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Landscape Design Technology Based on Tree Growth Simulation Modeling

Xiaotong HUANG[a],Yuchi MA[a],Yucheng WANG[a],Yinuo TIAN[a],Zhuo LI[a,1]
[a]*Heilongjiang University,harbin 150006,China*

Abstract. In order to solve the problems of traditional digital landscape planning system, such as low planning time and planning accuracy, the landscape design technology based on tree growth simulation modeling was put forward. Based on the hardware design of the traditional digital landscape planning system, this paper designs the overall framework and operation process of the system. Considering the flexibility of the system, network operation mode and system operation safety, the topological structure of the system is determined; According to the natural growth characteristics of tree branches and leaves, the growth process of leaves is simulated, the main branches of trees are generated by fractal algorithm, and the growth process of trees is simulated by Logistic model. According to the establishment principle of system database and the data to be stored, the system database is established from two aspects: data relationship and data type. Design the system to plan the landscape process of digital landscape architecture, and make the system have the function of planning digital landscape architecture. The experimental results show that the planning accuracy of the system designed in this paper can reach up to 95%. Conclusion: The digital landscape planning system based on visualization technology has high planning accuracy and short planning time.

Keywords.visualization technology, Digitization, Landscape architecture, Landscape planning, topological structure

1. Introduction

Fractal theory is a branch of mathematics that has developed rapidly in recent years. Its research object is the unsmooth and irregular geometric objects that appear in nature and nonlinear systems. Its implementation methods mainly include iterated function system (IFS), branching matrix, particle system, A system, etc. [1]. Fractal tree is an important branch of fractal, which is a typical fractal problem with self similar characteristics. Due to the influence of climate, soil quality, sunshine and other objective factors, the inclination angle and length of each branch vary greatly, so the self similarity of trees in nature is not absolute self similarity, and relevant control parameters need to be added in the modeling process [2].

Virtual natural scene is a challenging subject in the research field of computer graphics. Trees are an important part of natural scenes. At present, the modeling of plant morphological structure has been applied in many aspects, such as landscape design, film and television art modeling, computer games and other fields [3]. The growth model of plants simulates the growth process of plants through the prediction algorithm, which can truly show the growth and change process of plants [4].

[1] Corresponding Author.Zhuo LI,Heilongjiang University,E-mail:Z15100102301@163.com.

The morphological structure of trees plays an important role in their growth, for example, the leaf area determines their photosynthetic capacity, the relationship between organs determines the distribution of internal nutrients, etc. It directly reflects the growth and development of trees and is an important factor for scientific management decisions [5].

2. Literature review

Landscape design of landscape architecture has existed since ancient times. However, with the development of computer technology, drawing software such as Auticad, photoshop and 3Dsmax has been developed, which makes the design of landscape architecture systematic, comprehensive, true, reasonable, beautiful, accurate, efficient and easy to modify [6]. However, with the development of society, on the basis of new ecological civilization and information requirements, the landscape planning industry has covered urban ecological areas and infrastructure construction, making urban landscape planning more difficult [7]. For this reason, Chen, Y and others put forward digital landscape planning, analyzed the regional spatial environment of landscape planning by using the computing and graphics capabilities of computers, and rationally constructed objective and rigorous design logic, so that the landscape has both scientific, artistic and social values [8].

Because trees are composed of a series of different types of units that can be copied, the morphological structure is self-similar, that is, the part is similar to the whole. Therefore, trees are generally divided into several structural units in the structural model. One is organ-based decomposition with biological significance. For example, LIGNUM model proposed by Wang, H and others includes four basic units: branch (the part between two branches), bud, branch and axis (composed of a series of branches, branches and terminal buds) [9]. The GreenLab model proposed by Yan, Z and others divides the tissue of trees into four levels, from small to large: plant meristem (composed of internodes, terminal buds, leaves and axillary buds, etc.), growth unit (the sum of new meristem units that plants grow on the axis in a growth cycle), mother branch (composed of growth units that produce the main axis of branches) and substructure [10]. The other is space-based decomposition, that is, trees are decomposed into units or pixels, and then each unit is endowed with biological characteristics such as leaf density and illumination.

