Modular Information Fusion Model of Urban Landscape Design Based on Genetic Algorithm

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***Abstract*—In the process of continuous development of urban landscape design, with social progress, scientific and technological level and other factors, people have a new understanding of natural phenomena, geographical environment and human activities. For the city, its basic function is to meet the harmony between man and the natural environment. Therefore, this paper designs the modular information fusion model of urban landscape design based on genetic algorithm. Firstly, this paper expounds the function, characteristics and design principles of urban landscape design. Then, the principle and related application of genetic algorithm are introduced. Based on the algorithm, a modular information fusion model of urban landscape design is designed, and the model is tested by simulation experiment. Finally, the test results show that the performance of the modular information fusion model of urban landscape design based on genetic algorithm is very excellent, which can show that the model can meet the needs.**

Keywords—genetic algorithm, urban landscape design, information module, module fusion model

I. Introduction

Urban landscape design is a very complex process, which not only includes planning, construction and management, but also involves many aspects such as culture and art. With the acceleration of urbanization, the change of regional spatial development pattern and the adjustment of development direction, various resource and environmental problems have become increasingly prominent [1-2]. Therefore, the impact of natural factors on the overall system function must be considered in the comprehensive research.

Many scholars have conducted relevant research on urban landscape design. Domestic research on urban landscape design began in the 1990s. After putting forward the concept of "Regionalization", China will deeply discuss and analyze the module and apply it, so as to achieve the goal requirements of unity and coordination, operability and easy management. Initially, due to the lack of theoretical and practical experience, all aspects were also deficient [3-4]. However, with the continuous strengthening of China's foreign exchanges since the reform and opening up and the exchange and communication of relevant research results by some foreign scholars, a relatively complete, systematic, scientific and reasonable design criteria system has gradually formed, which can be applied to the development and construction of various urban complexes. It runs well and has certain economic benefits and social environmental effects [5-6]. In view of this, this paper designs the modular information fusion model of urban landscape design based on genetic algorithm.

Urban landscape design is a complex and systematic project. It not only needs to consider the adverse impact of natural factors on human beings, but also fully reflect the designer's own aesthetic consciousness. Based on this background, a Garden comprehensive benefit model composed of genetic algorithm theory and information theory is proposed.

II. Discussion on Modular Information Fusion Model of Urban Landscape Design Based on Genetic Algorithm

A. Urban Landscape Design

1) Function

Urban landscape design is a complex, multi-level and diversified development process. Its main purpose is to create a good environment through the influence of natural factors and human activities. The main purpose of urban landscape design is to make an artistic and systematic plan that can not only meet people's needs in material and cultural life, but also reflect the coordination of natural ecology, make maximum use of limited resources and protect the natural environment. It is conducive to the mutual adaptation between human and ecological environment. Each biological community in the ecosystem will decline or die more or less affected by environmental factors. Urban landscape design can make each part of the system react when human socio-economic activities interact with natural geographical conditions, so as to achieve a balanced state. Through the influence of natural factors and human interference, it creates a unique charm with a certain scale and quality, which can reflect the combination of local regional culture, history and reality. Urban landscape design can also maximize the overall optimal benefits by integrating information into a specific combination, so as to obtain the highest value point of comprehensive effects such as high work efficiency and social and economic value in a large space [7-8].

2) Features

Urban landscape design is regional. Urban landscape design is mainly based on the regional natural characteristics and socio-economic conditions, and on the full understanding of the local natural environment, cultural environment and customs. There are obvious differences among cities in the same region. For example, in the eastern coastal zone of China, there are many and more developed rivers and flat terrain. In some economically backward and inconvenient places in the central and western regions, because the terrain is low and not easy to be affected, it is often developed into tourist attractions or a regional cultural

identification area for tourism, which makes the landscape design of each region richer, more diverse and unique [9-10].

