13].

As an important part of modern urban public transportation, the subway not only undertakes the function of urban transportation, but is also an important carrier of urban culture dissemination. Metro public space because of its dense passenger, relatively closed characteristics, so that the flow of people is not easy to be disturbed by external things, vision and attention is relatively focused, and become an ideal medium for the dissemination of urban regional culture. However, the design of subway stations in many cities today is uniform and lacks regional cultural characteristics, which fails to meet people's needs for spiritual culture. Xi'an, as a famous historical and cultural city in China, has rich regional cultural resources, how to apply these traditional cultural elements to the metro space

design scientifically, not only to retain the original flavor of the culture, but also to meet the modern aesthetic needs, has become a problem worth exploring. The traditional extraction of regional cultural elements relies on the experience and subjective judgment of designers, and lacks scientific and systematic, which makes it difficult for the extracted elements to accurately express the connotation of regional culture. Computer-aided technology provides a new idea to solve this problem. By quantitatively analyzing and extracting regional cultural elements through algorithms, the cultural characteristics can be grasped more objectively and accurately. However, the current research on computer-aided regional culture translation in metro space design is still relatively insufficient, especially how to transform the extracted cultural elements into specific design elements and apply them to metro space design, which still needs to be explored in depth. As a representative element of Shaanxi folk art, the horse spoon integrates the characteristics of shape, color and texture, and has distinctive regional cultural characteristics, which makes it an ideal object for the study of regional cultural translation. Xi'an Metro Line 4 runs through several important economic and transportation areas in Xi'an, and its spatial design will effectively enhance the passenger experience and show the unique charm of Xi'an if it can integrate regional cultural elements.

Based on the above background, this study combines computer-aided technology with regional culture translation, takes Shaanxi folk art element horse spoon as an example, extracts its color and texture features through K-Means clustering algorithm and LBP algorithm, constructs color network model to analyze the color matching law, establishes a regional culture translation model, transforms the cultural elements into design elements, and applies them to the spatial design of Xi'an Metro Line 4. The research firstly defines the concept of regional culture, analyzes the concept of regional culture, and then analyzes the design of line 4. The study firstly defines the concept of regional culture and analyzes its application value in metro public space; secondly, extracts and analyzes the color and texture features of the horse spoon using computer algorithms; then builds a regional culture translation model, transforms the extracted cultural elements into design elements; finally, applies the design elements to the spatial design of Xi'an Metro Line 4, and analyzes the design effect through questionnaire surveys. This study provides new ideas for the scientific extraction and artistic translation of regional culture in urban public space, which is of great significance in solving the problem of “a thousand stations with one side” in metro space.

II. Computer-assisted regional cultural translation

II. A.Regional culture

Regional culture refers to the humanistic spirit that plays the role of cultivating, educating and value leading in the process of social development of a certain region, which is condensed and precipitated with the region as the spatial carrier, history as the main line of time, scenes and objects as the tangible carrier, and reality as the appearance [14], [15]. Metro stations are densely populated, the space is relatively closed, the passing people are not easy to be disturbed by external things, and the vision and attention are relatively concentrated, which determines that the public space of the metro is very suitable for acting as a medium for spreading urban regional culture, mainly manifested in the transmission of history and culture, the display of modern civilization, the creation of urban landmarks, the guidance of tourism information, the convergence of humanistic spirit, and the integration of culture and innovation, and other aspects.

Taking historical and cultural heritage as an example, through searching and sorting out the city's development lineage, it is clear where to go on the premise of knowing where it came from, so as to retain the city's roots. The public space of the subway can display the history of the city or specific places through murals, reliefs and other forms of art, so as to achieve the purpose of cultural dissemination and inheritance. In addition, designers can show the latest development results of the city's material and spiritual civilization through the innovative design of the internal and external landscapes of subway stations, and abstract, translate and express landmark landscapes or tourist attractions. For example, Xi'an Metro Line 4, both inside and outside of the station are full of Chinese red elements, and the red pillars inside the station are also in a unified style. These characteristic stations not only artistically show the landmarks or landscapes of Xi'an, but also skillfully play the role of tourist information guide for passengers, especially foreign tourists.

II. B. Extraction of regional cultural elements

II. B. 1) Color Extraction

Color extraction uses the K mean clustering algorithm (K-Means), which is an algorithm that performs clustering through constant iteration by dividing the data into K groups and constantly calculating the sum of squared errors between the groups until the function converges. This algorithm is expressed as a function:

Let the dataset $X=\{x_i \mid i=1,2,\ldots,n\}$ be the data to be clustered, and the objective is to divide the dataset X into K groups, $P_k=\{C_i \mid i=1,2,\ldots,k\}$, such that the squared error function $f(P_k)$ is minimized, then P_k is the result of clustering grouping. The function $f(P_k)$ is formulated as:

$$E=\sum_{i=1}^{k}\sum_{p\in c_i}\left|p-m_i\right|^2 \tag{1}$$

E is the sum of squared errors of each group, where c_i is the i th group and m_i is the mean of i th group, i.e., the center of the group, calculated as:

$$m_i=\frac{1}{n_i}\sum_{p\in c_i}p \tag{2}$$

where n_i is the sum of reorganized data items. The important basis for determining whether p belongs to the m_i is the distance from the p_i point to m_i, and this distance is calculated by the formula:

$$d(x_{il},m_{jl})=\sqrt{\sum_{i=1}^{d}(x_{il}-m_{jl})^2} \tag{3}$$

In the formula, x_{il} is the attribute of x_i on l, $j\in(1,k)$, and $d(x_i,m_j)$ denotes the distance from the i th data to the j th clustering center.

