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Research Article

Landscape Ecological Construction and Spatial Pattern Optimization Design Based on Genetic Algorithm Optimization Neural Network

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With the development of computer visual information processing technology, designers use visual image processing methods to analyze and extract the features of landscape ecological space environment, establish visual reconstruction models of landscape ecological construction and spatial pattern optimization design images, and improve their ability to identify and reconstruct the artistic features of landscape ecological space environment. In this paper, a landscape ecological construction and spatial pattern optimization design scheme based on NN and GA is put forward. In the process of image visual reconstruction of landscape ecological construction and spatial pattern optimization design, urban ecological landscape information fusion perception and block area template matching are carried out to realize urban ecological landscape design. Finally, simulation test and analysis are carried out. The results show that the accuracy of this algorithm is high, which is 9.34% higher than that of traditional GA. This method can effectively reduce the iteration times and running time of the algorithm and improve the efficiency of landscape space optimization design. Carrying out the research on ecological planning and design with landscape ecological protection and restoration as the core has important practical guiding significance for guiding all localities to construct landscape ecological security pattern and promote green urbanization.

1. Introduction

The history of human development is the history of continuous transformation and recreation of nature. As the largest creation of human beings at present, cities are the crystallization of human wisdom. Urbanization is the common trend of the development of all countries in the world and the symbol of human civilization [1]. Urbanization is the inevitable process of human progress. After urbanization, it marks the realization of modernization goals. The city is an artificial and natural complex ecosystem with poor natural adjustment ability, which depends on the negative entropy flow input from the external environment to exist and develop [2]. At present, the urban population is growing rapidly, the scale of the city is expanding, the density of buildings is increasing, the available land and space in the city are becoming less and less, and the ecological environment is deteriorating [3]. The emergence of urban ecoenvironmental problems also makes people gradually begin to think about what kind of development path to take and gradually begin to pay attention to and study the response mechanism of the environment and ecosystem to the urbanization process, hoping to slow down or eliminate the negative impact of urbanization on the ecological environment [4]. Today, establish visual reconstruction models of landscape ecological construction and spatial pattern optimization design images and improve their ability to identify and reconstruct the artistic features of landscape ecological space environment.

The feature reconstruction of landscape ecological space environment art is based on the visual

reconstruction of landscape ecological construction and spatial pattern optimization design images, and the distributed fusion of visual images and binary recognition method are adopted to carry out visual reconstruction of landscape ecological construction and spatial pattern optimization design images. The geometric feature analysis model of landscape ecological construction and spatial pattern optimization design images is extracted, and the three-dimensional reconstruction method of computer vision features is used to realize landscape ecological construction and spatial pattern optimization design and image vision reconstruction [5, 6]. The part of the urban ecosystem with large adjustment flexibility is mainly contained in the open space environment, but the traditional urban planning pays more attention to the layout and construction of the closed space in the city, while ignoring the sustainable utilization and protection as an important part of the urban space [7]. In order to effectively save calculation time, neural network technology and genetic algorithm are combined, so as to better complete the process of landscape ecological construction and spatial pattern optimization. The BP neural network is a multilayer network system with one-way propagation, which has very strong nonlinear mapping ability [8]. In view of the advantages of neural network, this paper uses neural network to simulate the individual evaluation function of the genetic algorithm in order to reduce the execution cost of the algorithm. Practice has proved that this combination can not only reduce the calculation time but also improve the quality and efficiency of landscape ecological construction and spatial pattern optimization.

The contradiction between economic growth and environmental protection in the process of land use has existed for a long time. Effectively coordinating the contradiction between them and balancing the demand for ecological, living and development land is an important measure to maintain the healthy and stable development of the region, and it is also a long-term task. With the rapid expansion of urban economy and population scale, urban land use gradually expands to the periphery in different forms, and the central city gradually radiates to the periphery, driving the development of the surrounding areas and forming a large-scale urbanized area and determines the nature of landscape pattern, including landscape diversity, spatial heterogeneity, and landscape connectivity. The basic nature of landscape pattern is landscape heterogeneity. It is because of heterogeneity that landscape pattern has the value and significance of research and analysis. In this paper, the visual feature reconstruction model of landscape ecological construction and spatial pattern optimization design images is established, and the urban ecological landscape information fusion perception and block area template matching in the process of visual reconstruction of landscape ecological construction and spatial pattern optimization design images are carried out, and the fuzzy feature quantity of landscape ecological construction and spatial pattern optimization design images is extracted. Its innovation lies in the following:

(1) In this paper, NN is used to simulate the individual evaluation function in GA in order to reduce the execution cost of the algorithm

(2) In this paper, the key feature quantities of landscape ecological construction and spatial pattern optimization design images are constructed, and pixel tracking fusion technology is adopted to realize landscape ecological construction and spatial pattern optimization design and optimization identification

This paper studies the problems of landscape ecological construction and spatial pattern optimization design, and the framework is as follows.