At present, the study of digital landscape planning methods at home and abroad needs to be planned from pedigree, parametric design, computer-generated design and so on. Foreign countries have also established a digital landscape planning method with four processes: digital model-sensitive system-network urbanism-self-realization, and completed the digital landscape planning. However, this method only stays at the research level and has not been practiced. In China, from the perspective of landscape parametric design, the basic system framework and parameter composition types are studied, and the landscape is planned by digital means on the computer, but there is a problem that the landscape can not be completely parameterized by software. Therefore, the visualization technology is introduced, and according to the spatial geographic information of landscape architecture, the landscape architecture is digitally planned, and the design of digital landscape architecture planning system based on visualization technology is put forward.

3. Methods

3.1 Overall framework of digital landscape planning system based on visualization technology

The design of the digital landscape planning system will design the software of the digital landscape planning system based on the hardware design of the traditional digital landscape planning system [11]. The system takes into account the requirements of digital landscape planning and the principles of practicality, advancement, safety and reliability, openness and sharing, economy and easy popularization of the system design. The overall architecture of the designed digital landscape planning system is shown in Figure 1.

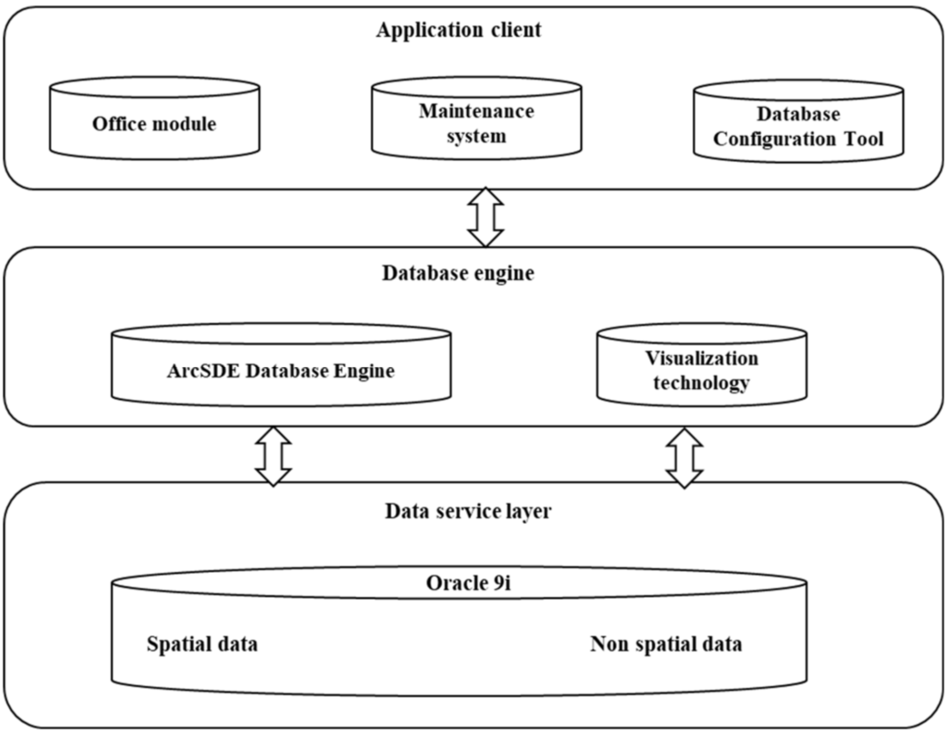

Figure 1. Overall architecture of digital landscape planning system

In the overall architecture diagram of the digital landscape planning system shown in Figure 1, the overall architecture of the system is divided into three layers: data service layer, spatial data engine and visualization technology, and application client.

The application client is used to display the system application, and the office module in the service layer serves for the client, providing the spatial and non-spatial data of digital landscape architecture that users need. In the digital landscape architecture configuration tool, users can plan the digital landscape architecture according to the spatial and non-spatial data of digital landscape architecture and form a visual digital landscape architecture model through visualization technology [12]. Among them, the database parameter configuration tool module is used to connect the data service layer. Every time the office module is used, the database parameter configuration tool module will configure parameters once and connect the database parameter file. The system maintenance module is used to ensure the operation of the system and maintain the system business and data, including three units: personnel business management, map management and tool management; The office module plans the digital landscape operation layer for users, including case handling unit (connector and office bar), map operation, map management and tool unit [13].

