Research Article

The Application of Genetic Algorithm in the Optimal Design of Landscape Space Environment

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Garden landscape not only provides people with places of rest and entertainment, but also protects the natural environment and maintained ecological balance. Although the traditional garden architectural style could retain the classical landscape style, the modern garden facilities and conditions had been greatly improved, and people’s expectations for the construction level of garden landscape continued to improve. Therefore, the effect of traditional landscape design could no longer meet the requirements of social development. This article proposed an interactive genetic algorithm-based landscape space environment optimization design method, in order to provide a certain theoretical reference for landscape design. Firstly, by analyzing the relationship between landscape and buildings, the change in people’s demand for landscape space environment and the relevant characteristics of landscape, this article expounded on the basic principles and methods that landscape design should follow and gave the problems existing in landscape design. Secondly, the interactive genetic algorithm and its innovative design theory were summarized, and the optimization design method of garden landscape space environment based on interactive genetic algorithm was proposed. Finally, the evaluation index system of landscape spatial environment was constructed, and experimental analysis was carried out with a landscape design as a case. The results showed that compared with the traditional landscape design methods, the design scheme proposed in this article could achieve better evaluation results. The optimization design method of landscape space environment proposed in this article could provide some technical support and theoretical reference for landscape architecture and design.

1. Introduction

With the continuous development of the economy and society, people have higher and higher requirements for production, living, and working environment. As an important part of human settlements and social environment, the development of landscape environment has been widely concerned [1]. Influenced by the development and changes of the times, the current landscape design mainly includes modern landscape planning and traditional landscape planning. Different from traditional landscape design methods, modern landscape design methods and concepts have undergone great changes, for example, in landscape environment design, including landscape architecture, landscape space, landscape culture, and ecology. Although there are many categories of modern landscape architecture, and the design objectives are also different, due to the increasingly rational human concept and social development, the design concept of landscape architecture mainly follows the principles of saving and environmental protection and meeting people’s needs [2, 3]. Traditional landscape design methods have been unable to meet the requirements of modern people and social development. While building modern buildings, we need to consider the matching landscape needs, which undoubtedly brings great challenges to modern landscape space design.

As an important part of modern architectural complex, garden landscape can better provide people with conditions for rest and entertainment, and also provide a guarantee for protecting the natural environment and maintaining ecological balance. On the premise of maintaining the unity with nature, designers usually plan and design the landscape
according to various needs and limited space and environmental conditions. The traditional garden architectural style is more natural, and uses limited space to create the original landscape environment [4]. With the improvement of modern garden facilities and conditions, people's demand and experience for garden landscape are increasing. Therefore, the traditional garden landscape design concept has been unable to meet the requirements of social development.

At present, most garden landscape design is still relatively backward in concept, and designers lack certain innovative thinking. For example, some designers adopt the copying method to simply superimpose or combine the garden landscape materials in order to pursue benefits [5]. The existing landscape design schemes are often difficult to integrate with the development of urban landscape, which not only makes the implementation effect of landscape design boring and single, but also cannot reflect the regional history and culture through the landscape environment. Therefore, based on the innovative design thinking of interactive genetic algorithm, this article puts forward the optimization design scheme of landscape space environment, which provides some technical support for modern landscape design.

2. Related Works

According to the existing research, classical garden design is mostly based on the local environment, with significant regional and personality characteristics. Although the traditional garden landscape is relatively simple in style, it has certain characteristics in the inheritance and integration of culture [6]. For example, many well-preserved classical gardens in China not only record the evolution of society for thousands of years, but also reflect the national cultural characteristics of different periods. This unique garden landscape provides a good idea for promoting the process of social development and the design of modern garden landscape. With the development of the times, more and more deficiencies have been exposed in the design of traditional landscape architecture. Due to the continuous progress of people's understanding and thinking of society, the traditional garden landscape has been insufficient to meet people's various needs [7, 8]. For example, modern architecture requires that the matching garden landscape environment be no longer limited to inheriting history and culture, but needs to meet people's experience of nature and ecological environment. Therefore, the traditional garden landscape design concept must be updated simultaneously.