Section 1 is the introduction. This part mainly expounds the research background and significance of landscape ecological construction and spatial pattern optimization and puts forward the research purpose, method, and innovation of this paper. Section 2 is a summary of relevant literature, summarizing its advantages and disadvantages, and putting forward the research ideas of this paper. Section 3 is the method part, focusing on the landscape ecological construction and spatial pattern optimization design method combining GA and NN. Section 4 is the experimental analysis. In this part, experiments are carried out on data sets to analyze the performance of the model. Section 5 shows conclusion and prospect. This part mainly reviews the main contents and results of this research, summarizes the research conclusions and points out the direction of further research.

2. Related Work

As an important field of landscape ecology application, urban landscape ecological planning mainly studies the function, change, and planning of urban landscape. At present, there is a consistent understanding of landscape in geography: landscape is a complex regional system composed of the simplest regional units that are ecologically and organically combined together, and it is the totality of the natural geographical process in which various elements interact, and this interaction determines the landscape dynamics.

Sun et al. equated landscape with land, and according to the principles of landscape ecology, proposed different spatial distribution levels of land, including main landscape, land system, land piece, and ecological landscape [9]. Hou and Wang regarded land as a complex ecosystem. In the process of classification, the land ecosystem was integrated into a larger geographic unit and then connected to the surrounding geographic units that interacted with it [10]. In the establishment of regional ecological security pattern, Munoz et al. believed that the analysis of ecological land fragmentation characteristics and mechanism is conducive to ecological conflict, spatial organization elements, and pattern recognition [11]. Ye et al. applied the concept of ecological infrastructure in biological conservation research [12]. An believes that the land-based economic output value takes priority over the land use method of ecological service functions, which has led to the problems of disorderly urban

expansion and deterioration of the ecological environment in recent years [13, 14]. He et al. used the method of landscape safety pattern, and based on the diagnosis of ecological environment problems, they chose to construct the safety pattern of water conservation, flood regulation and storage, biological protection safety pattern, and recreation safety pattern and integrated each safety pattern to form an overall landscape safety pattern [15]. Tai and Wei used GIS spatial analysis to construct the minimum cumulative resistance surface by weighting and superimposing two factors of surface cover type and slope [16]. Based on the methods and principles of landscape ecology, Gonzales-Inca et al. established the least resistance surface model by applying the theory of landscape ecological security pattern for the purpose of maintaining important protected areas and protecting biodiversity in the territory [17]. Shan and Sun proposed a land use scenario simulation method based on ecological security pattern based on the GIS and CA-Markov model [18].

Traditional ecological landscape design often has the problems of poor direct viewing effect and low satisfaction of residents, and there may also be some irrationalities in green design. In this paper, a landscape ecological construction and spatial pattern optimization design scheme based on NN and GA is put forward. In the process of image visual reconstruction of landscape ecological construction and spatial pattern optimization design, urban ecological landscape information fusion perception and block area template matching are carried out, and the landscape space is optimized from the aspects of construction cost and green belt, so that the distribution of ecological landscape space is more reasonable.

3. Methodology

3.1. GA Combined with NN Technology to Analyze Landscape Architecture. Through the mapping ability of NN, GA is used as a variable part of each level of neural network, and in this process, the objective function is used as an output variable. The calculation of the degree of use function is mainly completed by NN technology. After the individual passes the training process, the optimal value is obtained through GA.

3.1.1. The Internal Calculation Process of NN. (1) Clarify each variable, parameter, and function; (2) set the sample through operation and output by each level after NN training; (3) observe the training conditions to see if it meets the requirements; and (4) after NN training, it is transferred to GA.

3.1.2. The Calculation Process of GA. (1) Initialize the population and set reasonable parameters; (2) judge the excellent value of each individual through the trained NN and calculate its fitness value; (3) for the excellent individuals among them; and (4) transform and calculate its fitness value.

The main idea of GA optimization of NN in this paper is as follows: using BPNN mapping, the input variables of GA are used as input variables of each layer of NN, the objective function is designed as the output variable, and the calculation of fitness is realized by NN; the good individuals after training are realized by GA solving for optimal values in mathematical models. The solution process is mainly divided into the NN module and GA module.

3.2. Optimal Design of Landscape Pattern Based on BPNN. The city is an open and complex system. Only by relying on the negative entropy flow continuously input from the outside can the entropy increase generated in the process of urban development be offset, and the stability and order of the urban ecosystem can be guaranteed [19]. Landscape is a geographical entity with obvious visual characteristics and mosaic of different land units, which has multiple values of economy, ecology and culture. Landscape ecology is the science of studying landscape pattern, function, and change. Landscape pattern refers to the spatial relationship between patches, while landscape function is the interaction of spatial elements [20]. Urban open space is a special regional complex that combines artificial landscape and artificial management landscape, while urban open space is a variety of landscape types with multiple functions that exist in cities.