This process can be understood as, after obtaining the number of classifications K, the data to be classified will be randomly determined K centroids as the initial clustering centers, and then calculate the distance of each point to the center, the distance from the center of the point is small to a group of points, each object will be classified into a clustering, the center of the clustering will be re-calculated, and the process is carried out continuously until the sum of the local squared errors and the minimum time will be terminated.

Based on the basic principle of K-Means, in the color extraction of a single picture, the color can be expressed as a three-dimensional spatial coordinates composed of RGB values, the color of all the pixels on a picture is all the points in this spatial coordinate, the classification of these colors is the classification of these points, in the given need to be divided into the number of groups K, the algorithm is constantly iterated to calculate the various spatial coordinates of the points to the After the number of groups K is given, the algorithm iteratively calculates the sum of squares of each spatial coordinate point to the center of the clusters, and the algorithm terminates when the spatial coordinates of the K cluster centers are the results of the color extraction. Similarly the color expressed by CMYK is a four-dimensional spatial coordinate point, and the color expressed by HSB is also a point in three-dimensional spatial coordinates, and the clustering process of the color is similar to the process described above. For the color extraction of multiple images, a color ensemble is obtained on the basis of the colors extracted from a single image, and then this algorithm is used again to classify the color ensemble with a secondary calculation.

In the construction of the color relationship network, first of all, the color relationship network refers to the matching relationship between various colors and the weight of each color in a visual scheme to show, in the color relationship network, through the circle surrounded by various small color blocks to indicate all the colors extracted, the size of each color block reflects the weight of the color size, the connecting line between the colors to indicate the matching relationship between the colors, the thickness of the connecting line reflect the two colors, and the thickness of the connecting line reflect the two colors. The thickness of the connecting lines reflects the frequency of the two colors appearing together.

In a nutshell, the construction of a color network is a process of quantifying and visualizing images. The first step is to quantify the color relationships, i.e., to build a color adjacency matrix, and then use Python to express the color adjacency matrix as an image. The color adjacency matrix expression is:

$$C=\begin{bmatrix} w_1 & & & & & \\ l_{2,1} & w_2 & & & & \\ \vdots & \vdots & \cdots & & & \\ l_{j,1} & l_{j,2} & \cdots & w_j & & \\ \vdots & \vdots & & \vdots & \cdots & \\ l_{n,1} & l_{n,2} & \cdots & l_{n,j} & \cdots & w_n \end{bmatrix} \tag{4}$$

$$\sum_{j=1}^{n}w_j=1 \tag{5}$$

where w_j denotes the weight of the j th color, and $l_{n,j}$ denotes the proportion of the sum of the number of times the n th color co-occurs with the j th color color.

II. B. 2) Texture Feature Extraction

The implementation principle of the original LBP algorithm: firstly, take the image pixel point as the center, and select the 3×3 pixel square neighborhood template for comparison, Fig. 1 shows the schematic diagram of the 3×3 pixel square neighborhood template, the circle indicates the center pixel point, and the dots indicate the neighboring sampling pixel points.The flow of the calculation of the LBP value is shown in Fig. 2.Assuming that the coordinates of the center pixel point are (x_c, y_c), the coordinates of the eight domain sampling pixel points within the 3×3 pixel square neighborhood template are (x_{c-1}, y_{c-1}), (x_{c-1}, y_c), (x_{c-1}, y_{c+1}), (x_c, y_{c+1}), (x_{c+1}, y_{c+1}), (x_{c+1}, y_c), (x_{c+1}, y_{c-1}) with (x_c, y_{c-1}), as shown in Fig. 2(a). Then the comparison of gray value between the center pixel point and the sampled pixel point is carried out, the pixel gray value of the gray scale image ranges from 0-255, in this paper, any size pixel gray value is randomly selected as the gray value of the center pixel point and the sampled pixel point, as shown in Fig. 2 (b), and the 8 sampled pixel points in the neighboring area are compared with the center pixel point for the difference of the gray value by using the formula (6) cycle, and if the center pixel gray value is less than the gray value of the surrounding 8 sampled pixel points, then the corresponding sampled pixel point position is marked as 1, and vice versa as 0, as shown in Fig. 2(c). Finally, taking the sampled pixel point to the upper left of the center pixel point as the starting point, the binary number 10000111 is obtained by using Eq. (7) in the clockwise direction, which is converted to the decimal number 135, i.e., the LBP value, which is used to reflect the information of the texture structure of the center pixel point in the 3×3 square neighborhood template. Iterate through the entire image to get the LBP value of all pixel points, remove the entire image of the first row, the last row, the first column, the last column of the pixel points, to get the LBP value of the matrix formed by the texture image, compared to the original image, the texture image is less two rows and two columns. That is:

$$s(i_p, i_c) = \begin{cases} 1 & if\ (i_p - i_c) \geq 0 \\ 0 & else \end{cases} \tag{6}$$

where, i_c denotes the gray value of the center pixel point, i_p denotes the gray value of the neighboring pixel point, and $s(i_p, i_c)$ denotes the gray value of the comparison between the sampled pixel point and the center pixel point in the square neighborhood. I.e:

$$LBP(i_p, i_c) = \sum_{p=0}^{p=7} 2^p s_p \tag{7}$$

where, $LBP(i_p, i_c)$ denotes the LBP value of the pixel point and p denotes the number of the LBP code.