In a broad sense, garden landscape space means that people experience the space environment of architectural groups through living activities in the living environment, so as to obtain the psychological and physiological satisfaction of the space environment. Landscape space combines space environments of different sizes and forms an environmental system with a certain structure [9]. Therefore, garden space is a broad concept, including landscape space planning, landscape space environment construction. Research shows that the planning of garden landscape space usually needs to consider people's perception and utilization of space functions and the relationship between them. Most research results show that the construction of landscape space environment should not only consider the layout, form, and function of landscape space, but also combine specific user requirements, existing conditions, and functions to create different levels of space environment for people.

The design of garden landscape needs to follow people's various perceptual needs. Generally, people's perception of landscape space mainly includes static and dynamic [10]. The so-called static perception refers to the various cognitive conditions of landscape space under static conditions. Due to the differences in the size, shape, and color of landscape space at all levels, people have different feelings about landscape space. Therefore, people's static perception of landscape space is usually not limited to spatial entities, but the real impression of spatial components. Designers usually make appropriate adjustments to the landscape space according to people's behavior and use needs [11]. The so-called dynamic perception refers to people's cognition of spatial sequences at different levels. Generally, people's cognition of landscape spatial sequence in the process of sports is related to people's psychology, mood, and other factors. For example, the size, shape, and other elements of landscape space will continue to change with human movement factors, thus affecting people's cognition of landscape space.

Garden space design is a systematic project, in which the landscape forms different visual effects with various functions and styles, and comprehensively reflects the style of garden landscape environment. The research shows that the design of landscape spatial environment cannot be limited to the innovation of landscape individuals, but needs to integrate the landscape environmental design concept into the whole landscape space [12]. The effective integration of individuals into the garden environment system can not only reflect the overall landscape effect, but also realize the function and value of the garden landscape space environment. Some scholars believe that in landscape design, landscape individuals cannot be concentrated in a limited space environment, but can simplify the design of landscape morphology and appropriately increase the dependence and coexistence between different landscape individuals. In the design of garden landscape space, we should not only consider the individual characteristics that constitute the landscape form, but also take into account the correlation between different landscape individuals in terms of function and form, so as to make the garden landscape become an indivisible whole.

3. Basic Theory of Landscape Space Design

3.1. Overview of Garden Landscape

3.1.1. The Relationship between Landscape and Buildings. As the public infrastructure of human life, garden landscape is a combination of garden, green space, landscape, and environment, which can be considered as the art of human living space. On the basis of traditional gardens, through
artificial landscape environment decoration, natural gardens can stand in the landscape environment, thus forming a symbiotic space environment between nature and human beings, so as to meet people’s material life and spiritual needs. As a part of garden landscape, architecture is not only used to meet people’s living conditions, but also can provide people with a place for rest and entertainment [13]. The shape of the building and the surrounding landscape, green space, vegetation, and so on together constitute the landscape environment for human survival. Although buildings occupy a small space in landscape gardens, they can add human wisdom and art to nature, so that natural gardens can not only become a material landscape for human appreciation, but also become a symbol of people’s pursuit of a better life.

The role between buildings and landscape is irreplaceable. They integrate with each other and together form a part of people’s production and life. Although the landscape individuals are separated by various buildings in space, if the landscape individuals are not accompanied by buildings, human society may return to its original natural state. On the contrary, if there is a lack of garden green space and landscape environment between buildings, even if the city is full of high-rise buildings, human society is bound in some lifeless small blocks, and a single space makes people’s psychology and physiology vulnerable to all kinds of depression. Therefore, buildings and natural landscapes are interdependent and complement each other. The coexistence of garden landscape and modern architecture is not only necessity for the development of human society, but also a symbol for people to explore and create nature.

3.1.2. Human Demand for Space Environment of Garden Landscape. As the main body of buildings and landscape, there is a certain interactive relationship between human beings and the spatial environment of landscape. People’s perception of the environment is a comprehensive reflection of the response to the needs of various factors, including people’s physiological needs, safety needs, social needs, and self-realization needs [14]. As shown in Figure 1, it describes the hierarchical relationship of human needs for the environment. People’s demand for the environment is not limited to the quality of the landscape, but to consider the various needs of the garden space at the same time. As shown in Figure 1, it describes the level of human demand for the spatial environment of garden landscape.