The database engine is the middle layer of the system, in which the ArcSDE database engine is used to retrieve the spatial and non-spatial data in the data service layer, and can also store the spatial and non-spatial data needed in the process of digital landscape planning through the ArcSDE database engine. Its programming interface can improve the access rate of the data service layer, and the occupancy rate of system memory and disk space is low [14]. Visualization technology is to give the system data the outer contour and the cognition of specific appearance, such as trees and buildings.

According to the overall architecture of the digital landscape planning system shown in Figure 1, the system needs to have a flexible and convenient network operation mode, which can process the system data in time, filter the data information that endangers the system, prevent foreign invasion and undermine the system operation safety.

3.2 Tree modeling algorithm

3.2.1 Integral Modeling Algorithm Based on Fractal

Recursive algorithm is a classical algorithm in fractal geometry, and it is also widely used in computer programs. When studying graphics, it is often used to construct fractal models [15]. In this paper, the fractal tree is generated in a specific form of recursive algorithm. The basic principle is: first, the basic generator is specified, and then the basic generator is redrawn at each level on the computer according to the generation rules until the preset recursive end condition is reached [16]. It is stipulated that different generators can generate different fractal trees. The basic idea is to draw the trunk first, and then draw the branches at the top of the trunk according to the set included angle, sometimes the included angle is a random angle with a set range, and the length of the branches should be $K(0<K<1)$ times of the trunk, and finally the fractal tree is generated after repeated recursive calls [17].

3.2.2 Leaf growth prediction

Under restrictive conditions, the growth of leaves has the following characteristics: at the initial stage of culture, the growth rate is inhibited, and then the growth rate is accelerated. When the growth rate reaches the maximum, it will gradually decrease and even stop growing, that is, μ changes from small to large, and then from large to small, showing a "bell" curve [18].

Describe the law of μ changing with time as shown in Formula (1):

$$\mu = \mu_{max} \times e^{\frac{(t-t_{max})^2}{-2\times t_L^2}} \tag{1}$$

Where μ_{max} is the maximum specific growth rate, t_{max} is the time when μ reaches μ_{max}, and t_L is the time of delay period.

The size of plant leaves will change with time, and the leaves of the same plant will have different growth results because of light.

Generally speaking, according to the color of leaves, we can judge the orientation of leaves, and the density of leaves can judge the relationship between geographical locations. For example, the direction where branches grow luxuriantly is sunny, or plants are positive. The prediction and analysis of leaves is to set different growth parameters according to the amount of sunlight, so that different leaves have different growth factors [19].

When predicting the size of leaves, let them grow an ideal value every time, and the value is 0.5 through expert system evaluation. The algorithm is as follows: I = 0.5;

$$\text{Target} = (\text{i}) * \frac{1000 - \text{islider}}{1000} + \text{CurMin} \tag{2}$$

Among them, the Target value target is the leaf size. At present, iSlider is the influence degree of the previous leaf size, and CurMin is the current leaf size value.

The depth prediction of leaves needs to take into account the changes of trees, and let them adapt intelligently according to the changes of external conditions, and this should be taken into account when re drawing the prediction. Therefore, the depth test of leaves also has changes of trees themselves, in which the implementation of some generation (2) codes needs to modify their changed depth values, which are taken as 2 here, and the algorithm is as follows: formula (2): i=2; Where, the target value Target is the depth of leaves. Current results: iSlider is the influence degree of the front leaf depth, and CurMin is the current leaf depth value.

3.3 Establish a system database

The established system database takes into account the visual data of digital landscape data, which requires a higher database in the process of data adjustment. According to the five principles of database security, sharing, independence, high efficiency and expansibility, Oracle 9i database with higher level and faster running speed is selected as the established system database.

In addition, in the actual application process, the digital landscape data will always be in a state of growth. Therefore, it is necessary to consider the access rate of database data, so it is necessary to archive the data in the database to form a database management mode in which database tables and database files coexist, reducing the amount of data in the database cache, thus improving the response efficiency of database data in the process of data query [20]. When users query data, they can't query the data information in the database only by query criteria, which affects the efficiency of user data query. Therefore, in the database established this time, the database index is designed to improve the inherent characteristics of the database server itself. Therefore, according to the entity, attribute and connection of digital landscape data.

