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Research on Intelligent Translation of Regional Culture in the Design of Metro Public Space--Taking Xi'an Metro Line 4 as an Example

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ABSTRACT
Taking Xi'an metro station as an example, we analyze the artistic methods of metro public space to explain and spread the ancient rhyme culture, modern industrial civilization, modern revolutionary culture and other regional cultures, and put forward the concept of further innovative design in terms of increasing the occupancy, enlarging the pattern, highlighting the cultural characteristics of the ancient capital, and strengthening the comprehensive utilization of the metro public space in multi-level and multi-carrier. The study first establishes a multi-objective metro public space configuration model based on genetic algorithm to realize the reasonable layout of metro public space. Then it proposes a style migration method of regional cultural elements based on the improved circular consistency generating adversarial network, and realizes the color migration under multiple reference objects to realize the interface and color design of the entrances and exits of the metro public space, the station hall level and the platform level. The results of user experience show that the overall public space of Xi'an Metro Line 4 has an intermediate centrality of 8.8216 and an intermediate centrality potential of 0.5859, and its overall suitability is relatively balanced.

Keywords: metro public space design, Regional culture, genetic algorithm, style migration, improved cyclic consistency, generative adversarial network

1. Introduction

In recent years, China's economy has been developing rapidly, and there is a gradual variety of transportation modes around the country, and subway travel has become part of people's daily life[1]. As an important gas pedal of the current urban development, the subway not only continues to

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promote the optimization of the urban traffic pattern, but also an important place for the presentation of urban regional culture, always highlighting the cultural connotation of the city [2-4]. China is in the period of high-speed development of the subway, the strength of the engineering and construction is self-evident, but the construction of cultural space still needs to be improved [5-6]. At the beginning of the construction period, many large and medium-sized cities of the metro public space design is too modular, convergence of the design approach, resulting in the lack of regional and artistic metro public space, and even between the cities of the metro station style are more similar [7-10]. People gradually realize that the subway, as one of the most frequently used means of transportation for people's daily travel, is a very good carrier for the dissemination of regional culture [11-13]. Metro station public space as a carrier can lead the urban culture and art into the public's view, into all corners of the city, the formation of cultural and regional characteristics of the subway, the establishment of the city's image, the enhancement of urban competitiveness and economic growth play a good role [14-17]. The use of subway public space for intelligent translation of regional culture can make urban culture, national civilization and regional characteristics closely connected, and promote the subway public space to become a real national essence of the “booth” [18-20]. As a city with deep cultural heritage, Xi'an needs designers and artists to discover the profound meaning and creative value [21-22]. Therefore, exploring the intelligent translation design method of regional cultural elements in metro public space is of far-reaching significance to the cultural construction of metro public space.

A large number of scholars have carried out design practices for urban metro spaces, aiming to make metro stations into public spaces with cultural heritage, in order to highlight the cultural characteristics of the city. Literature [23] analyzed the direction of Xi'an metro public space construction by integrating regional visual elements, and actively guided the city's image to foreign propaganda by exploring regional cultural characteristics and developing related icons, walls and decorations in the metro space. Literature [24] shows that urban metro stations promote environmental design through the establishment of cultural landscapes, which positively affects users' perception of cultural image and place, and this effect is universal to different types of users, providing a theoretical basis for the design of cultural spaces in Chinese urban metro. Literature [25] shows that users need certain art propaganda to satisfy their pursuit of humanities and arts, which prompts the metro space to gradually change from a functional space to a humanities and arts space. Literature [26] from the space interface, public art, color three aspects of the subway art space design principles, for regional cultural elements into the subway station space design to provide a unified and effective design specifications.

With the development of new media and intelligent devices, it has become easy for human beings to acquire and output information. The public space of subway stations is not only a transportation space, but also a medium for information dissemination. Literature [27] investigated the cultural needs of users and the current situation of regional culture expression in metro public space, and proposed the use of new media interactive forms to innovate the design of regional culture expression in urban metro public space in response to the shortcomings of regional culture dissemination forms such as monotonous architectural space and less interactive design. Literature [28] describes the application of media convergence and new media industry in urban subway, and its innovative development provides a good platform for urban cultural propaganda, which is conducive to the realization of the double value of advertising culture and urban culture, and thus promotes the construction of urbanization. The use of new media art in the subway station space to intelligently translate regional cultural elements and information and interact with passengers accordingly is conducive to breaking the boundaries of visual appreciation and promoting the wide dissemination of regional culture.

The study takes the subway public space as a medium to realize the intelligent translation and dissemination of regional cultural elements in its interface, color and spatial form. Taking the subway unit center of mass as the demand point, a multi-objective spatial configuration model based on genetic algorithm is established, and a dynamic weighting method is adopted to obtain the optimal solution set for idealized subway public space siting. Meanwhile, a style migration method of regional cultural elements based on improved loop consistency generative adversarial network is proposed, which optimizes the structure of the generator network by adding Ghost convolution module and inverse residual improvement module, and improves the generative ability of the model by adding content style loss term, color reconstruction loss term and mapping consistency loss term in the loss function to enhance the generative interface and the quality of the color image generation. Finally, taking Xi'an Metro Line 4 as an example, after testing the effect of spatial layout, the design of its public space is completed by combining the model from the three aspects of entrances and exits, platforms and stations, and the feedback from users is discussed.

2. Intelligent translation of regional culture in the design of metro public space

2.1. Metro Public Space and Symbols of Regional Elements

2.1.1. Symbols of regional cultural elements. Regional culture refers to the cultural traditions of a specific region that have a long history and are unique and still functioning, and is a manifestation of the ecology, folklore, traditions, habits and other civilizations of a specific region. Within a certain geographical scope, the region is fused with the environment and has uniqueness. Regional culture mainly contains regional dialect culture, food culture, folk beliefs, folk architecture, natural environment, costumes and artifacts, etc., with a wide range. Regional culture element symbols refer to the explicit and implicit representations of various regional cultures extracted by the design field in the implementation of the design process, which can be a building with historical value, a historical story of the region, or a certain spirit left behind and passed down by the local people. Condensing Xi'an's history and culture, capturing its characteristics and skillfully applying them in the design is the cultural nature that the designer pursues, i.e. the application of regional cultural symbols.

2.1.2. Important media for the dissemination of regional cultures. Regional culture refers to the humanistic spirit that plays the role of cultivating and educating and value leading, which is condensed and precipitated in the process of social development of a certain region 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. Metro stations are densely populated with passengers, the space is relatively closed, the passing people are not easily 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 serving as a medium for spreading urban regional culture, mainly manifested in the transmission of history and culture, the demonstration 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.

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, abstract, translate and express landmark landscapes or tourist attractions through the innovative design of the internal and external landscapes of metro stations.

Xi'an metro line 4, for example, into the regional cultural characteristics, Regional cultural distribution is shown in Figure 1.in the design of the entire line, in different areas we should be into the different cultural characteristics, the focus of the station design should be combined with the local cultural characteristics, fast passengers in the underground space, but also can feel the cultural characteristics of the region, reducing the differences between the ground and the underground and enriched the entire metro line of cultural characteristics.

