Analysis on Spatial Layout Model of Urban Road Green Landscape Based on Discrete Probability

Yang Yao
College of Architecture and Urban Planning, Chongqing Jiaotong University, Chongqing, 400074, China
yaoyaolwzy@163.com

Abstract: The development issues about urban road greening design are constantly emerging in modern urban road construction. Therefore, a model of spatial layout of urban road green landscape based on discrete probability was built. The relevant urban road data was collected and the corresponding three-dimensional model of urban road was built. On this basis, the spatial layout and characteristics of urban road were analyzed. According to the analysis results, the greening modes and configuration methods that met the humanistic characteristics were established reasonably. Moreover, the green landscape vegetation was selected in consideration of the growth potential, height and seasonal phase of plants. Then, the discrete probability was used to determine the initial planting location and planting density of vegetation. Finally, following the principle of macro control and micro coordination respectively, the spatial layout of urban road green landscape was achieved from the horizontal and vertical directions. Based on the evaluation for the spatial layout model, it is concluded that the comprehensive score of the designed model is improved by 4.3 points compared with the traditional model.

Key words: Discrete probability; Urban road; Green landscape; Spatial distribution; Layout model
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1 Introduction

The urban road refers to the road that is accessible to all regions of the city for urban transportation and pedestrian use, and connected with roads outside the city. According to the status and traffic function of road in urban road system, it can be divided into: expressway, main road, secondary trunk road and branch road [1]. Because vehicles will emit a lot of vehicle exhaust when running on urban roads, the automobile exhaust will spread to the urban area if they are not treated in time. It is necessary to build a green

landscape. The road green landscape is mainly due to the requirements of urban residents for the environmental appreciation of urban roads [2]. According to the physical function and psychological function of green landscape, the functions can be summarized into four aspects: environmental protection, traffic organization, traffic safety, landscape function and other functions. Therefore, the green landscape can not only bring visual pleasure, but also relax the driving mood, reduce the diffusion speed of exhaust gas and absorb exhaust gas [3-5]. The purpose of spatial layout of green landscape is to arrange different vegetation reasonably. The green land is an important part of urban road landscape, which mainly refers to green plants within the scope of urban road green space. The road green landscape is an important part of road culture. Through the overall design, greening and ecological restoration, landscape construction, landscape improvement, the overall style of road green landscape can molded [6]. Different urban roads need the different ways in spatial layout, but the green landscape can not affect the normal traffic order. Therefore, it is necessary to consider the degree of beautification, the degree of road safety and other aspects in the spatial layout of green landscape, so as to ensure that the urban road green landscape has the biggest influence.

In recent years, the urban construction is very fast, which changes the face of the city to a great extent. However, the urban landscape is only arranged partially, and it is accompanied by temporary urban renewal. In terms of the current situation, the urban road landscape design mainly ignores the contradiction among greening, underground pipe network and over-head line. The species of plants are unitary. It does not fully consider the seasonal changes. The seasonal phenomena are not rich. Local characteristics and cultural characteristics show deficiently [7, 8]. In order to solve the above problems, it is necessary to optimize the urban road spatial layout method at this stage and consider the design needs, so as to improve the function and performance of the results of urban road green landscape spatial layout. During the optimization design, the concept of discrete probability is introduced into the urban road green landscape spatial layout method. The discrete probability is a concept of discrete mathematics. This parameter can be applied to the spatial layout and thus to realize the quantitative processing of design, which can improve the scientificity and data performance in the process of design. It is very important to apply the green landscape spatial layout model of urban road to the actual planning for improving the urban landscape, protecting the urban environment and promoting the urban connotation.

2 Basic Definitions

In order to ensure the using performance of results of spatial layout of urban road green landscape, many aspects should be fully considered during the design of layout model. The specific design measures include the coordination

between urban roads and green plants, the full utilization of basic terrain and the rational use of color [9]. In addition, it is necessary to follow certain principles to design spatial layout model, including the principles of ecology, adaptation to local condition, security and benefit.

2.1 Construction of 3D Model of Urban Road

The three-dimensional model of urban road mainly contains the traffic road and buildings around the road. Therefore, it is necessary to use some equipments of image acquisition or remote sensing data acquisition in a fixed coordinate system to realize the three-dimensional construction of urban road model.