3.1.3. Characteristics of Garden Landscape. Unlike natural landscape or ecological scenic spots, garden landscape has similarities with urban landscape or rural landscape, but it has some characteristics of its own [15]. Firstly, the garden landscape has diversity in terms of its constituent elements. Garden landscape is composed of multiple elements, including tangible, intangible, natural, and man-made elements. Factors such as road arrangement or structure are the main part of garden landscape. Secondly, the landscape is multidimensional from the perspective of time and space. Because the garden landscape has infinity in space and continuity in time, the garden landscape has a multidimensional nature of time and space. Thirdly, from the perspective of the main body of the evaluation, the landscape has multidirectionality. Because the design goal of garden landscape has certain directivity, and the evaluation subjects of garden landscape may come from different groups, such as residents, travelers, or operators, the construction of garden landscape often seeks a balance from different groups, that is, to meet the needs of different evaluation subjects as much as possible. Finally, the garden landscape is diverse in terms of the composition of the environment. Different from the design objectives and styles of other works of art or decorative pieces, garden landscapes usually have their own design styles or organizational structures according to their own characteristics to meet the culture, customs, and people’s living needs of social development.

3.2. Basic Principles and Methods of Landscape Design

3.2.1. General Principles to be Followed in Landscape Design. When designing the garden landscape, we need to start from people’s needs and follow certain design principles. The main thing is to design according to people’s different sensory needs of the landscape environment. People’s experience of garden landscape space is formed through the perception of the external environment by different organs of the human body. In the design of garden landscape, it is necessary to integrate human vision, hearing, touch, and other different senses into the garden space, so that the designed landscape can fully meet people’s various needs [16]. As shown in Figure 2, the principles that should be followed in landscape design are given.

The design of garden landscape is to create a favorable activity space for people’s leisure and entertainment. People can perceive the whole landscape space environment through their own senses. Among them, when people enter a certain garden landscape, the eye is the main organ to perceive the landscape form. The perception of the whole landscape environment is first completed through vision, and from it, they experience various elements of the landscape, such as the shape, color, light, and shadow of the landscape.
As an important part of garden landscape, auditory landscape mainly senses all kinds of noises from the external environment through the human ear. Although the scope of the landscape perceived by hearing is less than that of visual space, hearing can not only make people truly feel the landscape environment, but also bring surprise and pleasure to people. Because modern urban life is full of all kinds of noisy sounds, and gradually makes people lose all kinds of primitive scenes endowed by the natural environment, people are eager to perceive the sounds from nature in their spare time, and seek a quiet and relaxed life by listening to the sounds of the garden landscape space environment. For example, in the landscape space environment, the sound of running water, bird calls, and so on can cause the auditory resonance of tourists, so that people can immerse themselves in the natural landscape environment.

The smell produced by the landscape space in the garden environment can make people use their sense of smell to feel the existence of nature. The fragrance of garden landscape in the space environment forms a pleasant microclimate. It not only enables people to obtain a suitable resting environment through appropriate temperature and humidity, but also integrates human beings with the environment, making people feel extremely happy. Among the constituent elements of the landscape, plants, as the soul of the landscape environment, can interact with nature through photosynthesis and adjust the space and climate environment of the landscape, so as to improve people’s olfactory needs for the landscape environment. In the garden landscape design, we can plant some Osmanthus fragrans lour, lilies, camphor trees, and other plants to beautify the surrounding environment and create a happy living and leisure place for people.

Garden landscape environment not only needs ornamental plants, but also needs to create conditions for people’s experience needs on the tip of the tongue. In order to meet the needs of people picking fruits in nature to obtain taste, some plants with melons and fruits can be planted in the garden landscape. Therefore, in the landscape design, we can provide an experience park for people to pick delicious food, and plant some fruit trees for people to watch and appreciate, so that people can feel that they are returning to the natural life of the countryside. In addition, in terms of landscape environment design, people can also feel close contact with nature through various landscape modeling, species, and other elements, so that people can feel that they are actually from nature.

3.2.2. Common Methods in Landscape Design. In landscape design, path planning is very important for the design of space environment. Because people mainly feel the garden space through the path, the design of the path in the garden landscape includes the garden square, green space, water corridor, and other landscape elements in addition to the road. In garden landscape, the path can reflect the overall space of the landscape. People’s vision can form different observation angles with the change of the path, and then feel the changes brought by the whole garden space. Because the path is composed of multiple elements in the landscape, the path can connect various landscapes into a continuous spatial environment. Taking the path as the main line of viewing, people can organize scattered landscapes into a continuous garden space according to the sequence of activity time. At the same time, the path can help people plan their own viewing clues. With the changes of landscape topography and space, it is easy for people to find their own position and direction in the garden landscape, so that they can quickly become familiar with this garden environment.