On different research scales, the position of open space in urban regional structure is different, and its functions are obviously different. At present, there are many studies on the open space of built-up area, especially the layout of green space, wetlands, roads, and other elements based on this scale is often the focus of urban planners and decision-makers. Because of the different scale of cities, the specific planning research should also be combined with the scale of cities. With the continuous expansion of the city scale, the phenomenon of crowding out the open space of cities with large scale elasticity is widespread. Evaluating the urban ecological environment problems will help to optimize the urban spatial structure and promote the healthy and sustainable development of the urban ecosystem. According to the current situation, BPNN is the most popular of many NN technologies. This technology is a network system that completes the transmission process in a single way, and it has multilevel features and nonlinear mapping features, so it can summarize the data function relationship without prior formula process. The BPNN structure is shown in Figure 1, and its working principle is shown in Figure 2.

BPNN algorithm has outstanding characteristics, good self-learning ability, and nonlinear mapping ability, which can promote the construction of multi-input and single-output landscape ecological construction and spatial pattern analysis model. At the same time, with the application of this algorithm, if unknown sample data is added to the network in the subsequent error compensation process, the network can still be correctly mapped from the input space to the output space. According to various causes of errors in spatial pattern analysis, the mathematical model is constructed:

$$O_j(t) = f\left(\left[\sum_{i=1}^{n} v_{ij} x_i\left(t - \tau_{ij}\right)\right] - T_j\right). \quad (1)$$

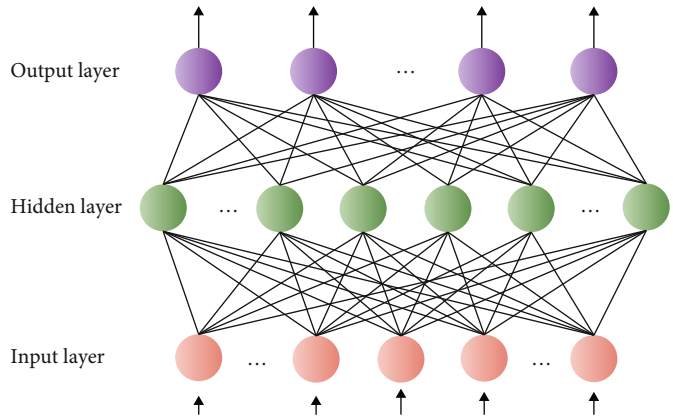

Figure 1: BPNN structure.

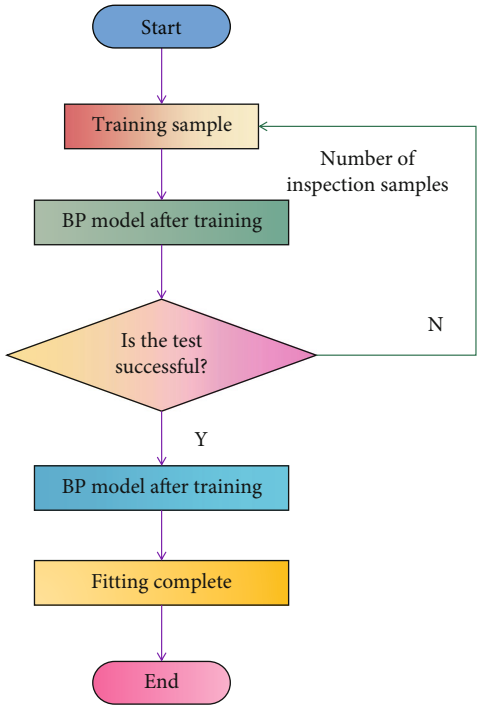

Figure 2: BPNN workflow.

Among them, O_j represents the output error, $f(\cdot)$ represents the activation function of the neuron, T_j represents the corresponding threshold of the neuron j, τ_{ij} represents the corresponding synaptic delay between the input and output, v_{ij} represents the corresponding weight of the neuron i to the neuron j, and x_i represents the input volume. For a certain sample (WT, p), when the output y is not equal to the expected output p, there is an output error:

$$E = \frac{1}{2}(y-p)^2. \tag{2}$$

Although landscape pattern analysis will be influenced by many factors, a single hidden layer BPNN can basically fit all nonlinear functional relationships. The error trend of BPNN training is shown in Figure 3.

The function of landscape is controlled by the specific spatial configuration of ecosystem, which can combine the ecological flows between adjacent ecosystems or within ecosystems. For the natural landscape and agricultural landscape in open space, the primary productivity of ecosystem, net biomass, and photosynthesis productivity are undoubtedly the most important characteristics. People who have lived in artificial landscapes for a long time are more eager for the naturalness and openness of urban landscapes. It is necessary to specify the parts that need to be calculated and then obtain the quality of each window and height. At the same time, it is also necessary to obtain the sunshine time of each part and the data of calculation accuracy. Secondly, the area in the area should be reasonably divided, and the maximum volume of the building can be obtained through the combination of square columns, and the optimization process of this combination can be calculated by GA.