Urban landscape design is cultural. Different regions and the same region have unique regional characteristics. These unique regional conditions and cultural environment will be reflected through their own ways of expression, which shows that all types of cities form common values and aesthetic interests in the process of social and economic development. As the legacy of history is one of the most important components of China's traditional aesthetic system, various historical background materials contained in different regions, as well as the contents related or generated or changed, developed and continued.

Urban landscape design is sustainable. Urban landscape design is a continuous work. In the implementation, we need to constantly solve the problems in the process of planning and management. The long cycle and large scale of urban construction projects may lead to multiple influencing factors in a region. Looking at the problem from the perspective of ecology is to ensure that social and economic activities can meet the requirements put forward by people or have been implemented without damaging the environment. At the same time, they should also have good and perfect resource utilization rate, high resource recovery rate and renewable land utilization, so as to realize the harmonious coexistence and coordinated development between man and nature [11-12].

3) Design principles

Urban landscape design is a very complex system, which involves multi-disciplinary knowledge. After the preliminary design scheme and planning calculation, in order to ensure the principles of data exchange, information sharing and coordination among various modules, the following principles must be followed:

(a) Overall principle. The overall function realization and the overall order of each subsystem shall meet the expected requirements without affecting the normal operation of other modules. In urban landscape design, we should make overall consideration, reasonably allocate resource allocation and ecological protection. In the process of combinatorial optimization, the unbalanced relationship formed by the mutual influence and restriction of various factors in the region should be fully considered. This requires us to have a whole, unified and scientific coordination of the whole system environment. At the same time, it should be determined according to different regions, the same type and regional differences.

(b) Scientific principle. The urban landscape design scheme must meet the requirements of relevant national laws, regulations and standards. The environmental quality indicators of the selected plot should cover the urban green belt. The selected land type is appropriate and has no impact on the ecological environment. It should also reflect certain differences in meeting functional and ecological needs. Urban landscape planning is a very complex and challenging and innovative project, which must be based on certain theories, We should grasp the overall law and the relationship between various parts from the overall situation, and also consider the role of objective factors such as natural conditions and climate environment in the whole process, as well as various influencing factors related to construction land and their mutual coordination degree. In addition, we should make full use of existing resources and solve the problem of urban future development planning.

B. Genetic Algorithm

1) Principle

Genetic algorithm is a natural evolutionary computing model. It transforms the complex, diverse and differential problems in the biological world into a system that contains several data structures and features that are interrelated, and can adapt to a variety of operating environments. It has strong ability and good global optimization characteristics. It combines the representative individual gene groups in the population through selection, crossover and mutation, so as to produce the population. According to the theory of biological evolution, after the survival of the fittest in nature becomes a natural person, a series of individuals with special ability structure, different degrees of characteristics or states will be formed. These are redefined and used to study the relationship and variation law between random phenomena and systems. Simulated annealing problem plays a very key role. It can solve some important problems, such as the dynamic behavior of genetic diseases and degenerative systems and some complex and orderly processes. It is one of the irreplaceable technologies in the biological evolution theory of gene function with great significance.

2) Relevant application

Genetic algorithm is a random search method that simulates biological evolution and natural selection. By cross coding two or more species, it retains only one gene per individual in the population.

(a) Simple adaptation function

The construction of simple adaptation function is very simple. If f (x) is the objective function, the adaptation function can be taken as:

$$\text{fitness}(x) = f(x) \tag{1}$$

$$\text{fitness}(x) = M - f(x), M > \max_{x} f(x) \tag{2}$$

The optimization target value of equation 1 is the maximum value. The optimization target value of equation 2 is the minimum. It can be seen that this construction method is directly related to the objective function and has the advantage of simple construction.

(b) Sorting adaptation function

The M chromosomes in the population are arranged in ascending order according to the objective function value, and their corresponding distribution probability is:

$$p(i) = \frac{2i}{m(m+1)}, 1 \le i \le m \tag{3}$$

In this way, the premature problem of some fitness functions is avoided, and the optimal individual of each generation is inherited with the greatest probability.