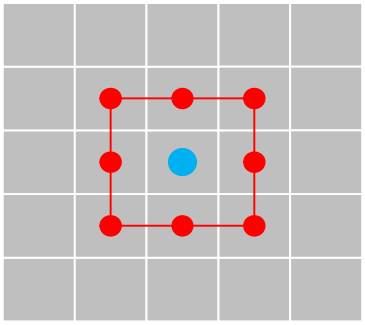


Figure 1: Square neighborhood template

(x_{c-1},y_{c-1})	(x_{c-1},y_{c-1})	(x_{c-1},y_{c-1})
(x_{c-1},y_{c-1})	(x_{c-1},y_{c-1})	(x_{c-1},y_{c-1})
(x_{c-1},y_{c-1})	(x_{c-1},y_{c-1})	(x_{c-1},y_{c-1})

a) Pixel coordinate values of 3×3 square field

8	6	5
9	7	4
1	2	3

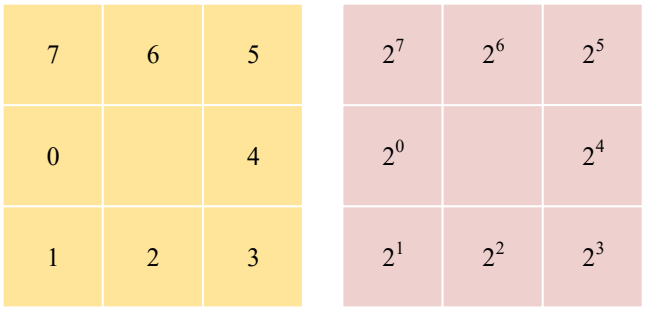
b) 3×3 square field pixel grey value

1	0	0
1		0
0	0	0

c) 3×3 square field pixel grey scale comparison value

Figure 2: Calculation process of LBP value

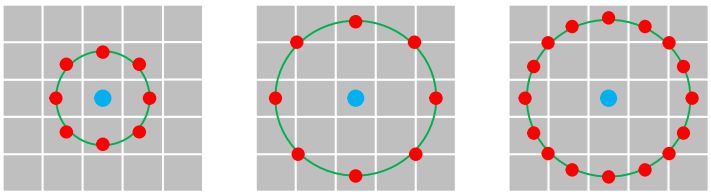
The LBP coding of the sampled pixel points is shown in Fig. 3, 2^p denotes the LBP coding of the corresponding sampled pixel point of the primitive LBP algorithm within the square neighborhood template, which is shown schematically in Fig. 2(a)~(b), and s_p denotes the grayscale comparative value between the sampled pixel point and the center pixel point within the square neighborhood template. The original LBP algorithm has the advantages of low computational complexity and high stability, but the original LBP algorithm is sensitive to image rotation changes.



a) Number of the LBP code b) LBP code

Figure 3: LBP encoding of sampled pixel points

Since the original LBP algorithm limits the extracted image texture to a neighborhood of fixed radius, it is not possible to extract larger texture structure information when the neighborhood range is small, and the stability of the image texture in the case of rotational changes in the texture structure information of the capture of the stability of the performance of the poor, in order to make up for the shortcomings of the original LBP algorithm, the uniform mode LBP algorithm is proposed. The uniform mode LBP algorithm changes the shape of the neighborhood template from a square to a circle, and the circular neighborhood template can be set to any size of the radius R and the number of sampling pixels P, the circular neighborhood template schematic is shown in Fig. 4, Fig. 4(a) shows the template schematic of the radius R of 1.0 and the number of sampling pixels P of 8, and Fig. 4(b) shows the template of the radius R of 2 and the number of sampling pixels P of 8, and Fig. 4(c) shows the template of the radius R of 2 and the number of sampling pixels P of 8. number P is 8, Fig. 4(c) shows the schematic diagram of the template with radius R of 2 and the number of sampled pixel points P of 16. In this paper, the radius R of 1 and the number of sampled pixel points P of 8 are selected.



a) R=1.0, P=8 b) R=2.0, P=8 c) R=2.0, P=16

Figure 4: Circular neighborhood template

In the first stage of the implementation of the uniform mode LBP algorithm, the coordinates of the central pixel (x_c, y_c) are assumed firstly, and the coordinates of the 8 sampled pixels in the circular neighborhood are calculated by equation (8). Then, the bilinear interpolation algorithm is used to calculate the pixel gray value of 8 sampled pixels, as shown, and the gray difference is calculated with it, if the gray value of the center pixel is less than the gray value of the surrounding 8 sampled pixels, the corresponding sample pixel position is marked as 1, and vice versa is 0. Finally, the sampling pixels in the upper left of the center pixel are used as the starting point to obtain the binary number 01111111, which is converted to the decimal number 127 as the LBP value, and then the circular neighborhood template is gradually rotated to obtain the other 7 binary numbers. A total of 8 binary patterns are obtained, which are 01111100, 10111100, 11011100, 11101100, 11110100, 11111000, 11111100 and 11111100, and the decimal values corresponding to these 8 binary modes are: 124, 188, 220, 236, 244, 248, 252 and 252, and the smallest value is taken as the LBP value, that is, the LBP value is 124.

$$\begin{cases} x_p = x_c + R\cos\left(\dfrac{2\pi p}{P}\right) \\ y_p = y_c - R\sin\left(\dfrac{2\pi p}{P}\right) \end{cases} \tag{8}$$

where, x_p denotes the horizontal coordinate value of the pixel point in the circular neighborhood, y_p denotes the vertical coordinate value of the pixel point in the circular neighborhood, x_c denotes the horizontal coordinate value of the center pixel point, y_c denotes the vertical coordinate value of the center pixel point, R denotes the radius of the circular neighborhood template, and p denotes the number of the LBP code.