3.3. Image Fusion and Reconstruction Model. Landscape pattern has obvious spatial correlation and scale dependence. The definition of scale is the time and space range of investigating the characteristics and changes of things, so the definition of scale should include four aspects: object, subject, and space-time dimension. Landscape ecology mainly studies landscape structure, spatial form, and its influence on various ecological processes and functions. Landscape structure mainly refers to the composition and pattern of various landscape types, while spatial form refers to the visual landscape perceived by human beings. Landscape structure and spatial form together constitute the basic feature of landscape-spatial configuration [21]. As an important field of landscape ecology application, urban landscape ecological planning mainly studies the function, change, and planning of urban landscape. It mainly includes the following aspects: ① urban landscape architecture, ② study on urban rivers and lakes, ③ study on "green road" and "green line" and their ecological functions, ④ wild animals and plants were reintroduced into urban planning, and ⑤ natural process. Landscape pattern system contains complicated information, which cannot be expressed by a single index. Generally, an index can only outline one or a few aspects of the whole

Figure 3: BPNN training error trend.

landscape system. Usually, the landscape pattern index can be analyzed at three levels, namely, patch level, type level, and the whole landscape mosaic level. Using the principle of landscape ecology to carry out ecological protection and construction will consider the coordination of regional ecological protection, governance, and management from a holistic and systematic point of view, which will play a positive role in improving the ecological environment. The key ecological land is an important patch to maintain regional ecological security and provide stable ecological space services, and it is also the lowest guarantee of regional ecological land, that is, to achieve the greatest effect through the most effective protection.

Landscape heterogeneity is the most common feature in nature, which comes from the abiotic environmental heterogeneity, such as topography, geology, hydrology, soil, and human factors. Landscape heterogeneity plays an important role in the stability, anti-interference ability, self-repair ability, and species diversity of landscape system. In the process of urbanization, within the scope of possible urban expansion, landscape evolution has to go through two processes: artificial agricultural landscape replaces the original natural landscape; urban landscape gradually replaces agricultural landscape. Landscape pattern not only reflects the heterogeneity of landscape but also reflects the effects of various ecological processes on different scales. Landscape pattern can regularly affect the diffusion of disturbance, the movement and distribution of biological species, the horizontal flow of nutrients, and the formation of net primary productivity, etc., and the process on landscape scale plays a decisive role in the formation of landscape structure. The key feature quantity of the image of landscape ecological construction and spatial pattern optimization design is constructed, and the pixel tracking fusion technology is adopted to realize the landscape ecological construction and spatial pattern optimization design and optimization identification. The research on the related landscape ecological construction and spatial pattern optimization design methods has attracted great attention. The template matching model of image visual reconstruction of ecological construction and spatial pattern optimization design is shown in Figure 4.

Construct a spatial distributed detection model of visual features of landscape ecological construction and spatial pattern optimization design images. The distribution of the visual characteristics of the image of ecological construction and spatial pattern optimization design is as follows:

$$G\left(\vec{x}\right) = \sum_{j=1}^{p} G_j\left(\vec{x}\right). \tag{3}$$

The adaptive fusion method is adopted to reconstruct the image vision of landscape ecological design, and the edge vision reconstruction model of landscape ecological construction and spatial pattern optimization design is constructed, and the fuzzy closeness function of landscape ecological spatial environment image is obtained:

$$\text{fitness}\left(\vec{x}\right) = f\left(\vec{x}\right) + (Ct)^{\alpha} \sum_{j=1}^{p} G_j^{\beta}\left(\vec{x}\right). \tag{4}$$

Assuming that the P_N coordinate of the landscape ecological construction and spatial pattern optimization design

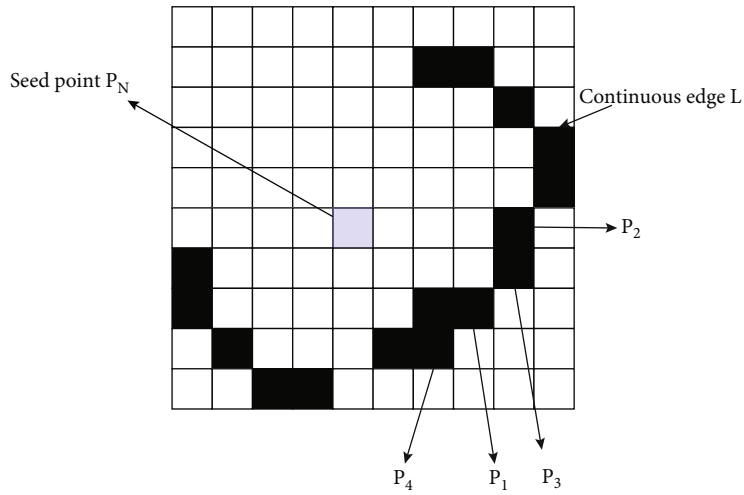

Figure 4: Template matching model of landscape ecological construction and spatial pattern optimization design.