2.1.1 Construction of 3D Spatial Coordinate System

Based on actual urban roads, the three-dimensional spatial coordinate system is established. In actual environment, the due north is the positive direction of z axis, the due east is the positive direction of x axis, and the due west direction is the positive direction of y axis. Then, the plane formed by due east and due west is the operation plane of urban road, and the two planes formed by the due east and due north and the due west and due north are the corresponding planes of the buildings around the urban roads.

2.1.2 Collection of Geometric Information of Urban Roads

There are two ways to collect the geometric information of urban roads. The first way is to use the remote global image acquisition equipment to overlook and determine the distribution of urban roads, and then use precise instrument to measure the specific data information of urban roads and buildings [10-13]. We should start the remote image acquisition equipment and geometry data acquisition equipment in order and input the remote image acquisition results into 3D max software directly as the bottom image of model, and then input the relevant combined data into the software to achieve the spatial quantification of urban road [14].

2.1.3 Making 3D Landscape of Urban Roads and Buildings

The three-dimensional landscape model of urban roads and buildings is made in two steps. The first step is to build the urban road model, and the specific process is shown in Figure 1.

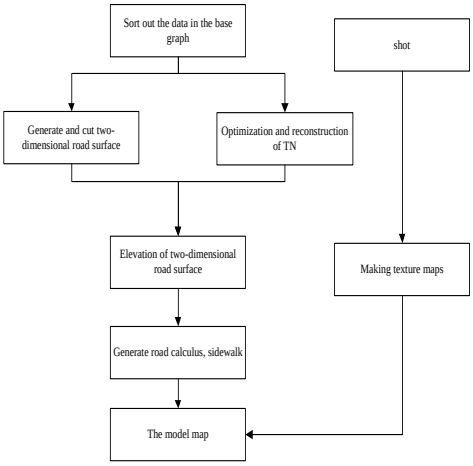

Figure 1. Production Process of Road Surface Model

Firstly, the purpose of subdividing the two-dimensional road surface is to retain the key points influencing the road shape. The second purpose is to facilitate the subsequent use of polygon modeling, so as to reduce the complexity of editing the model and model decals process [15-18].

Currently, no more convenient and effective subdivision method has been found. This work mainly relies on manual operation. Then, the existing terrain is edited by taking the road boundary and elevation point as constraints to improve the position accuracy of TIN. Next, the model will be refined in 3ds Max. It is necessary to convert the 3D road surface into a format which can be recognized by the three-dimensional drawing software. Meanwhile, the parameters and output path are determined. The next step is to continue to improve the road surface model on the basis of the carriageway, including expanding the curbstone, sidewalk and mapping the model. The 3D road surface is shown in Figure 2.

Figure 2. Production Results of 3D Rode Model

The second step is to make the relevant equipments and buildings around the road. The ancillary facilities mainly include traffic safety facilities and other ancillary facilities. The road traffic safety facilities include road signs, markings, and guardrails. The other ancillary facilities include road lamps, separation belts, billboards, dustbins and border trees, etc. The production process of buildings around the road is shown in Figure 3.

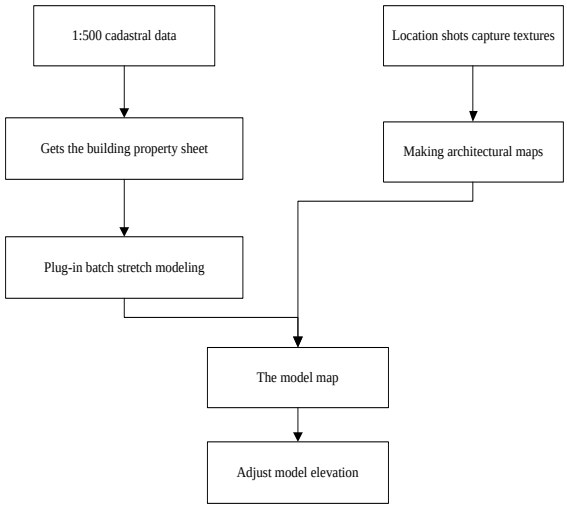

Figure 3. Production Process of Buildings around Roads

The basic principle of restoring 3d model of buildings based on the building bottom is to squeeze a certain height from the building bottom in 3ds Max software, and then add the material to the empty model after stretching, and finally adjust the model to the correct elevation position. Because some operations such as stretching and elevation homing belong to the repetitive jobs which are most suitable for batch processing by writing plug-in components. According to the production process and steps in Figure 4, the modeling results are shown in Figure 4.