From the perspective of garden space, a single space design is mainly surrounded by boundaries. Some boundaries of garden space are relatively clear, while others are not clear enough. The scale of garden space is usually formed by the height and length of the boundary. For example, plants, buildings, or terrain in the landscape can form the height of the boundary, and the distance from the viewer’s viewpoint to the boundary object can form the length of the boundary. According to the existing landscape space design research, the size of the garden space mainly depends on the ratio of the length and height of the boundary [17]. For example, spaces dominated by garden buildings are generally designed with a smaller ratio, while spaces dominated by trees or terrain are generally designed with a larger ratio. As shown in Figure 3, the effect of the relationship between human visual angle and landscape space is described.

In landscape design, nodes, as some core parts of the landscape, are the focus of attention in the space environment. If there is a lack of nodes in the landscape space, it will make the garden space lack highlights. The node can be an independent entity or a combination of multiple entities in the landscape, and its location is arbitrary, for example, it can be located inside and outside the space or on the boundary. Nodes and paths together constitute a part of garden space. People can not only change the state of garden space, but also make people feel that the environment is changing by adjusting the location of nodes or the shape of paths. In addition, as the core part of the landscape, signs are the most attractive and symbolic nodes of all landscape elements, usually located in the most prominent position of the landscape space [18]. The design of garden landscape needs to meet people’s various needs. Among the elements of garden landscape, people usually pay most attention to the
symbols of garden landscape. Signs are generally set reasonably according to the distribution of landscape space, roads, and other elements. For example, sculptures, pools, and other landmarks that can enhance the attractiveness of garden landscapes need to consider a variety of factors in the design, so that people can be quickly attracted by landmarks when viewing the landscape environment.

As shown in Figure 4, it describes the comparative effect of the location relationship between garden terrain, buildings, landscape, and people.

3.3. Problems in Landscape Design. Affected by the traditional landscape structure, some designers may lack innovative thinking and blindly follow the inherent garden space mode in the design of modern garden landscape, resulting in the mismatch between landscape design and modern architecture. In order to pursue the economic benefits of landscape, some designers violate the essence of landscape design. The use of some inferior materials not only makes the landscape effect unable to meet the ornamental requirements, but also fails to improve the spatial environment of landscape. In addition, in order to pursue artistic conception innovation, some designers unrealistically formulate landscape design schemes, which not only makes the scheme difficult to implement, but also causes a waste of resources.

In terms of landscape space and environment design, it is still not enough to integrate human demand elements into landscape design. According to the existing research results, at present, due to the lack of theoretical guidance of landscape designers in landscape design, some designers often design according to their own experience or ideas, resulting in the landscape design effect being difficult to meet people’s various needs. From the existing landscape design research, designers can fully consider people’s physiological needs, psychological needs, and behavioral habits. At present, many landscape designs do not consider the various needs of human scale, which makes the designed landscape environment difficult for people to achieve expectations and happiness.

In addition, in the current landscape space environment design, there are still many problems in the greening, facilities, and characteristics of the landscape. As an important embodiment of landscape effect, greening is a very important element to create a landscape space environment. The greening effect is often related to the invested funds, local climate and environment, and other factors. Therefore, in order to reduce costs or ignore the limitations of local climate conditions, some designers ignore the greening elements in landscape design, resulting in the lack of natural ecological elements in the landscape space environment, which affects people’s leisure and entertainment. The lack of rockeries, fountains, scenic pavilions, and other facilities in the garden landscape, or the unreasonable scale of the facilities, to a certain extent, not only affects the layout of the landscape space, but also makes the garden landscape environment single. As shown in Figure 5, the comparative effect of different proportional relationships between human visual distance and landscape space height is described.

4. Using Interactive Genetic Algorithm to Optimize the Space Environment of Landscape Architecture

4.1. Interactive Genetic Algorithm and Its Innovative Design Theory. Genetic algorithm (GA) is a method used to simulate the genetic and evolutionary processes of related organisms in nature [19]. As an adaptive global optimization method, genetic algorithm is often used to solve some complex system optimization problems. A basic genetic algorithm is usually composed of scheme coding, fitness function solution, operator selection, and other elements. When applying genetic algorithm to solve specific optimization problems, we first need to encode the actual problem and form the corresponding chromosome for computer data processing. Common coding schemes include binary coding, real coding, and tree structure coding. After using genetic algorithm to obtain the target solution of the problem to be optimized, the result needs to be decoded in order to convert it into the corresponding actual optimization solution.