is (X_{P_N}, Y_{P_N}) and then compare the edge point coordinates (x_k, y_k) and P_N of all landscape ecological construction and spatial pattern optimization design on L:

$$\begin{aligned} &\text{When } x_k > X_{P_N}, i_L = i_L + 1, \\ &\text{When } x_k < X_{P_N}, i_L = i_L - 1, \\ &\text{When } x_k = X_{P_N}, i_L = i_L + 0. \end{aligned} \tag{5}$$

The perception fusion model of urban ecological landscape information fusion is constructed, and the fitness function of urban ecological landscape information fusion is obtained as follows:

$$\text{fitness}\left(\vec{x}\right) = \begin{cases} f\left(\vec{x}\right), \text{If feasible,} \\ 1 + rG\left(\vec{x}\right), \text{Otherwise.} \end{cases} \tag{6}$$

Considering the gray pixel level f of landscape ecological construction and spatial pattern optimization design, the grayscale invariant moment eigendecomposition method is used to construct the discrimination model of landscape ecological space environment vision:

$$\begin{aligned} W_u(a,b) = e^{j2\pi k \ln a} \times \frac{K}{\sqrt{a}} \left\{ \left[\frac{a e^{(j2\pi f \min/a)(b-b_a)}}{f_{\min}} - \frac{e^{(j2\pi f \min/a)(b-b_a)}}{f_{\max}} \right] \right. \\ \left. + j2\pi(b-b_a) \left[Ei(j2\pi f_{\max}(b-b_a)) - Ei\left(\frac{j2\pi f_{\min}}{a}(b-b_a)\right) \right] \right\}. \end{aligned} \tag{7}$$

Among them, $b_a = (1-a)((1/af_{\max}) - (T/2))$, $Ei(\cdot)$ represents the output of the visual information feature reorganization of the landscape ecological space environment and combined with the model identification method, the landscape ecological design is carried out.

Table 1: Information of examples of buildings to be built.

Number	Spacing	Length of building to be built
1	40 m	50 m
2	50 m	60 m
3	60 m	70 m
4	70 m	80 m
5	80 m	100 m
6	90 m	90 m

4. Result Analysis and Discussion

The relationship between landscape pattern and function has always been one of the core issues in landscape ecology research. Landscape spatial pattern is the main determinant of landscape function, pattern, and process changing with time. Therefore, the optimization of landscape spatial pattern can regulate ecological flow and improve landscape function. In order to verify the application performance of this method in landscape ecological construction and spatial pattern optimization design, a simulation experiment was conducted, assuming that the number of seed points in landscape design is 40, the coefficient of feature matching is 0.36, and the block size of pixel points is 200×200. In order to verify the universality of the application of this method, six types of building areas to be built are set, as shown in Table 1. For each example of the building to be built, set different distances between the building to be built and the sheltered building and the length of the building to be built in the east-west direction. The uniform width of the partition spacing of the building to be built is 1 m, the width and spacing of the partition window are 1.6 m, and the floor height is 4.6 cm.

Due to the characteristics of BPNN technology, the speed of calculating individual fitness function can be reduced by combining with GA, thus reducing the resource consumption in this process. All parameters of GA are set, the input variables are binary coded, the population size is

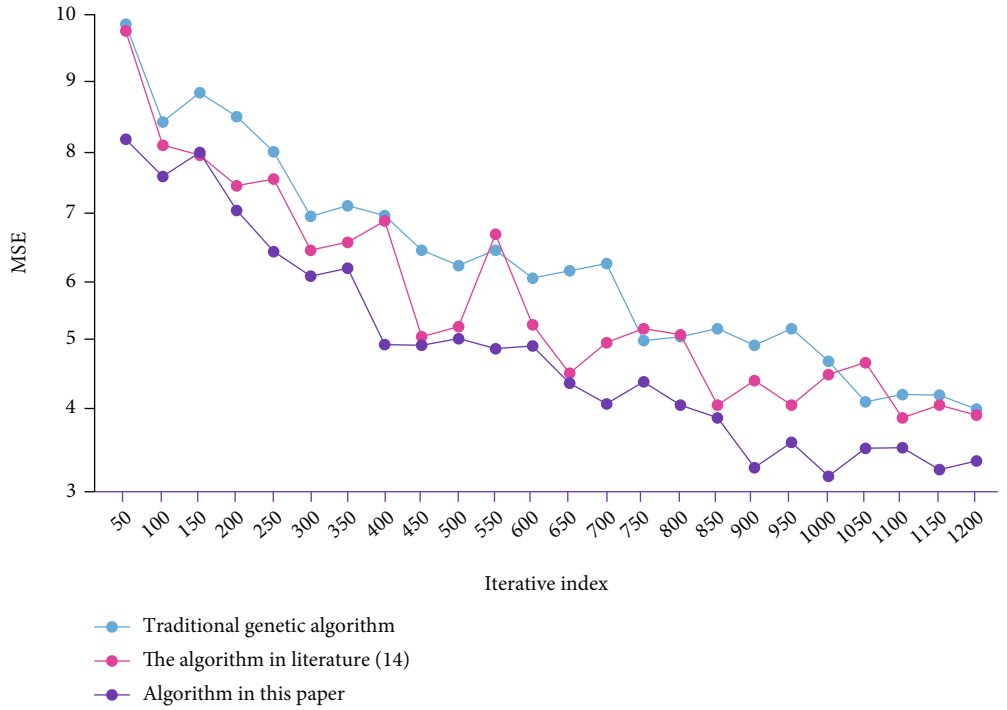

Figure 5: MSE experimental results.