II. C. Regional Cultural Translation Model

In the previous section, the regional cultural elements have been extracted, but the extracted regional cultural elements can not be directly applied to the space design of Xi'an Metro Line 4, but also need to be transformed into design elements through certain methods, and build the regional cultural translation model.

II. C. 1) Overview of geo-cultural translation

Regional cultural translation is the process of translating a more abstract regional cultural element into a more recognizable design element and integrating it with the product [16]-[18]. Regional culture translation is mainly divided into three steps: firstly, the regional culture elements are extracted from the perspectives of explicit cultural symbols and implicit cultural values. Secondly, the extracted regional cultural elements are translated into design elements through the methods of extraction and reconstruction of modeling elements and extraction and reconstruction of image elements. Finally, the translated design elements are integrated with the products to design products with regional cultural characteristics.

II. C. 2) Transformation of regional cultural elements into design elements

In this stage, a large number of product sample pictures are searched by using network research and literature research, case study method is adopted to sort them out, and typical cases are selected for statistical summarization. There are seven methods to translate regional cultural elements to design elements, namely: image element extraction and reconstruction, modeling element extraction and reconstruction, color element extraction and reconstruction, local copying and innovation, connotation extraction, pattern use and material use. Among them, image element extraction and reconstruction, modeling element extraction and reconstruction, color element extraction and reconstruction, local copying and innovation, pattern following and material following are applicable to the translation of the external cultural symbols of regional cultural elements, and the connotation extraction method is applicable to the translation of the internal cultural values.

II. C. 3) Design element expression

This stage mainly discusses the expression forms of design elements, aiming to prepare for the subsequent integration of design elements and products. The expression of design elements mainly includes the simplification of the main form, the exaggeration of the main form and the reconstruction of the main form.

(1) Simplification of subject form

The main form is simplified by using Photoshop, Adobe Illustrator and other software to depict the outline of the main shape, and further simplify the internal detail lines, and ultimately delete the redundant transitions.

(2) Exaggeration of the main form

Exaggeration of the main form is mainly an abstract treatment of the typical design elements, so that its overall form gives a sense of abstraction. At the same time of its exaggeration, the recognition and readability of the design elements should be ensured, and the abstract exaggeration should not be carried out blindly.

(3) Reconstruction of the main form

The main form reconstruction method refers to the use of mirroring, overlapping, deformation, rotation, scaling and other methods to form new design elements in the matrix while retaining its internal lines.

II. C. 4) Translation of regional cultural elements to design elements

In this stage, the above regional cultural elements are mainly translated to the design elements, which will be summarized in the following as an example of a certain regional culture. The externally visible cultural symbols of a certain regional architecture as a cultural prototype are the form of Wanshou Pagoda, the eaves of the pagoda, and the octagonal shape, and the implicit cultural values are the culture of the Ancient Canal, and the architectural culture of the Ming Dynasty. The most obvious feature of the Wanshou Pagoda is the tower-like shape, so its apparent cultural symbols are mainly translated by the method of extracting and reconstructing the modeling

elements, and simplified by the simplicity of the main form, and the rest of the regional cultural elements will be used as a reference for the translation of the design elements.

III. Regional Culture Translation in Metro Space Design Practice

III. A. Design principles

III. A. 1) People-oriented

Because the main body of the station is people, the design of its public space reflects the relationship between people and space. By means of design, the whole space has a soul and temperature, from a cold modern building to a carrier of regional culture. The individual perception of the entire space as the starting point for the design, and ultimately get the psychological feeling for the landing point, to effectively meet people's inner needs, to provide a full integration of traditional culture and modern design and comfortable and harmonious subway public space, so that users can enjoy and the spirit of the state in a happy.

III. A. 2) Harmonization of functionality and decoration

As an important part of urban public transportation, the transportation function of the subway is the core attribute. On the basis of ensuring the transportability, the regional cultural characteristics of the space are strengthened, so that the users do not simply take the subway as a means of transportation, but also as an innovative carrier for the promotion of traditional culture. This design is to take the Shaanxi folk art element of horse spoon as an example, through the extraction of innovative means and methods to make the station and the horse spoon element theme, mood, environment of the unity of the station entrances and exits, platforms, station hall level of the facade, public space decorative design. Thus, on the basis of service functionality, it meets the needs of modern technology and spiritual function, etc., and reflects the unique regional cultural characteristics of Shaanxi.

III. A. 3) Security principles

Subway station does not belong to the general building, its overall most of the construction in the underground space, so its core principle is safety. Subway public space is more humid, the intensity of passenger flow is higher, and the people are more dense. If a dangerous situation occurs, such as fire, gas leakage and other emergencies, the consequences are unimaginable. At the same time, due to the high standard of the construction of subway stations, most stations will not be re-designed and remodeled, the selection of moisture-resistant, corrosion-resistant materials has become an inevitable choice. So that in the choice of materials, whether it is the top, wall, floor should be selected with corrosion resistance, waterproof, moisture-proof, low water absorption of environmentally friendly insulation materials, and to facilitate people's daily care and maintenance, to reduce the impact of maintenance on the user.