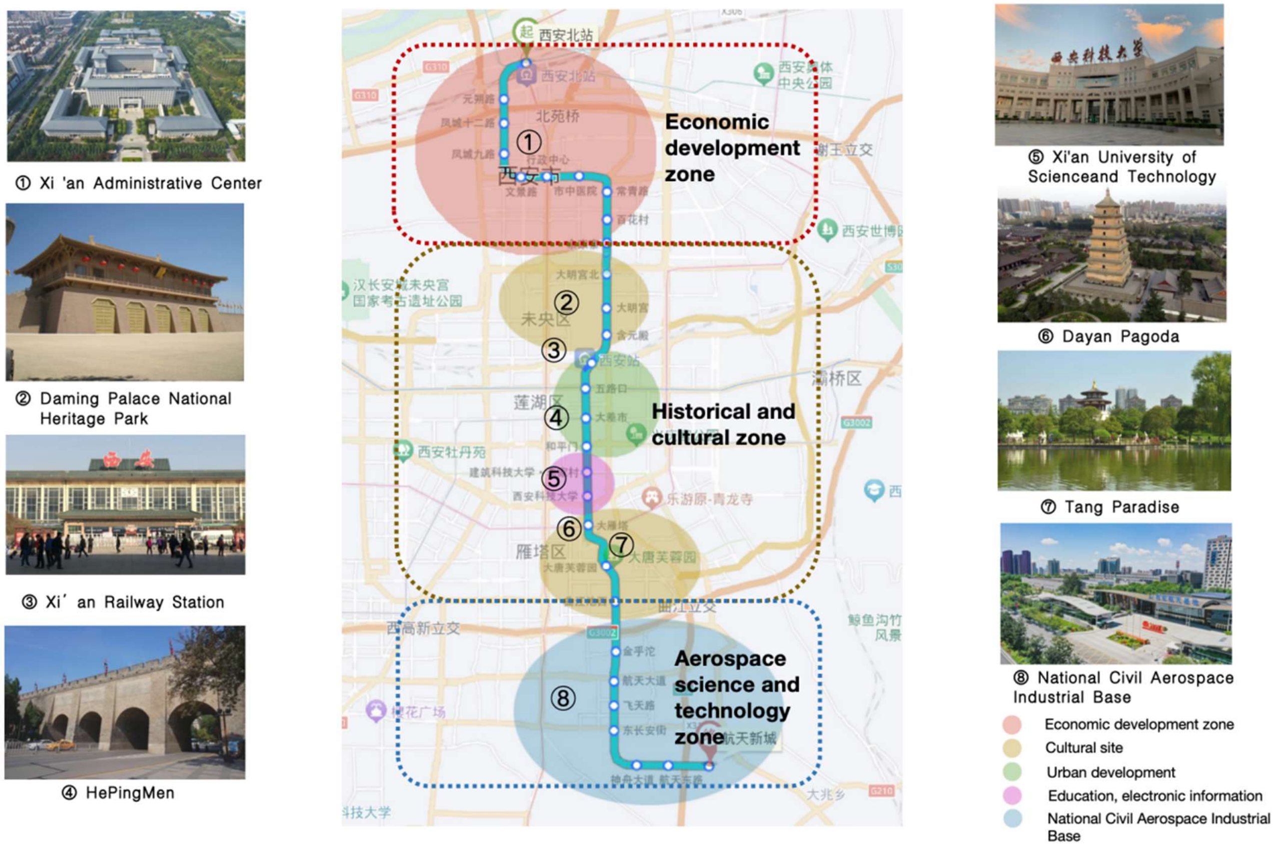


Fig. 1. Environmental Overview of Xi'an Metro Line 4

3. Improving the stylistic migration of CycleGAN geo-cultural elements

3.1. Intelligent Translation of Regional Symbols in the Design of Subway Public Space

2.2.1. Interface design. The interface includes all the "surfaces" inside the building, which are roof, floor, wall (each facade) and column. The division and design of interface is the main part of the design of architectural decoration, and its main content includes "surface" modeling, material and color design, which is an important factor reflecting the overall effect of space.

First, the figurative modeling design. Through the extraction of local characteristics of the historical lineage of entities or the shape of the outline of natural objects, reorganization, simplification, so as to form a different modeling, and then applied to the modeling design, reflecting the regional characteristics.

Secondly, bionic form design. Bionic design is to extract the structure, shape and function of things existing in nature, imitate the form and principles of living creatures, and then through innovative means of design methods. Among them, biomimicry is the most common design technique in subway stations.

2.2.2. Color design. The use of color is an important factor in spatial expression, which can serve as a reminder of attention, directional guidance, display publicity and show the characteristics of the city, but also an important way to show and express the emotions of the city, and the color differences between different cities are also very obvious. Through the first color stimulation, the brain processes the visual stimulus, and when seeing the color again, it will filter out the relevant color information, produce associations and imagination, so that the viewer will resonate with the city and regional culture. According to the regional culture color library, analysis for different subway lines, so that the design and culture echo each other.

The color design of the metro public space area has three main aspects: the main (large interface) color, functional color, and auxiliary (small area) color. Analyze and design for different subway lines.

2.2.3. Space design. In the subway space, facilities and vignettes reflect the temperature of the design, through the local integration of regional characteristics, can better promote regional culture, to achieve the effect of "small see big". Facilities and vignettes mainly include the design of infrastructure in the public space of the subway, such as the internal seat modeling of the train, the rest seats in the public area, the internal handrails and pull rings of the subway, the garbage cans, and the design of the screen door [29]. These facilities and vignettes are small in size compared to the whole space, but they are all present in the public space of the whole subway. Regional characteristics, historical elements, folk customs and other cultural abstraction extracted to these small facilities, can be well echoed with the space, so that cultural penetration in all aspects of the space.

1) Metro spatial information mapping. Population distribution includes two sub-indicators of population aggregation and transportation accessibility. The agglomeration indicator is calculated by capturing the number of residential households and corrected by Baidu Heat Crowd Distribution; the accessibility indicator is weighted by walking accessibility and walking suitability, of which the accessibility is analyzed by sDNA and the suitability is evaluated by semantic segmentation of the street view map.

Land efficiency includes two sub-indicators, namely, commercial vitality indicator and land price. The quantification is done by capturing big data such as house price, distribution of commercial facilities, types, and utilization price.

The cultural potential aspect includes two sub-indicators of locality and heritage. The geographical characteristics are weighted by the scale and number of cultural heritage elements, and the degree of inheritance is obtained by the degree of importance of cultural heritage and the heat map of the distribution of cultural facilities.

2) Multi-objective optimization algorithm. The location allocation model (LA) is mainly used to optimize the spatial configuration of a certain service facility [30]. The optimal allocation problem not only needs to satisfy the optimal number of service facilities needed within a certain range, but also needs to determine the optimal location or location of these service facilities.

In this paper, a continuous median block configuration model is chosen, which is usually computed using the interactive exploratory algorithm proposed by Lahington. The study area is assumed to be a two-dimensional continuous plane with n demand point U_j (neighborhood center point) randomly distributed. m services U_i (public space points) are established to serve the demand points. The computational process consists of the following parts:

Step one. A number of demand points are randomly generated as initial locations of service facilities.

In the second step, the demand points are grouped so that each demand point U_j is assigned to the nearest facility point U_i, U_i is the location of the service facility (i is $1 \sim m$): U is the location of the demand point (j is the midpoint of the neighborhood divided by $1 \sim n$). Find the minimum value of the objective function.

$$f = \sum_{i=1}^{m} \sum_{j=1}^{n} a_{ij} \times d_{ij} \times w_j \tag{1}$$

where: a_{ij} is the allocation decision variable for service facility U_i and demand point U when the demand point is allocated to the service facility, $a_{ij} = 1$, otherwise $a_{ij} = 0$, W_j are the weights of each demand point: d_{ij} is the Euclidean distance between demand point U_j and service facility U_i.

$$d_{ij} = \sqrt{\left(x_i - x_j\right)^2 + \left(y_i - y_j\right)^2} \tag{2}$$

where: x_i is the x-axis coordinate value of service facility U_i; y_i is the y-axis coordinate value of service facility U_i; x_j is the x-axis coordinate value of demand point U; y_i is the y-axis coordinate value of demand point U_j.

From the four directions summarized in the previous section that affect the pattern of public space to establish four target factors, each target factor function expression is as follows:

(1) The shortest weighted distance under the fairness vector:

$$f_1 = \sum_{i=1}^{m} \sum_{j=1}^{n} a_{ij} \times d_{ij} J_j \tag{3}$$

where, J_j is the spatial information quantitative scoring result class weight under the demand point equity vector.

(2) The shortest weighted distance under the efficiency vector:

$$f_2 = \sum_{i=1}^{m} \sum_{j=1}^{n} a_{ij} \times d_{ij} EF_j \tag{4}$$

where, EF_j is the weight of the spatial information quantitative scoring result class under the demand point efficiency vector.

(3) The shortest weighted distance under the ecological vector:

$$f_3 = \sum_{i=1}^{m} \sum_{j=1}^{n} a_{ij} \times d_{ij} EC_j \tag{5}$$

where, EC_j is the weight of the spatial information quantitative scoring result class under the ecological orientation of the demand point.

(4) The shortest weighted distance under cultural orientation:

$$f_4 = \sum_{i=1}^{m} \sum_{j=1}^{n} a_{ij} \times d_{ij} C_j \tag{6}$$

where C_j is the hierarchical weight of the quantitative spatial information scoring results under the cultural orientation of the demand point.