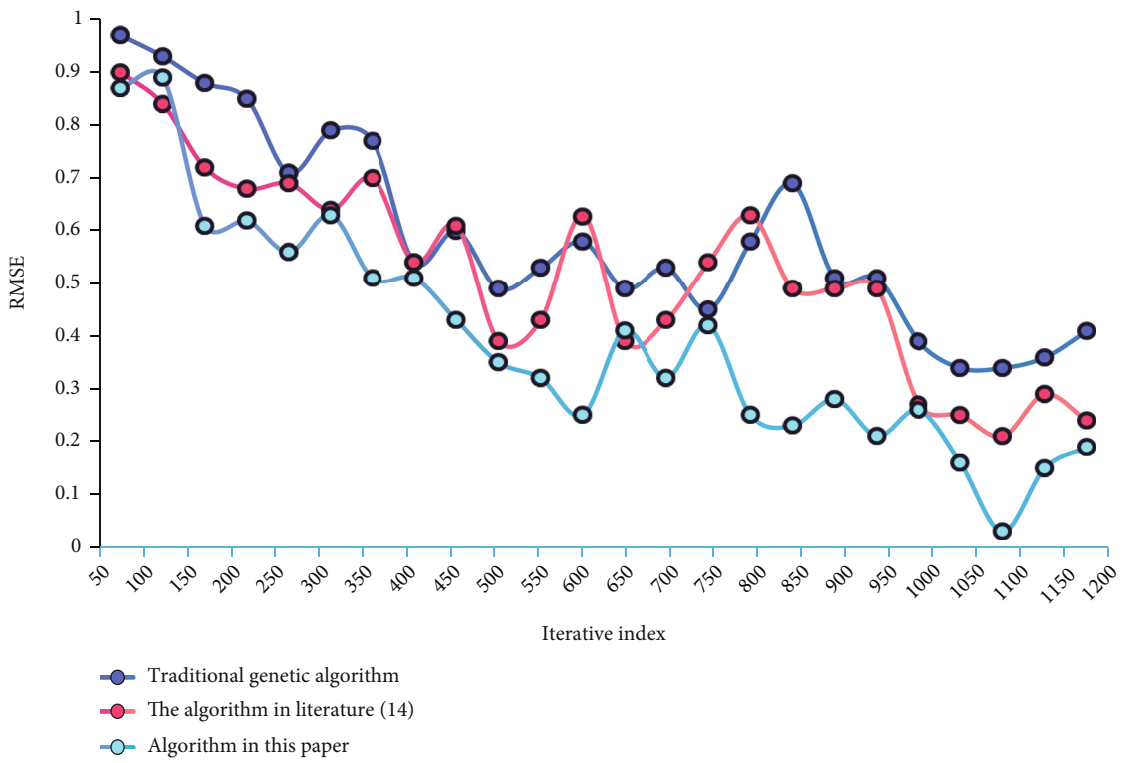

Figure 6: RMSE experimental results.

30, the selection operation is carried out by roulette, and single-point crossover and single-point mutation are adopted, with the probability of crossover and mutation being 0.2 and 0.8, respectively. The termination condition of the algorithm is to find the optimal value, or to reach the maximum evolutionary algebra. In the experiment, it takes 1200 generations. In this section, in order to verify the effectiveness of this algorithm, four model performance

Table 2: Comparative results of experiments with different methods.

Number	Method	Mean value	Iterative exponential reduction	MAE
	Traditional GA	536.12	—	1.86
1	The algorithm in literature [14]	512.37	15.21	1.43
	Algorithm in this paper	405.21	28.79	1.21
	Traditional GA	487.32	—	1.76
2	The algorithm in literature [14]	437.81	16.78	1.35
	Algorithm in this paper	324.58	30.25	1.05
	Traditional GA	752.39	—	1.79
3	The algorithm in literature [14]	714.52	5.89	1.46
	Algorithm in this paper	635.24	15.97	1.17