Figure 4. Schematic Diagram of

Production Result of Construction Model around Roads

The three-dimensional model of urban roads can be obtained by combining the building results of road surface and surrounding buildings.

2.2 **Analysis of Spatial Layout of Urban Roads**

The spatial layout of green landscape needs to be built on the basis of urban road spatial layout, so the specific spatial distribution of urban road and the relevant characteristics are analyzed in 3D model. Generally, the spatial layout of urban roads is composed of several parts, and the specific structure of urban road green space is shown in Figure 5.

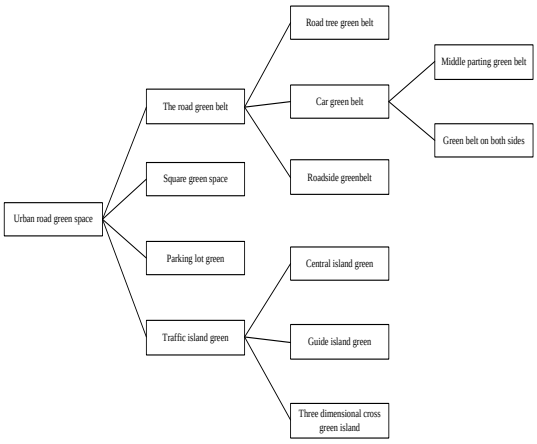

Figure 5. Spatial Composition Structure of Urban Roads

The component units in Figure 5 can be roughly divided into natural elements and human elements. In natural elements, the urban road skeleton needs to be fully combined with the landform. The visual landscape of road in plain city is limited in the road space. The mountainous city gives people a sense of vision changing rapidly, and the target breaks through the shackles of the road space and touches different levels of landscape. The artificial landscape elements mainly contain road network, cross section, buildings and structures, greening, road pavement, traffic facilities, street furniture, etc. However, different types of urban roads have different functions and operation modes. The classification results in Table 1 can be obtained by classifying urban roads according to types.

Table 1. Classification of Urban Road Green Landscape Spatial Layout

name	meaning	Landscape resources	Activity main body	Road properties
Green belts on both sides of the road	The green belt on both sides of the roadway is generally arranged in combination with the sidewalk to divide the flow of people and traffic	Natural landscape along the route	Car line, pedestrian	Urban main road

Central parting belt	Separation of fast and slow lane and two-way lane, the effect of first out on fast moving traffic flow	Vegetation, water and other natural landscape elements	Car line	Urban main road
Traffic island	An island between lanes of traffic above the road to control the direction of the vehicle and ensure pedestrian safety	Urban road landscape	Car line, pedestrian	Urban road
The slope	To ensure the stability of roadbed, roadbed made on both sides of a certain slope surface	Natural landscape along the route	Car line	Urban road
A motor vehicle,	Motorized roads	Natural landscape along the route	Car line	Urban main road
Non-motorized lane	A lane on which a motorized wheelchair, electric bicycle, etc is driven	Natural landscape along the route	pedestrian	Urban main road
The pavement	For pedestrians to walk, play a role in guiding the flow of people	Natural landscape along the route	pedestrian	Urban main road
Park road	The road is built around the park landscape	Beautiful landscape with park atmosphere along the road	hybrid	The road connecting the city park
avenue	The paths were lined with tall, thick trees	Urban road landscape	Car line, pedestrian	The city is not the main road, emphasizing the formation of continuous shade

The proportion of different road types is analyzed respectively, so that the basic spatial layout plan can be determined.

2.3 Greening Form and Configuration Method

Based on the three-dimensional urban road model, the location of green landscape spatial layout can be determined. That is the layout scope of the green landscape. Within the determined layout range, many factors should be considered to construct the urban road green landscape spatial layout.

2.3.1 Greening Form

During the greening design, its forms are very diverse. The comprehensive analysis of combining road and greening through scientific methods can ensure that its scheme conforms to the design of road greening. When determining the process of greening design, some factors should be considered, including the land use function on both sides of the road, underground pipelines and lines, the width of road and the style of the buildings on both sides of road.

2.3.2 Plant Landscape Configuration Method

According to the different configurations of plant species in road forest belt, it can be divided into pure woodland road forest belt and mixed woodland road forest belt. The pure woodland is a forest belt composed of the same tree species, which is suitable for the road forest belt of ecological protection. The ecological relationship between trees in pure woodland road forest belt is relatively simple. The relationship between individuals and groups is the main contradiction. Generally, the contradiction will be balanced by timely and appropriate intermediate cuttings. The mingled forest road belt is composed of two or more plant species. Under this configuration, the road forest belt has good biological and ecological stability, and the layout result is more complex. There are four levels of plant species allocation in mixed road forest belt, as shown in Figure 6.