Dynamic weighting is applied to each single-objective function function. The composite shortest weighted distance function (FW) is obtained:

$$FW = \sum_{h=1}^{k} f_h w_h \tag{7}$$

where: W_h is the single-objective function function weights; h represents the individual objective factors.

a_{ij} is the allocation decision variable for service facility U_i, and demand point U_j, $a_{ij} = 1$ when facility U is allocated to demand point U; and $a_{ij} = 0$ otherwise.

$$W_1 + W_2 + W_3 + W_4 = 1 \tag{8}$$

In the runtime setting, non-negative values W_1, W_2, W_3, W_4 are randomly generated to ensure that their sum is 1, but there is no restriction on the exact values to achieve dynamic weighting. Multi-objective optimization is not limited to finding a unique solution, but rather generates a solution set consisting of the optimal solutions obtained from all iterations, including the weighted values of the functions of the four objective factors, the associated weight vectors, and the mean of the corresponding weighted shortest distances. Thus, a library of alternative solutions is established, and the decision maker can select the optimal solution based on the established main criteria.

3) Optimal solution set identification process:

(1) Model implementation and validation:

For the purpose of modeling, the center of mass of the neighborhood in the study area is taken as the demand point, and the specific rules are as follows:

a) Drawing on relevant research results. The research object is defined as the smallest two-dimensional rectangular area containing the actual spatial boundary. Considering that for the whole geographic space, the difference between the coordinates of the points in the study area is very small after spatial projection, the projected horizontal and vertical coordinates of the points are directly used as the coordinates of the points in the construction of the model. The latitude and longitude coordinates of the extreme points of the boundary of the study space are obtained in GIS, and the maximum values of Δx_{max} and Δy_{max} of the difference between the horizontal and vertical coordinates are calculated respectively, and the minimum horizontal and vertical coordinates in the space are recorded as (x_{min}, y_{min}), and the maximum values of the horizontal and vertical coordinates in the space are restricted to be $x_{min} + \Delta x_{max}$ and $y_{min} + \Delta y_{max}$, respectively, and the points in the initial population are screened with the help of the hpolygon function in MATLAB.

b) The center point of the neighborhood is the demand point, and the evaluation result of spatial information level of each neighborhood corresponds to a weight, which is the size of the possibility that the facility point is assigned to each demand point.

c) Through dynamic weighting, 30 simulations were conducted to obtain the solution set of the non-dominated Pareto optimal solution.

(2) Optimal solution set parameter setting and solving:

Among them, the population size is set to 100, the crossover probability is set to 0.25, and the mutation rate is set to 0.009. It has been proved in the related spatial siting study that the model parameters have better effect, and the basis of weight selection includes two aspects:

a) Based on the status quo grade evaluation to comprehensively judge the reasonable distribution of the weights occupied by each target.

b) Prioritizing one target over the others. Finally, four weight vectors are filtered from the obtained data, and the selected four weight vectors are brought into the model to find the minimum solution. The relevant genetic operations are continuously performed, and when it is found that the value of the given objective function no longer changes, the iterative process of the algorithm converges and the algorithm ends.

3.2. Model structure

As a derivative network of GAN, CycleGAN has good generative ability.The learning training of CycleGAN does not depend on the similarity relationship between inputs and outputs, and this feature makes it practical to train on unpaired datasets. Therefore, CycleGAN is chosen as the basic structure in this paper, and its structure is shown in Fig. 2.

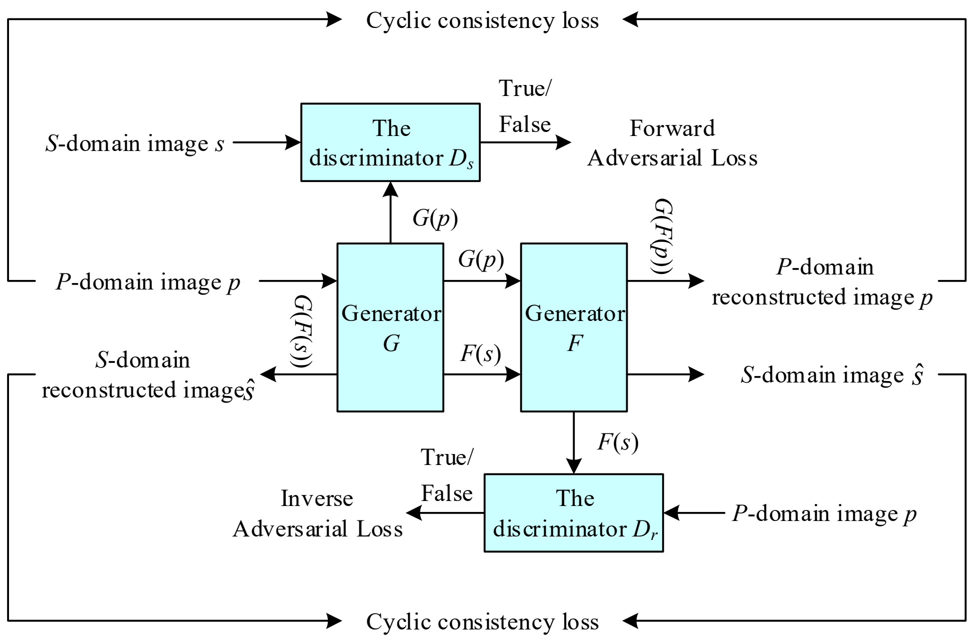


Fig. 2. Structure of Cycle GAN

CycleGAN consists of two generator networks and two discriminator networks and divides the overall network into two GAN network systems by cyclic consistency loss, i.e., GAN network system from source domain (P domain) to target domain (S domain) and GAN network system from target domain to source domain [31]. Generator G converts P-domain image p into S-domain image $G(p)$, discriminator D_S determines the generated image $G(p)$ true or false based on S-domain image while generator F converts $G(p)$ again into P-domain reconstructed image $F(G(p))$ i.e., $\hat{p}$ and this process is called forward process. On the contrary, the conversion process of S-domain image to P-domain image is the same and is called the reverse process.

Both of the above processes have independent adversarial loss and cyclic consistency loss. The adversarial loss optimizes the learning ability of the generator and the discriminator so that the data distribution of the generated image correctly matches the data distribution of the target domain image. The cyclic consistency loss can optimize the generator's generating ability, so that the data distribution of the reconstructed image is as close as possible to the original image data distribution. The cyclic consistency loss function is:

$$\begin{aligned} L_{cyc}(G,F) = {} & E_{p-D_{data}(p)}\left[\left\|\hat{p}-p\right\|_1\right] \\ & + E_{s-D_{data}(s)}\left[\left\|\hat{s}-s\right\|_1\right] \end{aligned} \tag{9}$$

where $D_{data}(p)$ and $D_{data}(s)$ are the dataset distributions of the P-domain image and the S-domain image, respectively; $\hat{p}$ and $\hat{s}$ are the P-domain reconstructed image and the S-domain reconstructed image, respectively. The forward adversarial loss function and the inverse adversarial loss function are represented as Eq. (10) and Eq. (11), respectively.

$$\begin{aligned} L_{f-adv}\left(G,D_S\right) = {} & E_{s-D_{data}(s)}\left[\log D_S(s)\right] \\ & + E_{p-D_{data}(p)}\left[\log\left(1-D_S(G(p))\right)\right] \end{aligned} \tag{10}$$

$$\begin{aligned} L_{b-adv}\left(F,D_P\right) = {} & E_{p-D_{data}(p)}\left[\log D_p(p)\right] \\ & + E_{s-D_{data}(s)}\left[\log\left(1-D_P(F(s))\right)\right] \end{aligned} \tag{11}$$

3.3. Generator Networks

3.2.1. Ghost Convolution Module. In order to reduce the learning cost of the generator network in the process of image style migration, reduce the amount of computation required by the model to process non-critical feature information, and improve the performance of the generator network, this paper introduces the Ghost convolution, which is combined with the instance normalization layer and the Leaky ReLU nonlinear activation layer to form the Ghost convolution module, and then it is added into the generator network.