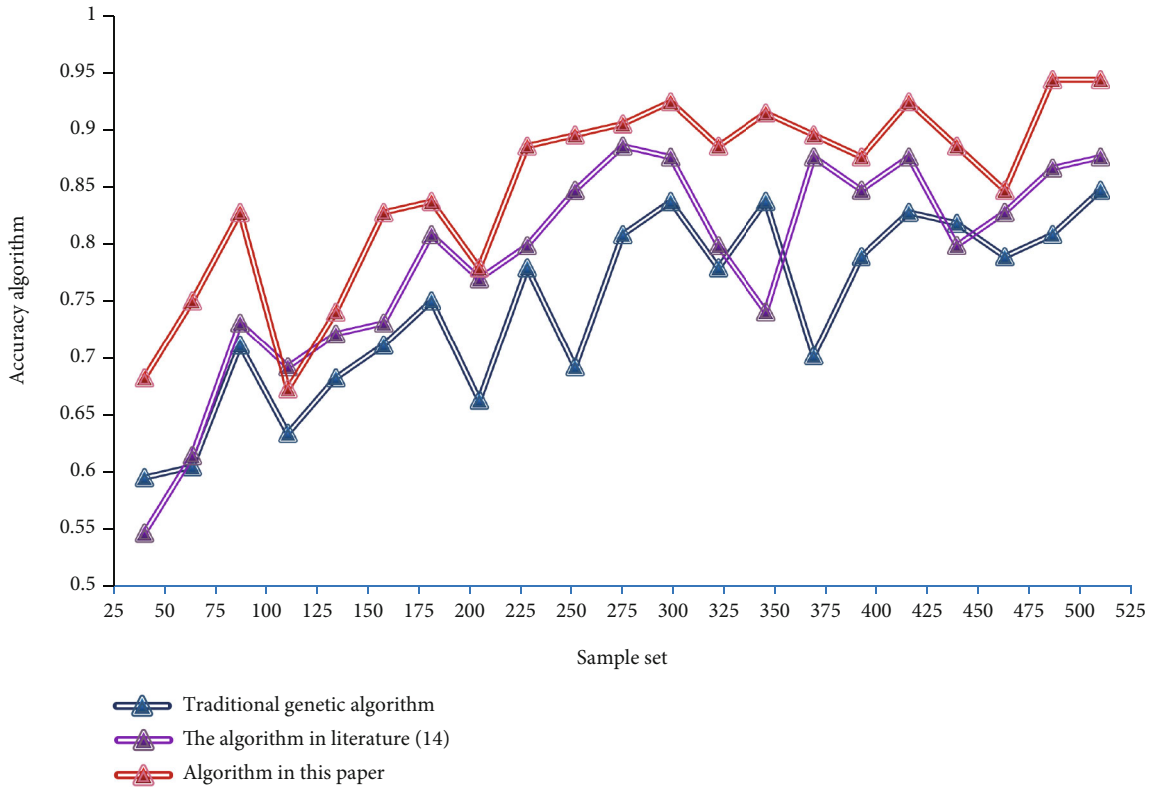

Figure 7: Accuracy comparison of different algorithms.

evaluation indexes are selected for evaluation. They are MSE (mean squared error), RMSE (root mean square error), and MAE (mean absolute error). The definitions of these three indicators are as follows:

$$\mathrm{MSE} = \frac{1}{n}\sum_{k=1}^{n}\left(y_k - y'_k\right)^2, \tag{8}$$

$$\mathrm{RMSE} = \sqrt{\frac{1}{n}\sum_{k=1}^{n}\left(\left|y_k - y'_k\right|\right)^2}, \tag{9}$$

$$\mathrm{MAE} = \frac{1}{n}\sum_{k=1}^{n}\left|y_k - y'_k\right|. \tag{10}$$

Among them, y_k is the actual value and y'_k is the model output value. The MSE experimental results of different algorithms are shown in Figure 5. The RMSE experimental results of different algorithms are shown in Figure 6.

According to the natural conditions and social and economic development, only by choosing a reasonable urban expansion mode can we ensure the development of the city and keep the openness of the open space. In this paper, sparse representation and superresolution reconstruction methods are used to visually recombine landscape ecological construction and spatial pattern optimization design, and interactive GA method is used to realize the fusion perception of urban ecological landscape information. In order to verify the effectiveness of this optimization algorithm, it is compared with other algorithms. In the