III. A. 4) Principle of feasibility

The reason why design is becoming more and more important in today's society is, on the one hand, the rising economic level, resulting in the growing importance of aesthetic and spiritual needs. More important aspect is that the design is for the actual service, if too much pursuit of beauty, color, effect and the expression of the sky, in order to design and design, then ignore the objective facts and feasibility of the design is invalid, but also pay attention to the overall coordination and unity of the space, the various spaces echo each other, because the subway public space for the whole community, then we must consider the moderation of the design, if too much emphasis on individuality and ignore the commonality of the effect will also be compromised. Emphasize the individuality and ignore the commonality, the effect of its presentation will be greatly reduced.

III. B. Xi'an Metro Line 4 and its spatial design

III. B. 1) Xi'an Metro Line 4

Xi'an Metro Line 4 runs through several important economic and transportation areas of Xi'an, linking the two major transportation stations of Xi'an, Beiqi Station and Xi'an Railway Station, and also linking Xi'an's administrative area in the north, the middle of the city through the center of the ancient city economic, tourism and cultural area, the south of the city linking the Big Wild Goose Pagoda as well as the river ecological, cultural and tourism area, and the most southern to the Aerospace New City, and other important urban areas. Metro line four for the north-south direction, and with most of the line and the Xi'an metro line two parallel, Xi'an metro line four and Xi'an metro line two of the double line of operation, together to build an important double corridor of the city's north and south, but also it also eases the Xi'an metro line two in the center of the city area of the pressure of the passenger flow. The specific route of Metro Line 4 links Cao Tan Modern Agricultural Development Zone, Zhangjiabu Square, Qujiang New District, Xi'an Aerospace Base, via Xi'an Railway Station, the five intersections within the Ming City Wall, as well as crowded areas such as Dacha City and Tae II Mausoleum Speed Site Park.

III. B. 2) Space design

This case takes the Shaanxi folk art element horse spoon as an example to design in the public space of the subway, through the analysis and screening of the horse spoon element modeling flat structure, vertical structure, color structure, can be seen as a combination of its horizontal and vertical cross-section of the circle and square, the combination of the form of simple and clear, and can be applied in the subway in all kinds of space. Horse spoon element color pattern, pattern variety, its pattern are implied for the meaning of peace and good luck, the ancient people put the horse spoon as a prayer for family joy, happiness and good luck of the artifacts. For example, the Five Roads Station within the Ming City Wall integrates the cultural spirit and national connotation of the horse spoon element with the modernization of the subway, selecting the most representative Qin opera and face painting as the main elements of the cultural wall, and depicting vivid characters through different scenes of the classic Qin opera characters, reflecting the unique regional cultural characteristics of Shaanxi. The water pattern generally expresses a spiritual beauty and the desire for a better life. Through the change of pattern, we can feel the rich connotation meaning of the element of horse spoon, and apply it in the guide design. This guide design adopts the concept of “water” pattern, and carries out the guide design through the direction of water flow. Through modern methods of expression in the public space of each area to embellish and integrate the elements of the horse spoon, so as to create a modern architectural cultural heritage in the overall visual sense of the interior space design. Through the application of the elements of the horse spoon design, so that the entire space to create a subway public space full of regional cultural characteristics, which focuses on grasping the design of the principle of proportionality, but not overemphasize the relationship between individuality and commonality, and effectively create a sense of people and culture, people and regions, people and space in harmony with the aesthetics of the same as to get rid of the “one side of a thousand stations” of the subway. Public space status quo, for the subsequent development of space to put forward a new direction of thinking and the application of elements.

IV. Analysis of the effect of regional culture extraction and practical design

IV. A. Extractive analysis of regional culture

IV. A. 1) Color extraction analysis

(1) Evaluation index

In order to determine the clustering effect of the two algorithms, the evaluation index---IoU is introduced, and the larger IoU indicates that the clustering results of the algorithms are closer to the actual. First of all, with the help of labeling software LabelMe to obtain the segmentation results of K-means and GMM as well as the corresponding different color feature regions of the tested horse spoon image, which are recorded as K_i, G_i and $O_i\left(i=1,2,\cdots\right)$, respectively, and derive the corresponding pixel values in the region. The specific calculations are as follows:

$$IoU_{K-means}=\frac{area\left(K_i\right)\cap area\left(O_i\right)}{area\left(K_i\right)\cup area\left(O_i\right)} \tag{9}$$

$$IoU_{GMM}=\frac{area\left(G_i\right)\cap area\left(O_i\right)}{area\left(G_i\right)\cup area\left(O_i\right)} \tag{10}$$

(2) Analysis of extraction effect

The two algorithms of K-means and GMM (Gaussian Mixture) are used for segmentation, color clustering and extraction of the measured horse spoon image respectively.K-means is based on the number of pixels for clustering, while GMM is based on the probability of pixels in a certain class cluster for clustering, the five body color extraction effect comparison analysis is shown in Table 1. The three color parts matched by colors with large differences in saturation and brightness make the overall contrast, so although the overall percentage of process-assisted colors and decorative colors is relatively low, it is still very important for studying the color composition of the horse spoon. Compared with GMM, the method used in this paper can extract the auxiliary and decorative colors other than the main color of the horse spoon more clearly, so it has certain advantages. As can be seen from Table 1, the IoU of GMM segmentation results is 0.8~0.85, which is lower than the IoU of K-means (0.92~0.98), indicating that the extraction effect of K-means is more stable, and the clustering effect of K-means is better, with a higher precision, which is able to be competent for the extraction of regional culture.