The Ghost convolution module first uses ordinary convolution to obtain part of the effective output features, i.e., the eigenfeature map, from the input features, which is computed as follows:

$$Y = f^{k\times k}(X) + b \tag{12}$$

where $X \in \mathbb{R}^{H\times W\times C}$ is the input feature; $Y \in \mathbb{R}^{H'\times W'\times m}$ is the eigenfeature map; $f^{k\times k}(\cdot)$ denotes $k\times k$ the ordinary convolutional layer; and b is the bias matrix. Then, the intrinsic feature map is processed by cheap linear operations, in order to obtain the output feature map similar to the intrinsic feature map, which is calculated as follows:

$$Y_{ij} = \Phi(Y_i), i \in [1, m], j \in [1, s] \tag{13}$$

where $Y_{ij} \in \mathbb{R}^{H\times W'\times s}$ is the output feature map obtained from the i nd eigenfeature map by the j rd linear operation; Y_i is the i th eigenfeature map; $\Phi(\cdot)$ represents the linear operation, and group convolution is chosen to realize the linear operation in this paper.

3.2.2. Inverse residual improvement module. In the generator network, this paper adds the inverse residual module to further reduce the number of model parameters and improve the network performance. Meanwhile, in order to prevent the loss of spatially localized feature information and enhance the detailed feature representation of the image, this paper improves the inverse residual module and proposes the inverse residual improvement module.

The input feature map is first expanded into a high-dimensional feature map by 1×1 convolution, and features are extracted in the high-dimensional space using deep convolution, and then the extracted features are compressed into a low-dimensional feature map using 1×1 convolution. In order to ensure that the generator can obtain richer feature information, this paper adds depth convolution after 1×1 convolution to secondary process the low-dimensional feature maps, so as to further improve the feature extraction ability of the model, enhance the expression of image features, and also prevent the loss of some spatial feature information.

3.4. Discriminator Networks

In this paper, the Patch GAN discriminant model with fewer parameters is chosen as the discriminator network. The discriminator network is mainly composed of three network layer components: ordinary convolutional layer, instantiated normalization layer and Leaky ReLU nonlinear activation layer.

The discriminator network first slices the input image into a number of image blocks of size 70×70, and the network determines the truth or falsity of each image block according to its features, and finally averages the results of all the image blocks and takes their truth or falsity as the final output of the discriminator network.

3.5. Loss function

In order to improve the quality of the generated images and enhance the texture details of the content features and style features, this paper incorporates a content style loss term and constructs this loss in conjunction with a pre-trained VGG-19 network. This loss function is defined as

$$L_{cennent-style}(G) = \omega_c L_{conntent}(G) + \omega_s L_{style}(G) \tag{14}$$

where, ω_c is the content loss weight, ω_s is the style loss weight, in this paper ω_c is taken as 1.5, ω_s is taken as 3.5, L_{coment} is the content loss function; L_{style} is the style loss function, and their functional expressions are defined respectively as

$$L_{content}(G) = E_{p-D_{data}(s)}\left[\left\|VGG_l(G(p)) - VGG_l(p)\right\|_1\right] \tag{15}$$

$$L_{style}(G) = E_{p\to -D_{data}(p),s-D_{data}(s)}\left[\left\|\begin{matrix} Gram\left(VGG_l(G(p))\right) \\ -Gram\left(VGG_l(s)\right)\end{matrix}\right\|\right] \tag{16}$$

where $VGG_l(\cdot)$ denotes the image features output by the l nd network layer of the VGG-19 network and $Gram(\cdot)$ is the Gram matrix.

In order to enhance the texture color effect of the generated image, the color reconstruction loss term is added in this paper. Firstly, the coding mode of RGB (Red, Green, Blue) color image is converted into luminance and chromatic aberration signal coding mode, i.e., YUV mode. Where, Y denotes the luminance component, U denotes the color component, and V denotes the saturation component. Then, the corresponding losses are constructed for the image features under the 3 different components in the YUV mode respectively, and the loss function is defined as:

$$L_{color}(G) = E_{p-D_{data}(p),s-D_{data}(s)}\left[\begin{matrix} \left\|Y(G(p)) - Y(s)\right\|_1 + \left\|U(G(p)) - U(s)\right\|_H \\ +\left\|V(G(p)) - V(s)\right\|_H \end{matrix}\right] \tag{17}$$

In order to improve the style migration ability of the model and make the generated image closer to the art style image, this paper adds a mapping consistency loss term to optimize the generative ability of the generator network by constructing a mapping consistency loss between the generated image and the style image, and then reduce the texture feature differences between the generated image and the style image, and its loss function is defined as

$$\begin{aligned} L_{mapp-identity}(G,F) = {} & E_{p-D_{data}(p),s-D_{data}(s)}\left[\left\|G(p) - s\right\|_1\right] \\ & + E_{p-D_{data}(p),s-D_{data}(s)}\left[\left\|F(s) - p\right\|_1\right] \end{aligned} \tag{18}$$

The loss function of this paper can be derived from the above equation as:

$$\begin{aligned} L(G,F,D_S,D_P) = {} & L_{cycleGAN}(G,F,D_S,D_P) + L_{content-style}(G) \\ & + \omega_{celor} L_{celor}(G) + L_{map-identity}(G,F) \end{aligned} \tag{19}$$

where ω_{coler} is the color reconstruction loss weight, in this paper ω_{color} is taken as 10.0, and $L_{cycleGAN}$ is the CycleGAN loss function defined as

$$\begin{aligned} L_{cyclegAN}(G,F,D_S,D_P) = {} & L_{f-adv}(G,D_S) \\ & + L_{b-adv}(F,D_P) + \lambda L_{cyc}(G,F) \end{aligned} \tag{20}$$

where, L_{f-adv} is the forward adversarial loss function, which is defined as shown in equation (10), L_{b-adv} is the reverse adversarial loss function, which is defined as shown in equation (11), and λ is the weight of the circular consistency loss function.

3.6. Multi-Reference Element Color Migration

In order to perform color migration through multiple reference locale cultural elements. This avoids the difficulty of having to select an appropriate reference locale to match the input locale, so the algorithm extends the "one-to-one" color migration matching to "one-to-many", as shown below.

For a given plurality of reference domain element $R_i(i=1,\ldots n)$, this paper calculates bidirectional NNFs between each reference domain element R_i on level $\tilde{S}^{L+1}$ and L level $(L=5,\ldots,1)$, and then reconstructs each pilot domain element G_i^L using the obtained NNFs. Next, in this paper, these bootstrap geographic elements are combined into a single G^L at each pixel p which needs to be selected as the best one out of the n candidate $G_i^L(i=1,\ldots,n)$ ones. The selection criteria include (1) how well the reference locale element matches the input locale element. (2) The degree of similarity between the obtained pixel colors and most of the bootstrap colors. (3) The degree of similarity between the pixels indexed by NNF. Based on these criteria, this paper computes the feature locality element by minimizing the following objective function I^L:

$$\varepsilon\left(I^L\right)=\sum_p \varepsilon_e(p)+\beta_m \sum_p \varepsilon_m(p)+\beta_s^L \sum_{p,q\in N_4(p)} \varepsilon_c(p,q) \tag{21}$$

In the case of multiple reference geographic elements, the bootstrap geographic element G^L during the color migration process is combined by the bidirectional NNFs after reconfiguring multiple $G_i^L(i=1,\ldots,n)$

where $N_4(p)$ is the 4-connected neighborhood of p, $\beta_s^L=0.04\times 2^{5-L}$, $\beta_m=0.2$.

Let E_i^L be the retrieval of the error of the i th NNFs, and the first term equation is the measurement of the matching error of each pixel point of R_i with the input image:

$$\varepsilon_e(p)=E_i^L(p) \tag{22}$$

The second term equation measures the difference between the color of each pixel of the bootstrap locale element and its own median color:

$$\varepsilon_m(p)=\left\|G_i^L(p)-median\left(G_i^L(p)\right)\right\|^2 \tag{23}$$

The third metric measures the slipperiness of localized regions of territory elements, which drives consistency of territory element characteristics between neighboring domains in the combined bootstrap territory elements:

$$\varepsilon_c(p,q)=\left\|F_{G_j}^L(p)-F_{G_j}^L(p)\right\|^2+\left\|F_{G_i}^L(q)-F_{G_j}^L(q)\right\|^2 \tag{24}$$

Here $i=I^L(p)$, $j=I^L(q)$.

Eq. (21) can be used as a Markov Random Field (MRF) problem on a two-dimensional spatial domain, which can be solved efficiently by using the multi-labeled graph cut technique. For further optimization to obtain good results, this paper initializes $I^L(p)$ by minimizing data terms $(\varepsilon_e(p)$ and $\mathrm{E}_m(p)$. After solving I^L, this paper obtains the final single bootstrap geographic element G^L, i.e., $G^L(p)=G^L_{IL P)}(p)$, by simply merging all bootstrap geographic elements from multiple reference geographic elements.Subsequently, G^L is used for the subsequent steps of local color migration described in the previous section.