M and n represent different numbers of relationships, where 1:1 represents a one-to-one relationship; 1:N represents a one-to-many relationship; M:N means many-to-many relationship. The data is divided into four parts: user information, administrator, construction drawing and construction drawing classification, which stores the digital landscape data that users are planning or have completed planning, that is, the non-spatial data in the database. In addition, the system database also includes the spatial data of digital landscape planning. Spatial data can be divided into graphic data and non-graphic data according to types.

3.4 Planning Digital Landscape Architecture

The system architecture of digital landscape planning system adopts visualization technology, and the planned digital landscape adopts parametric method. The design of digital landscape planning process is shown in Figure 2.

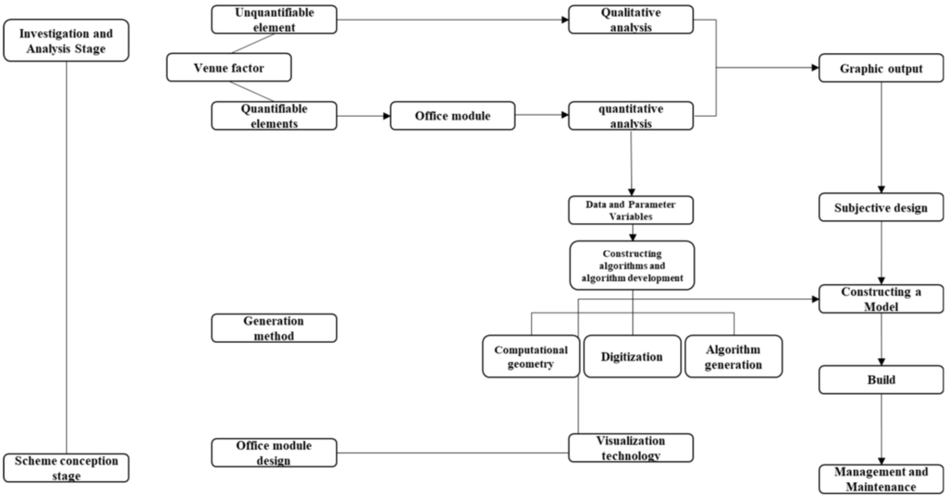

Figure 2. Landscape planning process of digital landscape architecture

The digital landscape planning process in Figure 2 is to analyze the quantitative factors and non-quantifiable factors according to the landscape site, store the data of the two factors in the system database, generate the digital landscape quantitative data algorithm through the office module of the system, and output the landscape graphics. Using visualization technology and landscape graphics, the digital landscape model is constructed and the digital landscape planning is completed. At this time, the next step of construction, management and maintenance can be carried out for the planned digital landscape.

This time, the digital landscape planning system is designed, and the overall architecture of the system is determined. According to the architecture, the topological structure of the system network is determined to ensure the safety and speed of the system network operation, and the system database is established to store the landscape data. The design of digital landscape planning system is completed by converting the designed digital landscape planning process into system running code and storing it in the system server chip.

3.5 System testing

Taking a digital landscape area as the experimental object, the digital landscape planning system of this study is verified by comparative experiment. The digital landscape planning system designed this time is recorded as system A, and two groups of traditional digital landscape planning systems are recorded as system B and system C respectively.

The digital landscape area selected for this experiment is trapezoidal from southwest to northeast, with a total area of 786m ^{2}. At present, 39 residential buildings have been built in this area. It is necessary to plan the garden landscape of the community between these 39 buildings. According to the three groups of systems selected for this experiment, Windows TN of TCP/IP is selected as the system network environment for this experiment. The operating environment of the three groups of systems is shown in Table 1.

Table 1. System Operating Environment

deploy	parameter	deploy	parameter
server	PC PII/400	memory	4 GB
CPU	intel core i5	hard disc	6 G
browser	Microsoft IE 8.0	CPU power	2.4 GHz

4. Results and discussion

The first group of experiments was conducted based on the experimental parameters set in this experiment. According to the digital landscape landscape selected in this experiment, the commonly used planning Landmark proposition is used as the comparison object of this group of experiments. From the digital landscape planning area, four buildings A, B, C and D are selected. Among these four buildings, a leisure area and parking lot are planned. The leisure area includes kiosks, lawns and fitness equipment. The parking lot is divided into two areas: bicycles and electric vehicles.

The solution can get the required solution time, garden area and parking area of the three groups of methods, and whether the garden and parking area exceed the planned area of the community. See Table 2 for the comparison results of the three systems.