It is known from the evolution process of organisms that individuals with strong adaptability to the environment can continue to reproduce and survive. On the contrary, the organism cannot reproduce or be eliminated by the
environment. In order to reflect this biological law, the fitness function is used in genetic algorithm to calculate the adaptability of biological individuals to the environment, and it is used as the optimization condition. Fitness function is very important for the implementation of genetic algorithm, and directly affects the efficiency of the algorithm and the search for the optimal solution. The construction of fitness function can be determined according to specific problems. For example, for simple optimization problems, the fitness function can be set as the problem to be dealt with, while for complex landscape spatial environment optimization problems, it is necessary to consider the constituent elements of landscape at the same time, so as to construct the fitness function.

In order to reasonably construct the fitness function to meet the needs of different evaluation subjects, interactive genetic algorithm (IGA) can be used to construct the fitness function on the basis of traditional genetic algorithm [20]. Due to the increase in user participation in the interactive genetic algorithm, the user’s evaluation value of individuals can be used as one of the parameters to construct the fitness function, which is also the advantage of interactive genetic algorithm.
algorithm in innovative design. New individuals generated by machine learning need to be evaluated by users, and then the machine recalculates the fitness of these individuals based on the user evaluation results and using the fitness function. As shown in Figure 6, it is a basic structural diagram of interactive genetic algorithm.

Selection operator is used to simulate the evolution of organisms in the natural environment. The fitness function can be used to obtain the adaptability of individuals to the environment, and the selection operator can be used to select individuals who are able to continue to evolve. In order to avoid local optimization and make the individual evolution process diverse, we can enhance the search scope of the algorithm. For example, by adding a probability factor to the search algorithm, the probability that individuals with strong adaptability will be selected is greater, and the probability that individuals with weak adaptability will be eliminated is greater.

When using the selection operator and selecting different individuals according to fitness, two individuals with small fitness difference can be crossed with a larger probability and the corresponding selection probability can be calculated [21]. The selection probability of the \( j \)-th individual can be expressed as follows:

\[
f_j = \frac{s_j}{\sum_{k=1}^{m} s_k},
\]

where \( m \) is the number of genetic individuals and \( s_j \) is the fitness of the \( j \)-th individual.

If \( s \) is used to represent fitness and \( s_j \) is relative fitness, the cumulative fitness \( s'_j \) can be expressed as follows:

\[
s'_1 = s_1,
\]

\[
s'_{j+1} = s'_{j+1} + s_j, j \in [2, n].
\]

When individual \( j \) is selected, its random number \( r \) must meet the following conditions:

\[
\begin{align*}
0 \leq r < s_{ij}, & \quad j = 1, \\
s_{ij} \leq r < s_{i(j+1)}, & \quad j \in [2, n], \\
s_{ij} \leq r < 0, & \quad j = n.
\end{align*}
\]

According to the above algorithm, all individuals are selected in turn. When selected, they are removed from the candidate population, and then the relative fitness and cumulative fitness of the remaining unselected individuals are calculated. After each round of selection, the number of next-generation groups and contemporary residual groups should be compared until the number of next-generation groups reaches a specified value, and the selection operator will not be repeated.

Whether the individual obtained by genetic algorithm is optimal or not also needs to be evaluated by using the relevant evaluation system. In order to build a more scientific evaluation system, interactive evaluation method can be used [22]. Because users participate in the evaluation, it is necessary to add user factors to the calculation of individual fitness, and the machine mainly realizes the substantive evaluation of individual fitness through automation.

In the substantive evaluation of individual fitness, the substantive examination result \( u \) can be described by the following formula:

\[
I_u = \begin{cases} 
0, & (u + v = 0), \\
\frac{2uv}{u + v}, & (u + v > 0), 
\end{cases}
\]

where \( u \) represents the practicability of the individual, \( v \) denotes the innovation of the individual, and \( u \) is the harmonic average of \( u \) and \( v \).

In order to realize the objective evaluation of individuals, it is necessary to adopt the method of interactive evaluation between users and machines. In the process of interactive evaluation, users and machines constantly screen the practical ability and innovative ability of individuals. Among them, the individuals removed from the population will no longer participate in genetic evolution. At the same time, the result \( I_u \) of each interactive evaluation is recorded, and the result will be automatically added to the training set of the classifier, so that the machine has adaptive ability to the evaluation results.