C. Effect of Genetic Algorithm on Modular Information Fusion Model of Urban Landscape Design

In urban landscape design, there are many factors that will affect the information fusion system, such as climate, landform and geological environment. Therefore, these elements need to be taken into account before the establishment of urban landscape modular model. Generally, to build a comprehensive index system including various parameters and their mutual relationship and synergy, it is necessary to preliminarily collect the data source types such as spatial attribute variables, hierarchical index values and change trends in the area to be studied and form the original data. Then the difference between the initial population and individual is determined by adaptive genetic algorithm. Secondly, through a certain scientific method, it is determined that there is a certain stable relationship between the variables, and this relationship is clarified, and its coordination degree is measured accordingly to form a multi-attribute information fusion system. According to the number of new species groups generated under different parameters in different periods, it provides a standard dimension and measurement scale interval for the subsequent modular information fusion model of landscape design.

III. Experiment of Modular Information Fusion Model of Urban Landscape Design Based on Genetic Algorithm

A. Modular Information Fusion Model of Urban Landscape Design Based on Genetic Algorithm

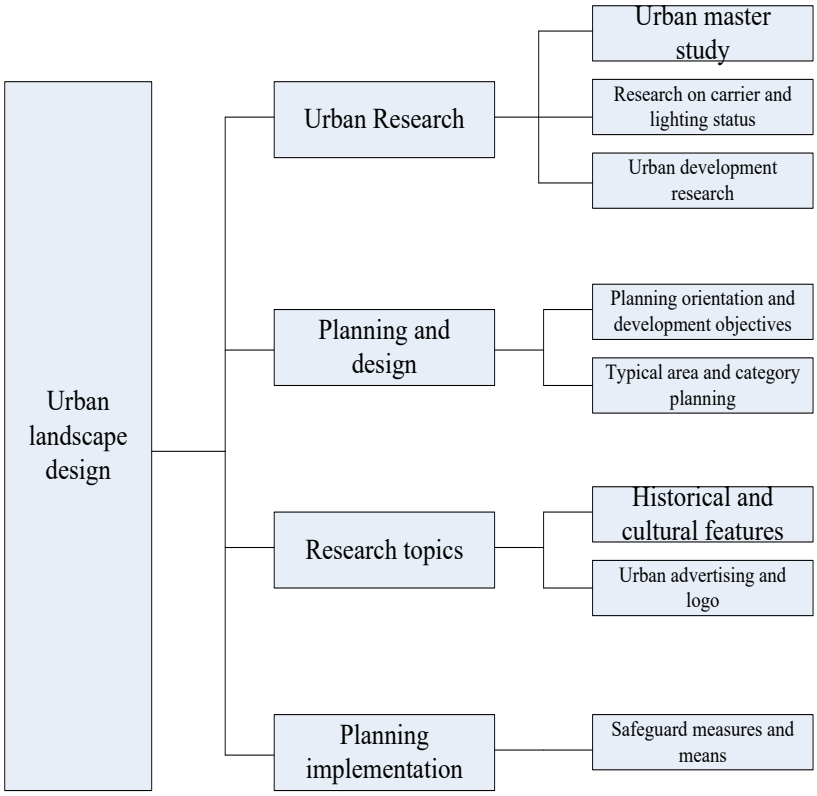

Figure 1. Modular information fusion model of urban landscape design based on the genetic algorithm

As can be seen from Figure 1, the urban landscape design information fusion model based on genetic algorithm decomposes it into multiple sub modules, and then realizes the objectives of each subsystem by integrating the data between each system module. In this model, it is necessary to determine a standard and specification to guide the advantages and disadvantages of different schemes and different design schemes. Modularization of urban landscape design is to decompose a complex system into several parts with independent functions. Each module is interrelated and interacts with each other to form a coordinated and unified comprehensive management system. The model comprehensively considers the genetic algorithm technology generated by the differences in time or space between each subsystem and other subsystems or different elements in the information processing process.