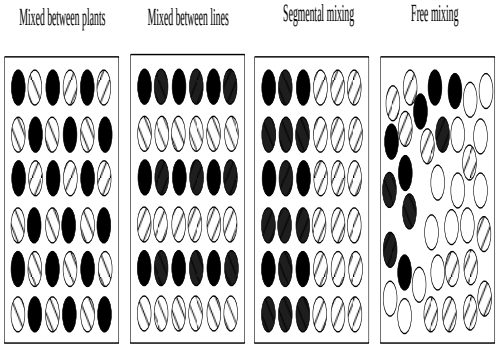

Figure 6. Species Configuration of Plants in Forest Belt of Mixed Road

In Figure 6, the mixture among plants means that two or more species of trees grow together under the regular forest belt plant landscape configuration method, the plants are mixed in the form of rectangle or triangle. The inter row mixing method also adopts the form of rectangle or triangle under the regular forest belt plant landscape configuration method, taking the row or column as the unit, which includes the symmetrical type and the asymmetric type. The free mixing method is to mix several plant species in an urban road forest belt without a certain rule to follow. In the regular forest belt plant landscape configuration method, the free mixed method is generally not used for configuration, which is often applied in the natural forest belt plant landscape configuration method, and the plants are organically combined and mixed. According to the analysis results

of urban road and different needs, the specific plant landscape configuration methods are determined.

2.4 Selection of Vegetation in Green Landscape

When selecting the green landscape vegetation, we need to fully consider the growth potential, height, season aspect and other factors of plants from the perspective of ecology. From the perspective of aesthetics, we need to consider the shape, size and combination mode of vegetation. The design of plant landscape strives to achieve beautiful flowers and fruits in four seasons. On the whole, the plant space should have an easy control in the matter, and the seasonal change should be obvious. This not only shows the beauty of change, but also conveys the information of seasonal change. In the spatial layout of urban road green landscape, the vegetation types and their characteristics often selected are shown in Table 2.

Table 2. List of Green Landscape Vegetation

type	Name of vegetation	genera	Native species or not	Whether it's a fast growing tree	Whether the evergreen	Ornamental parts	Resistance to pollution	The seasonal
Structure of tree species	cedar	Pinaceae cedar	no	no	yes	leaf	Dust detention	The four seasons
	Pinus tabulaeformis carr.	Pinaceae pinus	yes	no	yes	leaf	Dust detention	The four seasons
	using	Cypress of pinaceae	yes	no	yes	The tree	Dust detention	The four seasons
Populate	osmanthus	The family luteolidae	no	no	yes	fragrance	SO_2 absorption	In the fall

the tree	Ginkgo biloba l.	Ginkgo biloba	yes	no	no	Leaf and The tree	Dust detention、SO_2 absorption	In the fall
	ash	Luteinae: wax	yes	yes	no	The tree	Dust detention	In the fall
Tone tree species	mulberry	Moraceae morus	yes	yes	no	The tree	Dust detention、SO_2 absorption	Spring, summer,
	Weeping willows	willows	yes	yes	no	The tree	Dust detention	Spring, summer,
	Chinese jujube	Date of prune family	yes	yes	no	The tree	Dust detention、SO_2 absorption	The four seasons
Ornamental tree species	Red maple	Aceraceae aceraceae	no	yes	no	leaf	Dust detention、SO_2 absorption	Spring, summer,
	magnolia	magnolia	no	yes	no	flowers	SO_2 absorption	Autumn winter
	wintersweet	Wintersweet of the family winterswe et	yes	yes	no	flowers	SO_2 absorption	winter

In addition to the vegetation types in Table 2, there are other plant species applied in the green landscape of urban roads. The appropriate vegetation can be chosen according to the requirements of the style, culture, color of urban roads.

2.5 Use Discrete Probability to Determine the Planting Position of Vegetation

2.5.1 Construction of Planting Probability Model in Discrete Space

Suppose that $f(x)$ is the probability density function of target distribution in continuous space, then:

$$\begin{cases} \int_{-\infty}^{\infty} f(x)dx = 1 \\ f(x) \geq 0 \end{cases} \quad (1)$$

In order to accurately reflect the probability distribution of targets and consider the feasibility of calculation, the coordinate space is isolated and scattered. The planting interval is recorded as Δx. The density of discrete probability is shown in Figure 7.