Through the substantive evaluation, interactive evaluation, and automatic evaluation of individuals by machines, the corresponding evaluation values can be obtained. Thus, the fitness function of an individual can be constructed as follows:

\[
s = al_{u} + \frac{\beta l_{f} + y l_{g}}{10},
\]

where \( l_{u} \) is the result of machine automation evaluation, and \( a, \beta, \) and \( y \) represent the weights of \( l_{f}, l_{u}, \) and \( y \) in turn, which are also parameters of interactive genetic algorithm. Due to \( 0 \leq l_{u} \leq 10 \) and \( 0 \leq l_{g} \leq 10 \), it is necessary to normalize them.

As shown in Figure 7, it is the schematic diagram of interactive genetic algorithm module relationship.

4.2. Landscape Environment Optimization Based on Interactive Genetic Algorithm. Because garden space involves many elements and their combinations, such as paths, boundaries, nodes, signs, and so on, each element can be parameterized or characterized in order to optimize the garden landscape space environment by using interactive genetic algorithm. Although feature processing is superior to parametric design to a certain extent, improper feature selection will directly affect the efficiency and landscape effect of landscape design. Parameterized intelligent processing is conducive to optimizing the design scheme. Different design schemes are compared by solving multiple parameters, and then the optimal scheme of landscape design is obtained. Considering that different users have certain subjectivity in the evaluation of landscape design effect, and different evaluation standards will affect the final effect of landscape design, parametric modeling and human-computer interaction can be adopted. Landscape designers can finally achieve the ideal design effect by adjusting parameters when designing the landscape space environment.
It is advisable to adopt the set $D$ of morphological parameters to express the space and environment design of garden landscape, and its form is as follows:

$$D = \{d_1, d_2, \ldots, d_N\},$$

where $D$ is the set of landscape spatial morphological parameters and $d_1, d_2, \ldots, d_N$ are the relevant morphological parameters defined by the landscape designer.

An $N$-dimensional solution space can be constructed from the definition domain of relevant morphological parameters in formula (6). The design process of garden landscape is actually how to find the optimal solution from this space.

Using interactive genetic algorithm can let designers participate in solving the problem of seeking fitness function. Since the idea of the designer is included in the process of problem-solving, the choice of fitness function can be evaluated according to the idea of the designer. Then, with the help of the advantage of genetic algorithm in searching the optimal solution, the final scheme of landscape architecture design can be matched with the personal concept of landscape architects. Affected by the number of population, in order to search the optimal solution comprehensively, quickly, and accurately, genetic algorithm usually requires individuals to provide easily perceived parameters to designers [23]. Therefore, layer-by-layer solution method can be adopted. As shown in Figure 8, it is the schematic diagram of the layer-by-layer optimization search solution model.

In the layer-by-layer optimization search and solution model, the solution space of landscape design is coded and divided into $M$ layers. Using this hierarchical optimization model, in the corresponding sub-solution space of each layer, the problem to be solved is searched and solved by the interactive genetic algorithm with the participation of designers, and the solution results are treated as the sub-solution space of the next layer. Then, the same method is used to repeat the search and solution process until all parameter values are no longer changed. At this time, the optimization design process of the whole landscape space environment is over.

After dividing the landscape morphology parameter set in formula (6) into $M$ layers, its form is as follows:

$$\begin{align*}
D_1 &= \{d_1^1, d_2^1, \ldots, d_N^1\}, \\
D_2 &= \{d_1^2, d_2^2, \ldots, d_N^2\}, \\
&\vdots \\
D_M &= \{d_1^M, d_2^M, \ldots, d_N^M\},
\end{align*}$$

where $D = D_1 \cup D_2 \cup \cdots \cup D_M$, $N = N_1 + N_2 + \cdots + N_M$. 
In order to search and solve the landscape morphological parameters layer-by-layer, it is necessary to determine the weight of each morphological parameter, which represents the influence or importance of the morphological parameters in the design scheme. When determining the weight of each morphological parameter layer-by-layer, the larger the parameter weight value, the priority should be given [24]. At the same time, other relevant parameters adjust their weight values accordingly through adaptive methods. The weight coefficient $\lambda_k$ of morphological parameters can be expressed as follows:

$$\lambda_k = \frac{\delta_k}{\epsilon_k},$$

where $\delta_k$ indicates the standard deviation of the parameter weight curve, $d_i^k$ represents the mean value of the parameter weight curve, $d_i$ is the number of times that the value of parameter $k$ is selected in the $i$-th interval, and $N_k$ is the number of times that parameter $k$ is selected.