3.7. *Style Migration Experiment and Analysis*

This section compares the designed approach with ten commonly used migration modeling methods, including five global statistics-based methods (AdaIN, WCT, LST, AAST, and Artflow) and five local patch-based methods (SANet, MAST, TPFR, AdaAttN, and IECAST).

3.6.1. Comparative analysis of experimental results. In this experiment, Adam is chosen as the optimizer in this experiment to optimize the network training process. Compared with other optimizers, the Adam optimizer performs better in terms of operation, computation, and memory requirements, which is conducive to adjusting better parameters during the experiment.

The Adam optimizer is defined in the model training, the initial learning rate is set to 0.0002, the batch size is set to 1, 300 rounds of training are performed (Epoch), and λ=10 is set in the calculation formula.Figure 3 shows all the loss values of the training set of the CycleGAN model during the training process, and it can be seen that the process is a convergence process, the loss value gradually decreases from 2.11 to 0.15, which tends to be stable, and the convergence of the parameters allows the model to achieve a better optimization as well as generalization ability.

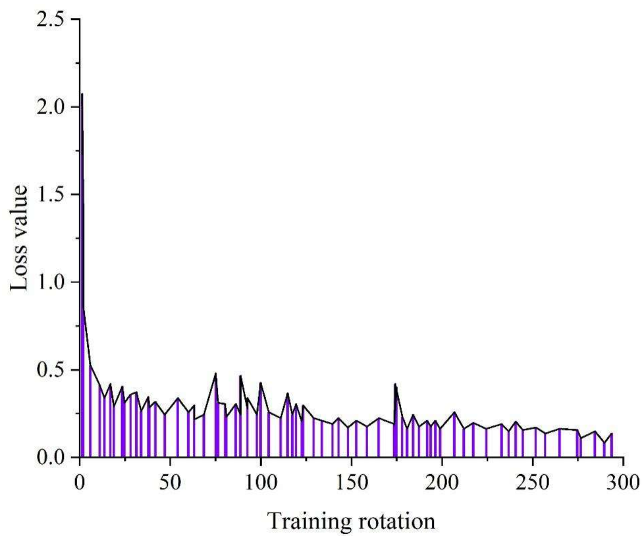


Fig. 3. The loss value of the model during training Source: Drawn by the author

To know the generation effect of generative adversarial network model, SSIM structural similarity and PSNR peak signal-to-noise ratio, as evaluation metrics, can be used to calculate the similarity of images. When two images are exactly the same, the value of SSIM is equal to 1, so the closer the value of SSIM is to 1, the better the generative effect is.The value of PSNR is in the range of (0,+∞), and the larger the value of PSN is, the more similar the images are.

Subsequently, after the same set of datasets, training rounds and learning rate and other identical parameter settings, the models are respectively compared for generative effect, and the results of the evaluation indexes are shown in Table 1. Among the style migration models after the same training, the CycleGAN network model used in this paper has the best evaluation index value, which is higher than the TECAST model, with values of 0.75 and 29.59, respectively. And it does not need pairs of style images for training, which is more suitable as a model for the generation of cultural and artistic style images for public space design.

Table 1. Comparison of evaluation indexes of different network models

Model	SSIM structure similarity	PSNR peak signal-to-noise ratio
WCT	0.31	18.33

AdaIN	0.39	21.48
LST	0.41	21.11
AAST	0.45	22.37
Artflow	0.25	25.19
SANet	0.34	24.95
MAST	0.43	26.73
TPFR	0.54	26.49
AdaAttN	0.58	27.28
TECAST	0.67	29.17
This method	0.75	29.59

3.6.2. Evaluation of numerical analysis. This section uses two objective metrics, structural similarity (SSIM) and learnable perceptual image block similarity (LPIPS), to more comprehensively and objectively assess the quality of Xi'an's regional cultural stylized images generated by this paper's stylistic migration model. Each model experiment used 2 content images and 10 style images, and a total of 20 stylized images were synthesized, and the SSIM and LPIPS scores of all the images were statistically computed as averages and displayed in the table, as shown in Table 2. As can be seen from the table, the image stylization method proposed in this paper outperforms other model values in terms of structural similarity and learnable perceptual image block similarity, and achieves an optimal balance between the quality of the style transformation and the retention of content information.

Table 2. Statistical results of numerical analysis of stylised test evaluations

Model	Pic1		Pic1	
	LPIPS ↓	SSIM ↑	LPIPS ↓	SSIM ↑
WCT	0.659	0.91	0.744	0.94
AdaIN	0.746	0.85	0.648	0.91
LST	0.85	0.82	0.692	0.87
AAST	0.792	0.84	0.721	0.84
Artflow	0.723	0.87	0.575	0.96
SANet	0.952	0.82	0.504	0.89
MAST	0.573	0.88	0.524	0.96
TPFR	0.509	0.85	0.483	0.95
AdaAttN	0.668	0.97	0.587	0.95
TECAST	0.854	0.87	0.421	0.96
This method	0.454	0.95	0.822	0.97

4. Xi'an Metro Line 4 Public Space Design Feedback

4.1. Testing and analysis of the effectiveness of the spatial layout

4.1.1. Spatial distribution separation test. The best way to test the effectiveness of the spatial layout design method is to test the separation of spatial distribution. Changes in the distance between functional areas have a more obvious effect on the degree of separation, so the separation of public space distribution before and after the optimization design is tested under the condition of increasing the distance between the functional areas. According to the requirements of public space design, the range of allowable fluctuation of the separation degree is 0.571~0.591, and the comparison results of the separation degree before and after the optimization design are shown in Fig. 4.

As can be seen from the figure, the separation distance is proportional to the separation degree of spatial distribution. Before applying the method proposed in this paper, the separation degree of each functional area is low, and there is an area that is not effectively utilized. After applying the design method proposed in this paper, the separation degree of spatial distribution of functional areas is always within the permissible fluctuation range, indicating that the application of the method proposed in this paper can carry out a reasonable optimization design for the layout of the main functional areas of the public space, and the design effect is better.

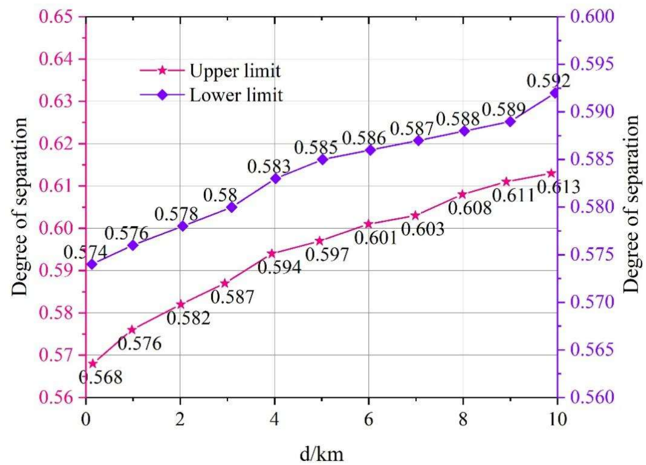


Fig. 4. The comparison results of the optimal design before and after design

4.1.2. Objective function testing. In the optimization design of the layout of the main functional area of public space, the objective function mainly selects the two factors of coordination and design cost related to the indicators of the number of buildings, green space area, traffic flow and other aspects. The size of the objective function affects the convergence speed and optimization effect of the algorithm, so the objective function is chosen as the test object, and the smaller the objective function is, the better the layout of the main functional area of public space is. Setting the inertia weight ω as 0.3, the learning factor are 0.6, coordination and design cost objective function results are shown in Figure 5.

As can be seen from the figure, when using the optimization algorithm to solve the objective function, with the increase in the number of iterations, the objective function results show a decreasing trend, and the minimum function value can be reached through continuous optimization. This is because in the quantum particle swarm algorithm, each particle maintains the original position and velocity on the basis of quantum mechanics to adjust and update all the particle information. As the number of iterations increases, the particles optimize the layout of the main functional area of the public space by constantly searching and updating the position information and selecting the appropriate speed direction based on the empirical and historical information, thus gradually approaching the optimal solution.