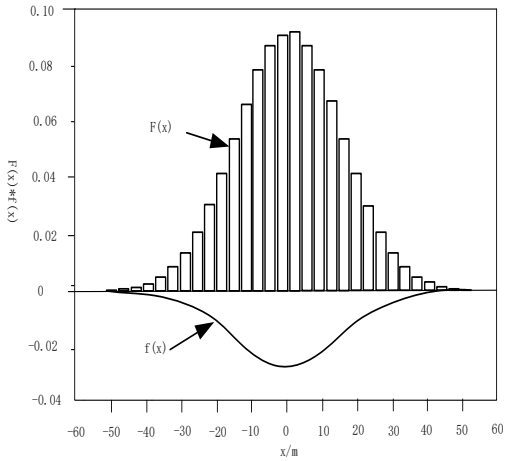

Figure 7. Discrete Probability Density Distribution

Thus, the distribution probability density $F(x_1)$ of the given target in the discrete space is obtained, namely:

$$\begin{cases} F(x_1) \geq 0 \\ F(x_1) = \int_{x_j - \Delta x/2}^{x_j + \Delta x/2} f(x)dx \\ j \in \phi \end{cases} \quad (2)$$

In the formula, x_j is the target location of the *j-th* planting point in the discrete probability space, and ϕ is the set of discrete probability space points. Thus, the planting density of vegetation in spatial layout of green landscape of urban road can be calculated.

2.5.2 Find the Solution of Initial Position

The center of urban road green landscape spatial layout is defined as $x_{m,k}$. The position of aim point is allocated with equal interval, which is taken as the initial value. Then, the initial position $x_{k,i,0}$ of vegetation planting in effective interval can be solved by Formula 3.

$$\begin{cases} -\frac{hM_k}{2} + (i-1)\frac{hM_k}{(m_k - 1)} + x_{m,k}, m_k > 1 \\ x_{m,k}, m_k = 1 \end{cases} \quad (3)$$

In the above formula, i represents the *i-th* planting position in the *k-th* effective subinterval. The value of $x_{k,i,0}$ obtained by solving Formula 3 is the initial position of green landscape planting. Then, the calculated planting density is used as the data support, and the number of plants and the planting location of each plant are determined by successive iterations within the specified planting range.

2.6 Achievement of Spatial Layout of Urban Road Green Landscape

2.6.1 Landscape Layout of Horizontal Space

In the landscape layout of transverse space, according to different road cross-section forms, the basic components of

forest belt in roads are different. After summary and integration, the urban road forest belt in the broad sense consists of middle lane separator, lane separator on both sides, alee-tree green belt and the roadside green belt. There are motorways on both sides of green belt in the middle lane separator, and most of the spectators are drivers and passengers. According to the different functional types and requirements of urban road forest belt, there are different requirements and principles for the design of the forest belt of the middle traffic separation green belt. One side of green belt is the motor way and the other side is the bicycle lane. Compared with the middle traffic separation green belt, it is closer to the sidewalk. On the one hand, it is appreciated by drivers and passengers under the vehicle speed. On the other hand, it is concerned by pedestrians and non-vehicle travelers more or less. The main function of street trees green belt is to provide a certain shade for pedestrians. As a part of the road forest belt, its value lies in the fact that its upper canopy can be connected with the roadside green belt and the green belt on both sides on the shadow of macrophanerophytes. The roadside green belt is the green space that is closely linked to the sidewalk. It directly affects the perception of pedestrians, which can provide the arrest points and rest places for pedestrians. The results of landscape layout of transverse space in urban road green landscape are shown in Figure 8.