Table 1: Comparison of the extraction effects of five main colors

Algorithm	R	G	B	H	S	V	Proportion%	Io U/%
K-means	176	0	42	344	103	66	37.7	92.3
	24	76	69	169	34	67	28.4	95.2
	248	16	119	326	88	103	17.6	96.2
	36	24	14	18	36	16	7.9	96.9
	126	94	79	14	41	47	6.4	97.7
GMM	179	0	26	344	103	68	35.9	82.9
	0	88	86	179	103	27	24.7	82.8
	248	0	137	324	103	103	16.8	84.5
	10	12	11	12	36	16	13.4	81.2
	212	119	119	7	34	84	5.9	82.5

(3) Color network

After the color extraction needs to further analyze the relationship between colors and the color matching law, to have a rational understanding of the extracted colors. Especially for the color extraction of regional cultural characteristics, the extracted colors should not only reflect the main color characteristics of the regional culture, but also restore the original color imagery in the design scheme. Constructing color network model is an effective method to analyze the relationship between colors. Take the color card of the horse spoon as an example, build a color network as shown in Figure 5, the main and auxiliary color matching relationship as shown in Figure 6, the color in the figure in order to indicate the increasing/decreasing relationship of the color percentage, the size of the node indicates that the dosage of the color percentage of the size of the node between the thickness of the connecting line represents the frequency of such color matching, the thicker the line, the higher the frequency of the color matching between the two colors, and vice versa. Considering the horse spoon as a typical regional cultural element, the original color law contains specific cultural connotations and artistic charm, restoring its color imagery in the design is conducive to strengthening the connection between metro spatial design and the original cultural relics. Therefore, in the color network model, b1 color, which occupies the largest proportion and has the strongest correlation with the rest of the colors, is taken as the primary color, b4, b7, b8, b9, b11 are selected as the secondary primary colors according to the correlation between the “Five Colors” and the primary and secondary colors, and b2, b5 and b6 are used as the secondary colors to enrich the picture.

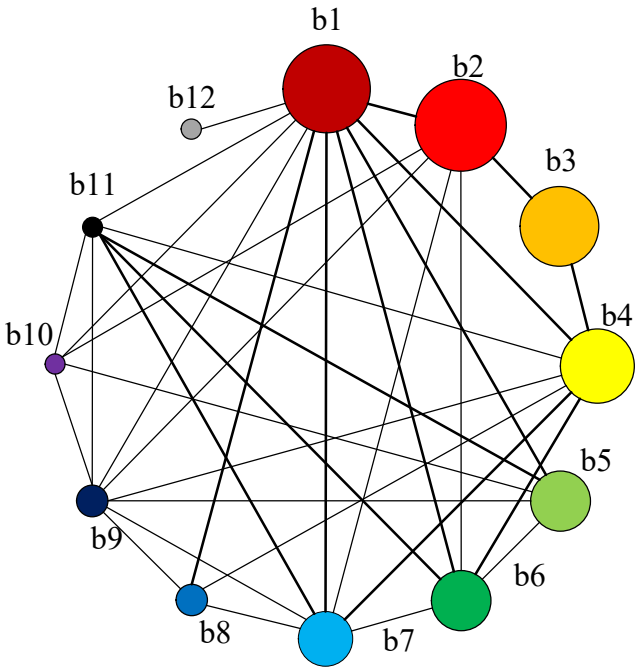


Figure 5: Color network model

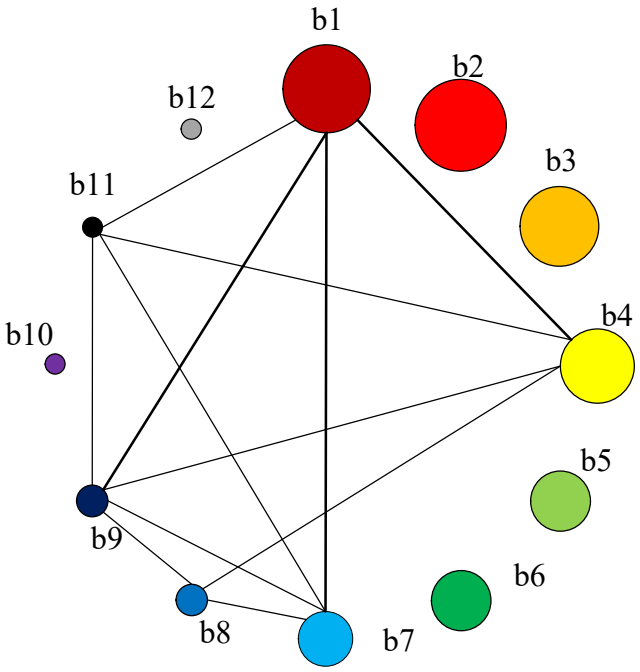


Figure 6: Matching relation between primary and secondary colors

IV. A. 2) Texture extraction analysis

(1) Experimental datasets

The experiments use four public texture datasets to evaluate the proposed LBP, the datasets include dataset C, dataset D, dataset E, and dataset F. Each dataset includes a variety of categories, and the images of each category of the dataset are divided into a training sample set and a test sample set according to 3:1, and each image category includes variations of rotation, distortion, and illumination.