The parameter value $d_{k,\text{max}}$ at the peak position of each parameter weight curve can be expressed as follows:

$$d_{k,\text{max}} = d_k|D=\text{max}.$$  

According to the above method, the weight values of all morphological parameters can be calculated, and then they can be sorted. Finally, the parameters required for the optimized landscape design scheme can be obtained, and their forms are as follows:

$$D_t = \{d_1, d_2, \ldots, d_N\},$$

where $D_t$ is the sorted set of garden landscape morphological parameters and $d_1, d_2, \ldots, d_N$ are the results of arranging the parameters in the initial design scheme according to their weight $\lambda_k$ from large to small.

### 5. Experiment and Analysis

In order to test and evaluate the scheme proposed in this article, we might as well take a garden community that has not been optimized as the object, and use the garden landscape space environment optimization design scheme based on interactive genetic algorithm proposed in this article to plan, and get the corresponding design effect. As shown in Figure 9, the comparison results of the effects before and after the optimization design of the garden landscape space environment are given.

In order to facilitate the objective and comprehensive evaluation of the optimized landscape design effect, it is necessary to establish the evaluation system of the landscape space environment. The evaluation system is composed of three levels of evaluation indicators: target level, system level, and index level, as shown in Table 1. According to Table 1, the target layer as the first level evaluation index is mainly the landscape space environment, while the system layer as the second level evaluation index mainly includes landscape elements, plant greening, landscape layout, landscape space, etc. Then, several corresponding observation points are set according to each second level evaluation index.

According to the established evaluation system, the evaluation value of the landscape design effect is obtained by issuing questionnaires and behavior observation to different groups in turn during the experiment. According to the survey results, each observation point in the index layer is assigned a value. Firstly, the evaluation value of the investigator on the observation point is calculated, and the assignment is multiplied by the weight of the corresponding observation point. Secondly, sum up the evaluation values of all indicators in the system layer to obtain the evaluation values of the system layer. Then, the evaluation value of the target layer can be calculated according to the evaluation value of the system layer and the corresponding weight, which is the comprehensive evaluation value of the design effect of the garden landscape space environment. As shown in Table 2, according to the evaluation value and corresponding weight of the system layer, the comprehensive evaluation value can be calculated as 3.0807.

In order to further show the superiority of the method proposed in this article in the design of garden landscape space and environment, the traditional garden landscape...
design method was comprehensively compared with this method in terms of relevant evaluation indicators during the experiment, as shown in Figure 10. According to the comparison results reflected in Figure 10, the results of each evaluation index of landscape obtained by using the method proposed in this article are better than the traditional landscape design methods, indicating that this method has obvious advantages.
Evaluation results

Figure 10: Comparison of evaluation results on relevant indicators between traditional landscape design methods and this method.

6. Conclusion

With the continuous development of economy and society, the traditional landscape design concept had been unable to meet the growing needs of people. There was a simple repetition in the design of modern garden landscape space environment, which was lack of certain innovation. Therefore, based on the innovative design theory of interactive genetic algorithm, this article proposed an optimization design method of garden landscape space environment. Based on the analysis of the relationship between garden landscape and buildings, the change in people's demand for garden landscape space environment and the relevant characteristics of garden landscape, this article expounded the basic principles and methods of garden landscape design, and expounded the common problems in garden landscape design. This article summarized the interactive genetic algorithm and its advantages in innovative design, and put forward the optimization design method of garden landscape space environment based on interactive genetic algorithm. Finally, taking a garden landscape design as an example, the evaluation index system of garden landscape space environment was constructed. Through experimental analysis and comparison, the results showed that compared with the traditional garden landscape design methods, the garden landscape space design scheme proposed in this article had achieved better evaluation results. The method proposed in this article not only has certain guiding significance for urban garden planning and modern architectural design.

Data Availability

The labeled data set used to support the findings of this study can be obtained from the author upon request.

Conflicts of Interest

The author declares that there are no conflicts of interest.

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