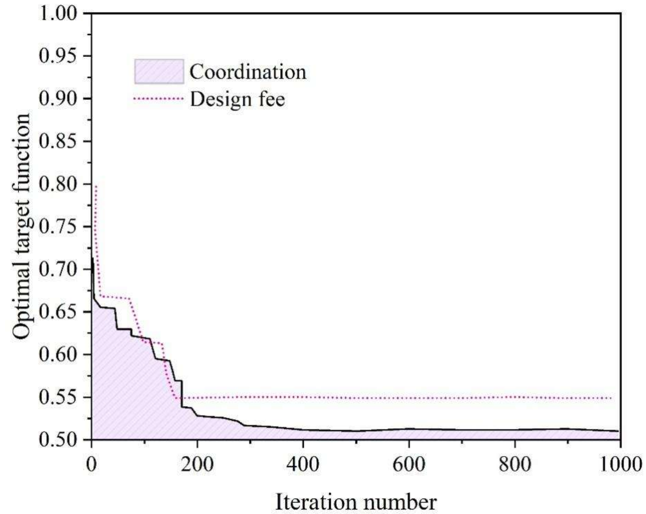
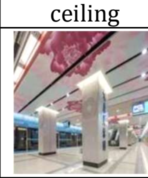
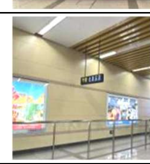
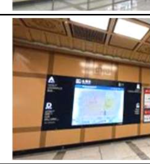
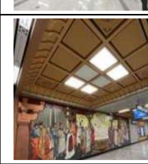
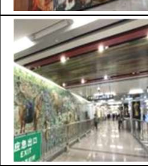
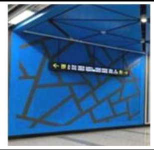
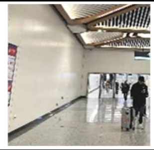


Fig. 5. Target function results

4.1.3. Station level design.The wide view space of the station hall level is the key to the design of public space inside the subway. The design area in the public space of the subway mainly includes: mural, wall, ceiling, column and floor. Through the use of new materials, new technologies; lighting and color design; guided design and other design techniques for space design, clever integration of Xi'an cultural symbols, to create a regional culture atmosphere of public space. as shown in Table 3. Customer service center is a window for passengers to handle ticket card service, and the customer service center planning position is fixed, as a humanized window connecting with passengers, high-quality customer service center design can reduce anxiety for passengers and provide passengers with a moment of service, Xi'an cultural symbols into the design of the subway customer service center, through the design of its countertops and tops, so that the combination of colors and the overall style of the public space of the subway echoes.

Table 3. Xi 'an Metro Line 4 station hall public space cultural expression

regional culture	subway station	mural	wall	ceiling	column
historical narratives	DATANGFURONGYUAN				
	DAYANTA				
	DAMINGGONG				
	DACHAISHI				

	DONGCHANG'ANJIE				
folk traditions	XI'AN BEIZHAN				
aerospace innovations	HANGTIANDADAO				
urban culture	HEPINGMEN				

4.1.4. Time test for adjustment of space layout parameters. After verifying that the proposed method can obtain the optimal objective function, the proposed method is further tested to accomplish the spatial layout parameter adjustment time. The collected data information on the characteristics of commercial area, modern residential area, old residential area, and traffic area are organized and analyzed to calculate the algorithm spatial layout parameter adjustment execution time. The results of the spatial layout parameter adjustment time are shown in Figure 6. From the figure, it can be seen that the proposed method can complete the spatial layout parameter adjustment of the main functional area of public space in 21.62ms, thus verifying that the proposed method has a high layout efficiency.

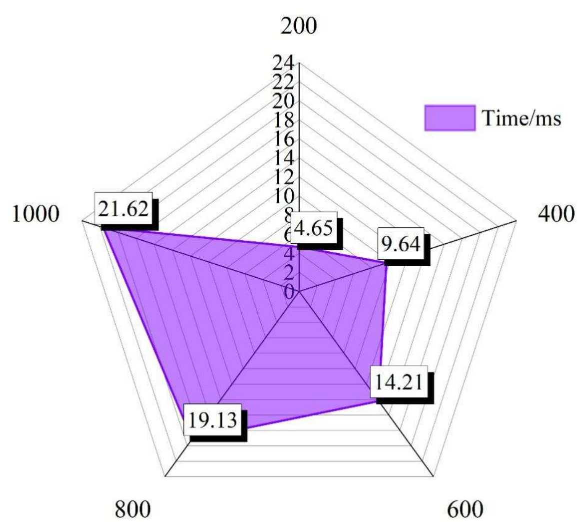


Fig. 6. The spatial layout parameters adjust the time result

4.1.5. Layout testing of the main functional areas of urban public space. The city is briefly divided into four areas, setting the commercial area area numbered 1, the modern area area numbered 2, the old area area numbered 3, and the transportation area area numbered 4. The initial layout of the main functional area of urban public space is shown in Figure 7.

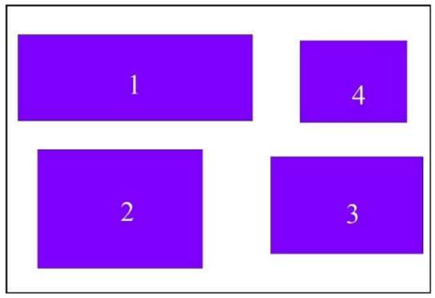


Fig. 7. The initial layout of the main functional area of the urban public space

The proposed method is used to obtain the main functional area layout plan of urban public space, and the optimized layout of the main functional area of urban public space is shown in Figure 8.

As can be seen from the figure, the main difference of the layout lies in the location arrangement of the old residential area and the transportation area, which divides the modern area and the old area by the transportation area and is adjacent to the commercial area. Adjacent to the commercial district can be convenient for urban residents to travel, but also attract commercial activities, bringing more convenience to urban residents.

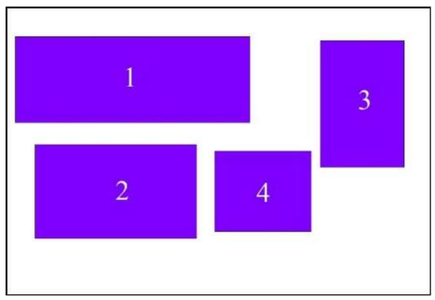


Fig. 8. The layout of the main functional area of the urban public space

4.2. Public Space Design for Xi'an Metro Line 4

4.2.1. Design of entrances and exits. As the construction of metro urban rail is generally later than the construction of the surrounding buildings on the ground, in the planning of metro entrances and exits need to be based on the flow of people on the ground, the topography of the surrounding environment and its function of the planning, metro entrances and exits are generally designed to present directly on the ground, and some of the metro entrances and exits and shopping malls are indirectly presented. The integration of Xi'an cultural symbols into the styling design of subway entrances can be divided into overall application and local application, combining Xi'an cultural symbols with the design of subway public space to better display Xi'an's excellent traditional culture. The role of the passage space is to link the different functions of the regional space, carrying the role of safe evacuation of the crowd, so in the design process should be simple and quick, reduce the residence time.

4.2.2. Station level design. Platform level is the waiting area for passengers, there is more time to observe the subway public space design, the range of public space on the platform level is the key design area. As the subway space is closed and narrow, it is easy to make people psychologically depressed, so the intervention of psychology is crucial. The design area mainly includes: ceiling molding, roof, columns and floor. Xi'an non-legacy culture is the bond that maintains the emotional integration of regional people, integrating the Xi'an cultural symbols with the design of the metro public space, psychologically obtaining the cultural identity of the passengers, and allowing them to better understand the culture of Xi'an. In the design of lounge chairs, attention should be paid to the unity of style with the overall public space of the subway, the shape of the Xi'an cultural symbols are extracted, the use of color science and reasonable matching of colors, Xi'an culture into the space device, in the limited public space of the subway, so that the passengers feel the Xi'an culture immersed in the scene.

4.3. User experience feedback and analysis

4.3.1. Accessibility Analysis of Urban Metro Networks. Spatial syntax is generally analyzed by using the axis model, firstly, the metro line of Xi'an city will establish the axis model according to the principle of spatial syntax, and then analyze it on the basis of verifying that the topological connection relationship of the axis model is correct. In this paper, the axis model is drawn based on the subway line map of Xi'an city in Gaode map.