(2) Comparison Algorithm

In the experiments, five commonly used different texture feature extraction algorithms are selected for accuracy and runtime comparison, including grayscale covariance matrix (GLCM), edge orientation histogram (EOG), simple gradient statistics (SGS), color histogram (CS), and statistics of original pixel values (SOP)

(3) Evaluation Metrics

In order to effectively evaluate the performance of each algorithm, this experiment uses the accuracy rate and the average running time of feature extraction to evaluate the metrics of the algorithms in the paper. The accuracy rate calculation formula is shown below:

$$acc = \frac{S_t}{S_n} \times 100 \tag{11}$$

where S_t represents the number of samples in which the predicted category of the test sample is the same as the true category of the test sample, and S_n represents the total number of test samples.

The average running time of feature extraction can measure the speed of the algorithm in extracting images under certain conditions, and the formula is shown below:

$$\bar{t} = \frac{t_n}{n} \times 100 \tag{12}$$

where t_n represents the total time for all image feature extraction and n represents the number of images.

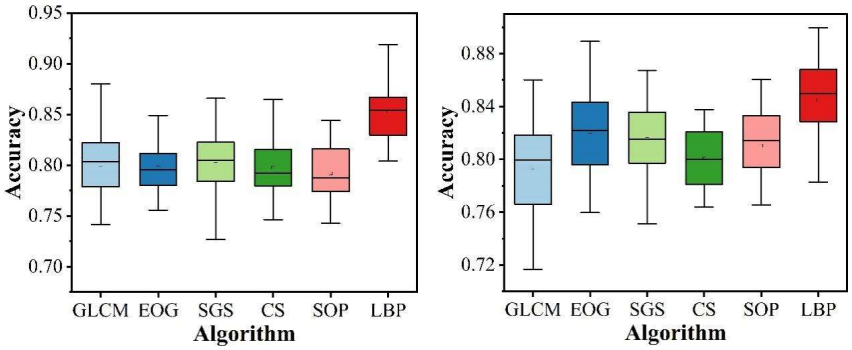
(4) Parameter Settings

In this paper, for the first neighborhood parameters are set as follows: the sampling radius is 2, the number of neighborhood points is 4, and for the second neighborhood parameters are set as follows: the sampling radius is 4, and the number of neighborhood points is 8. For the six feature extraction comparison algorithms, the linear kernel SVM classifier is used uniformly.

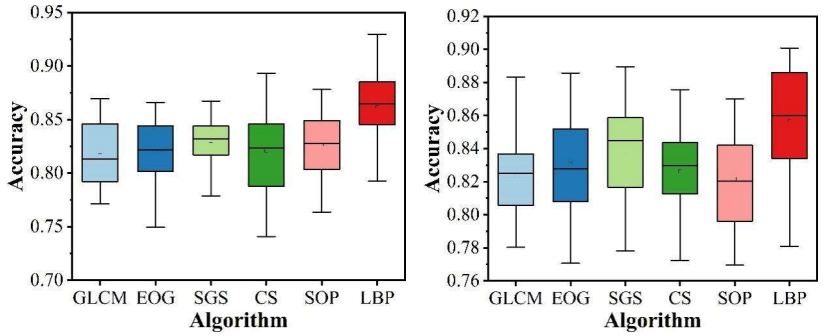
(5) Comparative analysis of accuracy rate

According to the above accuracy calculation formula, the accuracy of different algorithms for texture feature extraction of regional culture images is compared and analyzed, and the results of the accuracy comparison analysis are shown in Fig. 7, in which (a) ~ (d) are the datasets C ~ F. It can be seen through the data performance in the

figure that the LBP algorithm is better than the other five algorithms, which verifies the effectiveness of the LBP algorithm, which can extract more texture information about the horse spoon and thus improve the accuracy of classification.



(a)Dataset C (b)Dataset D

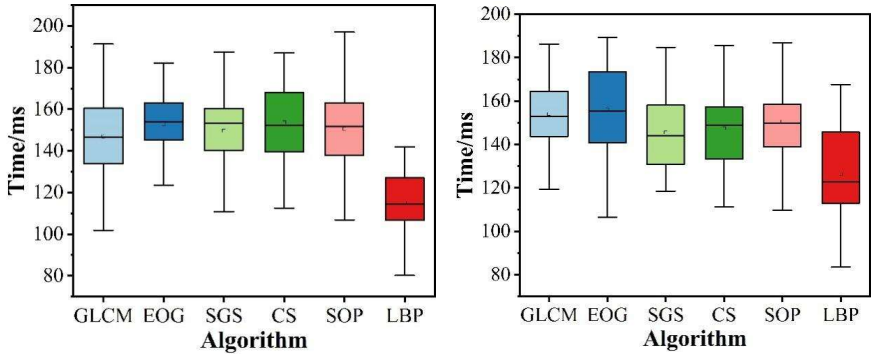


(c)Dataset E (d)Dataset F

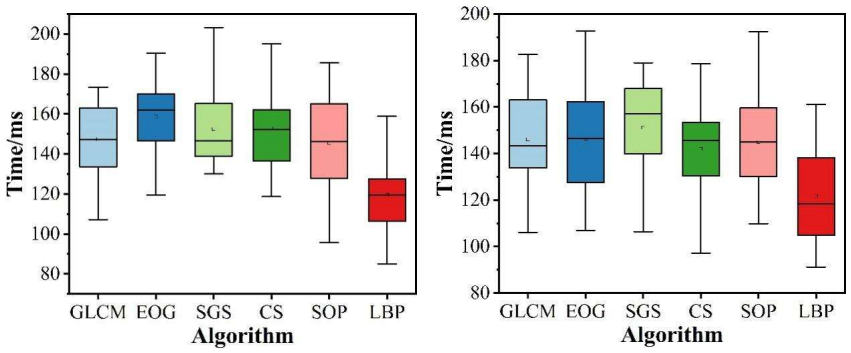
Figure 7: Accuracy rate comparison and analysis results