B. Performance Test of Modular Information Fusion Model of Urban Landscape Design Based on Genetic Algorithm

Modularization of urban landscape design is to transform a complex multi-objective combinatorial optimization problem into multiple single systems for genetic and variation at the same time. Through continuous cross evolution, each system can have its own uniqueness, efficiency and operability. In this process, we need to consider how to analyze the relationship between environment and human society from the perspective of environment, determine the initial population size of the system, and calculate its fitness value and variability after randomly selecting different individual populations. According to the actual situation, select the one with the highest fitness for cross operation. Within a certain range, the continuous generation repeats three times, completes a test for each person in the group, and exchanges data for many times to achieve the dynamic evolution effect, and finally obtains a better combination result to realize the modular performance index. The population size of the new generation is determined by using the spatial information entropy principle of genetic algorithm.

IV. Experimental Analysis of Modular Information Fusion Model of Urban Landscape Design Based on Genetic Algorithm

Table I is the performance test data of information fusion model.

TABLE I. INFORMATION FUSION MODEL PERFORMANCE TEST DATA

Test times	Sufficient degree	Complete degree	Perfect degree
1	5	4	3
2	4	4	5
3	5	5	4
4	5	4	5
5	4	3	5

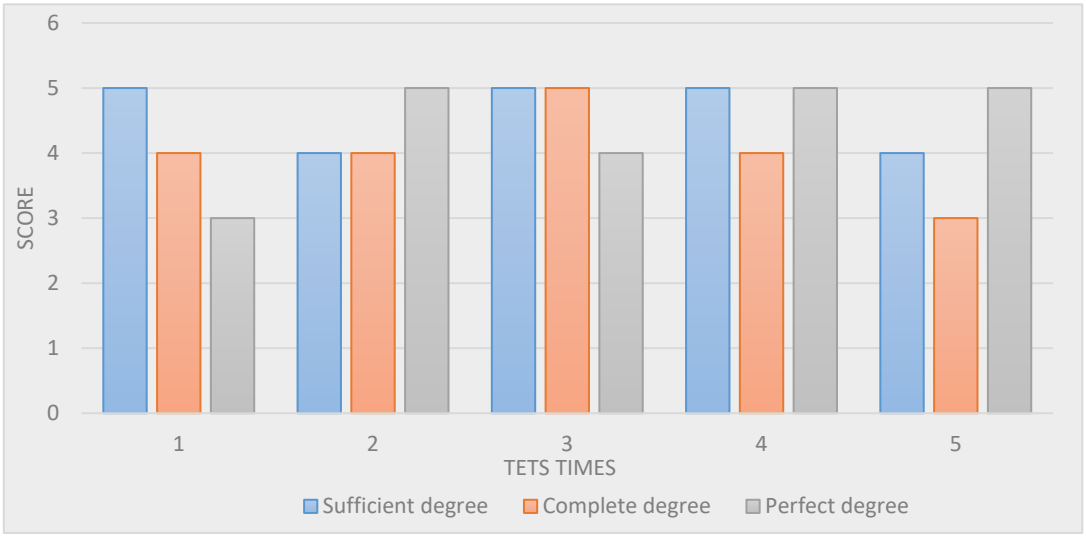

Figure 2. Information fusion model performance test data

After completing the construction of the modular model of urban landscape design, the system operation and test should be carried out to judge whether the expected goal is achieved. In order to verify the effectiveness of genetic algorithm and the coordination and consistency of fusion model in urban landscape design, this paper analyzes the influencing factors. As can be seen from Figure 2, the performance of the modular information fusion model of urban landscape design based on genetic algorithm is very excellent, which can show that the model can meet the requirements.

V. Conclusion

The development process of urban landscape design is accelerating all over the world. The spatial and temporal differences between regions are caused by economic, social and other factors. How to reasonably distribute regional natural ecological resources to various regions has become a difficult problem. Based on this background, a method of urban landscape modular information fusion using genetic algorithm is proposed. The idea is to combine multiple objective functions and then obtain the optimal solution set of the whole system, so as to complete the overall optimization problem.

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