1) Global integration degree. The analysis results are shown in Figure 9, in which the black line segments represent the road sections with high integration degree, followed by purple, green represents the general integration degree, and red indicates that the road section has a low integration degree. The subway platform line segments with high integration are organized and their connectivity and depth values are counted, as shown in Table 4.

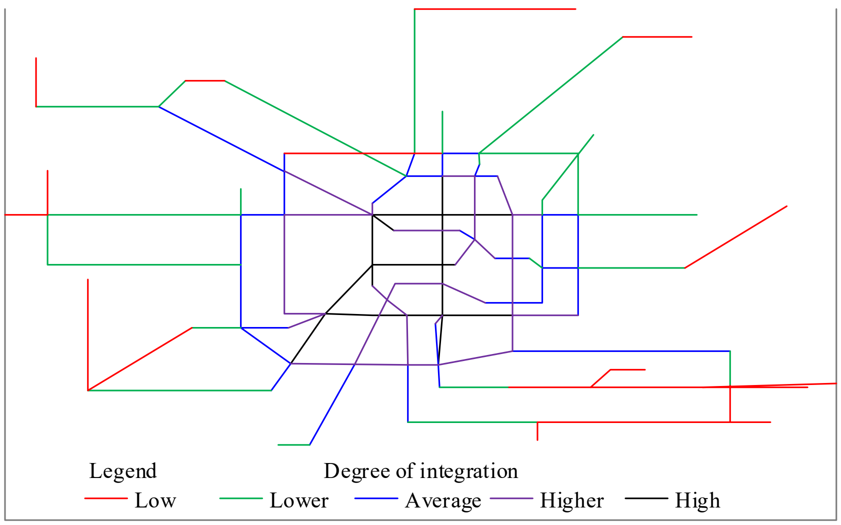


Fig. 9. Global integration of subway in xi 'an

The statistical results show that the subway station line segments with high integration are: platform 6 - platform 8 (Aerospace Avenue - Qujiangchi West), platform 4 - platform 9 (East Chang'an Street - Datang Furongyuan), platform 10 - platform 13 (Big Wild Goose Pagoda - Hepingmen), and platform 17 - platform 19 (Hall of Hanyuan - Daminggong North).

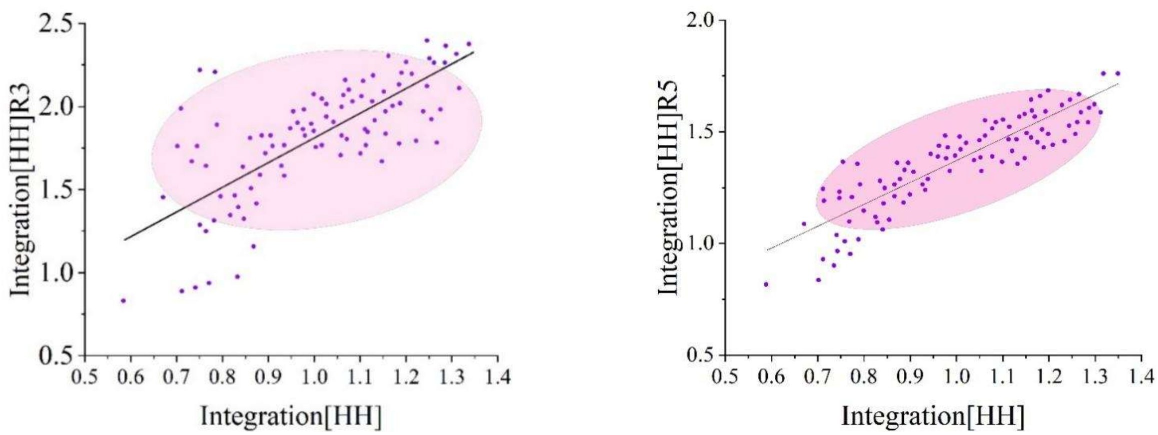
Table 4. The global integration level of the subway station

Platform	Road section	Global integration	Connection degree	Mean depth value
Platform 6 - platform 8	HANGTIANDADAO - QUJIANGCHIXI	1.380387	7	4.313793
Platform 4 - platform 9	DOGCHANG'ANJIE - DATANGFURONGYUAN	1.340672	7	4.382480
Platform 10 - platform 13	DAYANTA - HEPINGMEN	1.334311	5	4.392941
Platform 17 - platform 19	HANYUANDIAN - DAMINGGONGBEI	1.332846	8	4.472152
Platform 21 - platform 18	BAIHUACUN - DAMINGGONG	1.285792	8	4.512932

2) Local integration degree. Local integration degree analysis is an analysis of the integration degree of nodes within a few topological distances around a node, indicating the degree of closeness between that node and neighboring nodes.

3) Intelligibility. The comprehensibility reflects the relationship between the whole and the local, the higher the comprehensibility, the stronger the correlation between the whole and the local space. Intelligibility is generally expressed in R^2, R^2 the size of the value of the response to the difficulty of spatial identification, generally believe that $0 < R^2 < 0.5$ when the degree of comprehensibility is low, when 0.5 < comprehensibility is low, when $0.5 < R^2 < 0.7$, the degree of comprehensibility is high, $0.7 < R^2 < 1$, the degree of comprehensibility is very high. Comprehensibility is high when < 0.7 and high when $0.7 < R^2 < 1$.

The global integration degree is chosen as the horizontal coordinate, and the local integration degrees of three topological distances and five topological distances are used as the vertical coordinate, respectively, and the function is constructed to obtain the linear relationship between the global integration degree and the local integration degree as shown in Fig. 10, and Figs. (a) and (b) show the local integration degree of three topological distances and the intelligibility degree of five topological distances, respectively.



(a)Three topological distances (b)Five topological distances

Fig. 10. The integration and understanding of subway line road in xi 'an

The analysis results show that when the local integration of three topological distances is used as the vertical coordinate, the linear relationship between the global overall integration and the local integration is higher comprehensibility. y = 1.47893x + 1.47152, $R^2 = 0.55483$.

When the local integration of the five topological distances is used as the vertical coordinate, the linear relationship between the global overall integration and the local integration is: y = 0.945642x + 0.94238, $R^2 = 0.813462$, which has a high degree of comprehensibility.

It can be seen that the larger the value of the selected topological distance, the closer the results of the local integration analysis are to the global integration. When the integration degree of five topological distances is selected as the vertical coordinate, $R^2 = 0.813462$ is larger than the threshold value of 0.7, which indicates that the global integration degree is highly correlated with the local integration degree, reflecting the scientific nature of Xi'an metro line layout planning, which can be grasped locally as a whole, and perceived as a whole from the local area.

4.3.2. Spatial pattern analysis. Integration is a central quantitative metric of spatial syntax theory that measures a space's potential to attract arrival traffic and shows the degree to which a space is aggregated or disaggregated from other spaces. The larger the integration degree value (warmer color) the higher its spatial accessibility. Selectivity is the number of times it appears on the shortest topological path, i.e., the set of shortest topological paths from any one element to any other element in a spatial system. In isotonic urban systems, areas with high integration (high liveability) and high selectivity (high crossing rate) tend to overlap, whereas in modern large urban differential systems, a separation of integration and selectivity occurs, which confirms the impact of the proliferation of private cars on the original way of life.

The highest values of global integration in the Qianmen area are distributed along the central axis and in the middle part of Shikou Street, which happens to be located within the domain of Zhushikou subway station. Calculating the global selectivity results in a significantly higher degree of integration in the neighborhood with Qianmen Street as the central axis and Coal Market Street and Qianmen East Road as the two wings than in the surrounding areas, which is also consistent with the pedestrian flow observed in the field. The local integration degree (R=3,5,7,9,11) and the global integration degree (R=n) are respectively calculated for the smartness degree with the formula:

It can be seen that when $R=3$, $R^2=0.45$; $R=5$, $R^2=0.59$; $R=7$, $R^2=0.66$; $R=9$, $R^2=0.72$; $R=11$, $R^2=0.79$, by analyzing the values, it can be seen that with the increase of topological depth, the local integration degree gradually reflects the reality of the flow of people, while the depth value is high compared to the newer cities, which indicates that the cost of activity occurrence in the cities with historic districts is higher, and it is necessary to pass through more public space in order to reach the end of the activity occurrence. The linear correlation between the connectivity value and the global integration degree of the Qianmen area is measured to understand the degree, which is calculated by the formula:

$$R^2 = Connectivity(\deg ree) / Antegration[HH] \tag{25}$$

Intelligibility can reflect the ability to understand the overall spatial structure through a piece of area, the results show $R^2=0.185783$, $(y=5.55453x-0.871656)$, the correlation is low reflecting the poor intelligibility of the Qianmen area.