(6) Comparative analysis of extraction time

With the help of the above formula, the extraction time of the marsupial texture features of different algorithms is compared and analyzed, and the results of the extraction time comparison analysis are shown in Fig. 8. As can be seen from the figure, compared with the other five algorithms (GLCM, EOG, SGS, CS, SOP), this paper's algorithm minimizes the extraction time of the horse spoon texture features, which fully confirms the superiority of the LBP algorithm in the extraction of regional culture.



(a)Dataset C (b)Dataset D



(c)Dataset E (d)Dataset F

Figure 8: Comparative analysis of extraction time

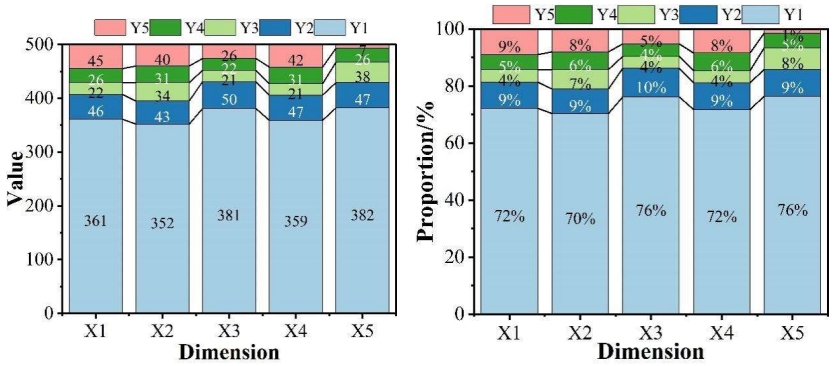
IV. B. Analysis of practice design effects

IV. B. 1) Questionnaires

Combined with the principle of feasibility of statistical analysis and existing References, satisfaction is taken as the evaluation index of the effect of practical design, in this regard, the satisfaction questionnaire of the practical design of regional culture transfer in the space of Xi'an Metro Line 4 is designed from the five dimensions of visual effect, cultural ambience, circulation of people, safety and accessibility, and the questionnaire has an excellent performance of reliability, which is a good guarantee of the results of the study. The questionnaire has excellent reliability and validity, which guarantees the validity of the research results.

IV. B. 2) Satisfaction analysis

500 riders were randomly selected as the sample of this study, and the research data were obtained by filling out the questionnaire, which will be statistically analyzed, and the results of the satisfaction analysis are shown in Fig. 9, in which (a) ~ (b) are the number of people and proportion, and X1 ~ X5 in the figure denote the visual effect, cultural atmosphere, personnel circulation, safety, and accessibility, respectively, and Y1 ~ Y5 denote the satisfaction, more satisfied, average, dissatisfied, and very dissatisfied. The results show that most of the samples are satisfied with the spatial design practice of Xi'an Metro Line 4 that incorporates regional culture, and their numbers are in the range of 360~390, corresponding to a percentage of 72%~76%, which proves the practical application value of this paper's research and provides guiding suggestions for the synergistic development of regional culture and metro spatial design.



(a)Number of people (b)Proportion

Figure 9: Satisfaction analysis results

V. Conclusion

The computer-aided regional culture translation injects new vitality into the spatial design of Xi'an Metro Line 4. The K-Means clustering algorithm performs well in the extraction of color features of the horse spoon, and its IoU value is as high as 0.92 to 0.98, which accurately identifies the auxiliary and decorative colors other than the main color and provides a scientific basis for the color scheme of the metro space. The color network model effectively analyzes

the relationship between colors and the color matching law, and determines the color matching scheme with b1 color as the main color, b4, b7, b8, b9, b11 as the secondary main colors, and b2, b5, b6 as the secondary colors, so that the design of the subway space not only retains the original color imagery of the Ma Spoon, but also meets the modern aesthetic needs.The LBP algorithm outperforms the five types of texture feature extraction, such as GLCM, EOG, SGS, CS, SOP and others, with its high IoU value of 92 to 98, and provides a scientific basis for the color matching scheme of the subway space, CS, SOP and other five commonly used algorithms, and it shows the highest accuracy and the shortest feature extraction time in all the four datasets (C, D, E, F) tests, providing an effective tool for the scientific extraction of texture elements. The practical effect survey shows that among 500 randomly selected passengers, 72% to 76% are satisfied with the spatial design of Xi'an Metro Line 4 that incorporates regional culture, which verifies the practical application value of this research method. The synergistic development of regional culture and metro space design has not only changed the status quo of “a thousand stations with one side”, but also realized the coordination and unity of functionality and decoration, injected the soul of regional culture into urban public space, and created a humanistic environment that integrates cultural heritage and modern design.

Funding

1. Project supported by the National Natural Science Foundation of China (No. 52078027).
2. Shaanxi Provincial Education Science Planning Project (No. SGH23Y2994).

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