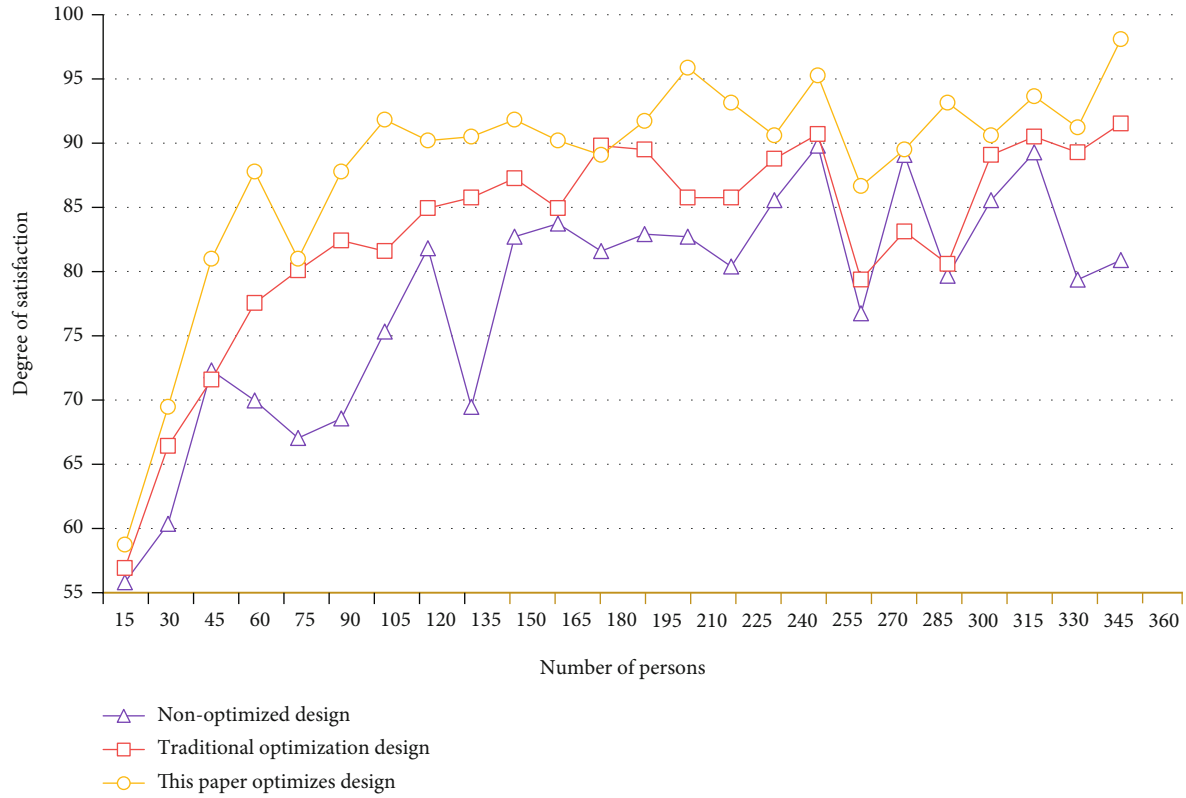

Figure 8: People's satisfaction after optimization of spatial pattern.

experiment, different methods were used to solve the optimal value, and the experiment was run independently for 50 times. The iteration times and running time of each evolutionary individual to find the optimal solution were recorded. The experimental results are shown in Table 2.

As can be seen from the data in the table, compared with other methods, this method always needs the least number of iterations and running time. This method has certain superior performance. The accuracy comparison of different algorithms is shown in Figure 7.

In this paper, combined with the fusion reconstruction method of fuzzy pixel regional features, the distribution pixel set of landscape ecological space environmental artistic features is obtained, and the information reconstruction and three-dimensional perception of landscape ecological construction and spatial pattern optimization design images are carried out to improve the environmental design ability. The area in the area is reasonably divided, and the maximum volume of the building is obtained by the combination of square columns, and the optimization process of this combination can be calculated by GA. The method proposed in this paper is used to optimize the spatial pattern of A city, and the degree of satisfaction is used to express people's recognition. Figure 8 shows people's satisfaction after optimizing the design of spatial pattern.

According to the data analysis, this method can effectively realize the optimal design of landscape ecological space environment, with high image recognition accuracy and improved design effect. This algorithm has a certain accuracy, which is 9.34% higher than the traditional GA. This result fully shows that the proposed method of building volume optimization based on NN and GA can effectively reduce the time consumption required to run the program without affecting the performance of the algorithm.

The simulation results of this section show that the quality of image visual reconstruction is good, the accuracy of image recognition is high, and the output signal-to-noise ratio of artistic feature reconstruction of landscape ecological space environment vision is high, which has a good effect of landscape ecological construction and spatial pattern optimization design.

5. Conclusions

In this paper, a landscape ecological construction and spatial pattern optimization design scheme based on NN and GA is put forward. In the process of image visual reconstruction of landscape ecological construction and spatial pattern optimization design, urban ecological landscape information fusion perception and block area template matching are carried out to realize urban ecological landscape design. Finally, simulation test and analysis are carried out. The simulation results show that the proposed algorithm has a certain accuracy, which is 9.34% higher than the traditional GA. This result fully shows that the proposed method of building volume optimization based on NN and GA can effectively reduce the time consumption required to run the program without affecting the performance of the algorithm. With this method, the quality of image visual reconstruction for landscape ecological construction and spatial pattern

optimization design is better, the accuracy of image recognition is higher, and the output signal-to-noise ratio of the reconstruction of artistic features of landscape ecological space environment vision is higher, which has a good effect of landscape ecological construction and spatial pattern optimization design. In recent years, with the development of remote sensing technology, it is easier and easier to obtain data with high spatial resolution and high spectral resolution. Selecting data with high spectral resolution can improve the accuracy of landscape classification, while data with high spatial resolution can analyze and study the details of landscape system. Therefore, it is worth further research and discussion to choose high-resolution basic data to analyze the urban landscape at different levels.

Data Availability

Data are available on reasonable request from the corresponding author.

Conflicts of Interest

The authors declare that they have no competing interests.

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