Based on the above analysis of the overall spatial pattern distribution of the Qianmen area to derive the integration degree core area of the area, summarizing the overall Qianmen area and the integration degree core area, as shown in Table 5.

Table 5. Conformity, intelligence and understanding

		Front door area	Integrated region	Remark
Topological depth	Mean value	15123	4128.87	The depth of the topology of the core area (variance st-devp=727.255)Obviously less than the whole region(2339.33)
	Minimum value	9466	2514	
	Maximum value	2671	7482	
Global integration average		0.70283	0.978912	-
Intelligence(Topological depthR=3)		$R^2=0.443521$, $y=2.4537x-0.252153$	$R^2=0.542767$, $y=1.79188x-0.137629$	The correlation between the core area is more than 0.5and it is strongly associated
Comprehensibility		$R^2=0.185783$, $y=5.55453x-0.871656$	$R^2=0.146326$, $y=3.89466x-0.615882$	There is a low number of values in the region of the core and the overall region, and the overall region is higher than the core

4.3.3. Evaluation and analysis of the appropriateness of metro public space. In order to further understand and analyze the appropriateness and reasonableness of Xi'an Metro public space, this paper adopts the complex network analysis method to analyze the balance of each variable cultural element, and the higher the balance is, the stronger the appropriateness of this type of cultural element is, and the elements with weaker appropriateness need to be combined with the field research to focus on solving the problem in the subsequent optimization plan.

In the balance analysis of the complex network analysis method, the "middle center potential" is mainly used as an indicator for calculation. The value of "middle center potential" is between 0 and 1, and the lower its value is, it means that the network is relatively uniformly distributed, while the value close to 1 means that the network power is concentrated and the network structure tends to be unbalanced. The lower the value, the more evenly distributed the network is, while a value close to 1 indicates that the network power is concentrated and the network structure tends to be unbalanced. The formula for calculating the "intermediate center potential" of each node is as follows:

$$C_{RBt} = \frac{2C_{ABt}}{n^2 - 3n + 2}, C_{ABt} = \sum_{j}^{n}\sum_{k}^{n} b_{jk}(t)\, j \neq k \neq t \qquad (26)$$
$$And\ b_{jk} = \frac{g_{jk}(t)}{g_{jk}}$$

where C_{ABt} represents the sum of the median centrality of all pairs of points and lines in the complex network, i.e., the absolute median centrality potential, C_{ABt} represents the relative median centrality potential, n represents the number of all points in the network, g_{jk} represents the number of lines that exist between points j and k, $g_{jk}(t)$ represents the number of shortcuts between points j and k that exist through the third point i, and $b_{jk}(t)$ represents the ability of the third point i to control the interactions of points j and k. So, the whole network is a "network".

Therefore, the formula for calculating the "intermediate center potential" of the whole network is as follows:

$$C_B = \frac{\sum_{i=1}^{n}(C_{ABMax} - C_{ABt})}{n^3 - 4n^2 + 5n - 2} = \frac{\sum_{i=1}^{n}(C_{RBMax} - C_{RBt})}{n-1} \qquad (27)$$

where C_{ABMax} is the maximum absolute intermediate centrality of a point in a network of size n, and C_{RBMax} is the relative intermediate centrality of its corresponding point. The "intermediate centrality" refers to the number of nodes that are directly connected to the node, and if a point has a high degree, it resides in the core of the network and has a lot of power. The formula is:

$$C = \frac{\sum_{t=1}^{n}(C_{\max} - C_t)}{\max\left[\sum_{t=1}^{n} C_{\max} - C_t\right]} \qquad (28)$$

According to the above formula, we can calculate the "middle centrality" and "middle centrality potential" of 13 metro factors as shown in Table 6. Then the overall center value of the network is calculated as shown in Figure 11, from which we can see that the center centrality is 8.8216, and the center potential is 0.5859, which shows that the overall balance of public space culture in Xi'an metro is better, which indicates that its overall moderateness is relatively balanced. From the table, it can be seen that the balance of eight single-point factors, namely, the regionality of the sign and facility system, the richness of the landscape and cultural facilities, the coordination of the surrounding environment, the appropriateness of the spatial scale, the appropriateness of the spatial color, the accessibility of the traffic flow, and the convenience of the infrastructure, is better, and the P-value of the fit is greater than 0.5, which shows that these eight factors are better balanced, and that means that the relevant indications and facilities of Xi'an Metro Line 4 have better regional characteristics, and the central potential is 0.5859, which indicates that its overall appropriateness is relatively balanced. This means that the regional characteristics of the signs and facilities in Line 4 of Xi'an Metro are more obvious, and the aesthetics of some public space interfaces in Xi'an Metro are the main factors affecting the appropriateness of public space in Xi'an Metro, and also the main direction of the subsequent field surveys and optimization of the design.

Table 6. Complex network equilibrium analysis of subway culture factors

Evaluation factor	Conformity (intermediate center degree)	Pseudo p value	Equilibrium (central degree)	Pseudo p value
Regional facility system	19.06	0.768	0.5865	0.534
Identification facility system cultural dissemination	8.76	0.976	0.6952	0.522
Identify the diversity of the facility system forms	9.25	0.876	0.6897	0.674
The overall echo of urban culture	7.51	0.777	0.6391	0.708
The richness of landscape and cultural facilities	4.06	0.705	0.2766	0.546
Coordination of the surrounding environment	5.17	0.673	0.4049	0.534
Reasonable distribution of commercial advertisements	2.23	1.113	0.7493	0.618
Commercial advertising distribution rationality	8.35	1.338	0.6545	0.515
The suitability of advertising implants	11.56	0.792	0.7392	0.676
Rationality of advertising dimensions	1.49	0.666	0.2493	0.882
The suitability of space scale	10.29	0.803	0.3727	0.524
The suitability of spatial color	16.77	0.747	0.5271	0.612
The communication of traffic lines	6.79	0.796	0.4175	0.554
Convenience of infrastructure	19.06	0.468	0.5865	0634

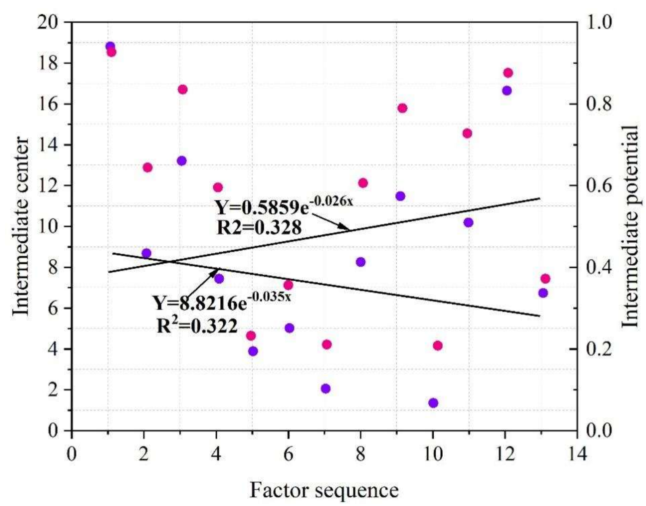


Fig. 11. Network overall center value

5. Conclusion

This paper proposes an image style migration algorithm based on the improved loop consistency generative adversarial network, on the basis of which the integration of Xi'an regional culture realizes the intelligent translation of culture in the design of subway public space. The improved style migration algorithm is compared and experimented with other models, and the results show that the model in this chapter is 0.75 close to 1 in terms of generative effect SSIM and 29.59 PSNR, which illustrates the feasibility of the method. Xi'an Metro Line 4 is tested as an example, and according to the spatial distribution separation test, it can be seen that the spatial distribution separation is kept in the range of 0.571 to 0.591, which has a good design effect, and the spatial layout parameter adjustment is completed within 21.62ms, which has a high layout efficiency. Then the Xi'an urban rail transit model based on spatial syntax is constructed, and the accessibility analysis of Xi'an metro network is carried out by combining spatial syntax theory and GIS. The results show that Xi'an metro network has high spatial accessibility and is holistic in spatial layout. Finally, the spatial adequacy design of metro stations is analyzed, and the overall balance of public space culture in Xi'an metro is better.

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