Table 2. Comparison results of three groups of systems

system	A system	B system	C system
Solution time /S	3	12	7
Garden area /km ^{2}	0.0010	0.0016	0.0020
Whether it exceeds	Not exceeding	Not exceeding	exceed
Parking area /km ^{2}	0.0006	0.0009	0.0010
Whether it exceeds	Not exceeding	Not exceeding	exceed

As can be seen from Table 2, the planning solution of system C takes a relatively short time, but both the garden area and the parking area exceed the planning area, and the planning solution obtained is the worst; B system planning solution, although the garden area and parking area are not beyond the planning area, but it takes the longest time; A system planning solution, not only takes the shortest time, but also the garden area and parking area are not beyond the planned area. It can be seen that the digital landscape regional planning system designed this time can plan the landscape according to the landscape area of the landscape garden, and it takes a short time.

According to the results of the first group of experiments, the second group of experiments was carried out. According to the functional modules of three groups of systems, the system test cases are designed to test the system operation function. From four aspects: user management, database, system maintenance and planning and design, the following cases are designed: ① When adding user information, if the required items are not filled in, will a prompt box pop up? ② Whether there is a prompt box when deleting or modifying user information; ③ Whether there is a backup in the system after the data information is accidentally deleted; (4) retrieve the data in the database, and whether the retrieved content is consistent with the retrieved content; ⑤ Whether there is security verification when changing user settings; ⑥ If the printer is connected, whether the data information can be printed will pop up for verification; All landowners change, delete, add drawings, whether there is a prompt box; ⑧ Retrieve the construction drawings and check whether the construction drawings are classified according to the project category. According to the eight cases designed above, it is verified whether the system functions meet the expected results and whether there are any problems left over during operation. The experimental results are shown in Table 3.

Table 3 . System Function Test Results

	case	Expected result	test result	remaining problems
A system	1	Pop-up prompt box	pass	without
	2	Pop-up prompt box	pass	without
	3	Existing data backup	pass	without
	4	Consistent content	pass	without
	5	Pop-up security verification information	pass	without
	6	Pop-up security verification information	pass	without
	7	Pop-up prompt box	pass	without
	8	Classify by category	pass	without
B system	1	Pop-up prompt box	pass	without
	2	Pop-up prompt box	pass	without
	3	Existing data backup	fail	have
	4	Consistent content	pass	without
	5	Pop-up security verification information	pass	without
	6	Pop-up security verification information	fail	have
	7	Pop-up prompt box	pass	without
	8	Classify by category	pass	without
C system	1	Pop-up prompt box	pass	without
	2	Pop-up prompt box	pass	without
	3	Existing data backup	fail	have
	4	Consistent content	fail	have
	5	Pop-up security verification information	pass	without
	6	Pop-up security verification information	pass	without
	7	Pop-up prompt box	pass	without
	8	Classify by category	fail	have

As can be seen from Table 3, both system B and system C have failed test cases, that is, the test results are inconsistent with the actual expectations, and there are still some problems left over; All cases of system A have passed, and there are no remaining problems. It can be seen that the digital landscape planning system designed this time has perfect functions.

According to the results of the first group of experiments and the second group of experiments, the third group of experiments is carried out, and the planning accuracy of digital landscape architecture in the first group of experiments is extracted. In order to ensure the rigor of the experiments, the planning accuracy of digital landscape architecture in system B is checked for 50 times, and the fluctuation difference of accuracy is as high as 14, and the highest accuracy is only 81%, and the planning accuracy is the lowest; Although the fluctuation of landscape accuracy of C system planning digital landscape architecture is small, the planning accuracy still does not reach 90%; A system planning digital landscape accuracy, not only the planning accuracy difference is small, but also the planning accuracy reaches 89% at the lowest and 95% at the highest. It can be seen that the digital landscape regional planning system designed this time has high planning accuracy.

5. Conclusion

This paper puts forward the landscape design technology based on tree growth simulation modeling. In order to improve the planning accuracy and shorten the planning time of digital landscape planning system, this paper designs a digital landscape planning system based on visualization technology. On the basis of the current research on the software and hardware of digital landscape planning system, this paper designs the software of digital landscape planning system, and makes full use of visualization technology to build a digital landscape model, which can express the three-dimensional space in real time and simplify the process of digital landscape planning.

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