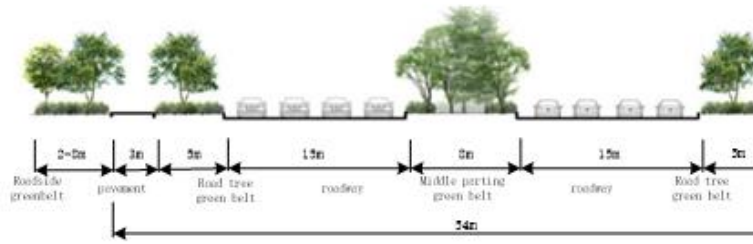

Figure 8. Horizontal Spatial Layout of Green Landscape of Urban Road

2.6.2 Landscape Layout of Longitudinal Space

The vertical greening has the advantages of less land occupation, quick effect and high green looking rate. It has significant effect in absorbing harmful gas, eliminating dust, isolating noise, increasing humidity and adjusting the temperature. The climbing greening means that lianas with suction cups or air roots, such as Parthenocissus, Virginia creeper, Trachelospermum jasminoide, Ficus pumila and Campsis grandiflora, are used to climb along walls, stone walls and fences without any support and traction materials. The greening height can reach 8-10 meters or more. In addition, the layout of vertical space landscape can use the height of different plants to present a three-dimensional sense of space.

2.6.3 Boundary and Transition

As a node of urban green space, the dotted-like space and green land need people to feel them, so the dotted-like space should be a protruding and open space range to a large extent, which can be seen in field of vision. It should also be convenient for access. Therefore, it is necessary to try to select vegetation with the same height and similar species as the starting point of the next area at the

connection position.

3. Evaluation Experimental Analysis of Spatial Layout Model

The purpose of the evaluation experiment for spatial layout model is to test the application effect of the designed spatial layout model of urban road green landscape based on the discrete probability. The designed spatial layout model and the traditional model are used to get different spatial layout results in the same urban road. Finally, the evaluation results are obtained by calculating the corresponding evaluation indexes, so that the goal can be achieved and the function of designed model can be proved.

3.1 Selection of Experimental Site

Based on the principle of proximity, select the cities with slow greening process and complex traffic roads are chosen as the experimental environment, so as to avoid the influence of the original urban greening environment on the model design. The results of experimental site selection are shown in Figure 9.

Figure 9 Environment of experimental site

The specific road distribution and land occupation in experimental environment are shown in Table 3.

Table 3. Components and Area of Urban Road Landscape in Experiment

type	area(m^3)	The proportion%
Green belts on both sides of the road	355187	15.9
Central parting belt	12239	0.5
Two side car belt	57710	2.6
Traffic island	10452	0.5
The slope	10915	0.4
A motor vehicle	1896000	62.3
Non-motorized lane	147340	6.6
The pavement	251010	11.2

3.2 Setting of Evaluation Indexes

In the experiment of spatial layout model evaluation, it is necessary to evaluate the effectiveness of results of spatial layout model in an all-round way, the specific evaluation and analysis are carried out from aspects of environment, function and aesthetics, and corresponding evaluation indexes are set. The evaluation indexes set in the process of environmental evaluation include the over-standard rate of pollutant emission, the coordination degree of traffic and ecological environment and the

rationality of urban pattern. The evaluation indexes of functional angle contain the road network connection degree, the function clarity rate and the grading structure of road network. The evaluation indexes of aesthetic angle include the color balance degree and the coordination degree between road greening and road characteristics. Respectively, the judgment level and judgment weight are set to get the evaluation results.

3.3 Experiment Process

In this evaluation experiment of spatial layout model, the traditional urban road greening landscape spatial layout model adopted as the experimental comparison group. According to the implementation process, the spatial layout results of the designed model and the traditional model are obtained respectively, and then evaluation is achieved from three aspects of environment, function and aesthetics.

3.3.1 Environmental Assessment

The evaluation of the environment is mainly to research the changes of local ecological environment before and after the spatial layout. The relevant air quality testing equipments are used to collect the air quality changes under the same situation of vehicle operation respectively, and then get the quantitative evaluation results.

3.3.2 Function Evaluation

The way of function evaluation is the same as the way of environment evaluation. From the perspective of drivers, pedestrians and riders, the road conditions observed in different spatial layout environments are photographed. According to the analysis of images, the clarity rate of road function can be determined. For the connection degree and grading structure of road network, it is necessary to use the authoritative software of spatial distribution analysis to get the scientific evaluation results.

3.3.3 Aesthetical Assessment

For the aesthetic evaluation of the spatial distribution results of urban road greening landscape, it is necessary to hire relevant artists. Because art and beauty are a virtual concept, different people have different observation angles and aesthetic judgments on the same thing, so it is necessary to hire more than one evaluator, and thus to ensure the credibility of evaluation results.

Integrating with the evaluation results of environment, function and aesthetics, we convert the evaluation results into the form of scoring in proportion, so as to facilitate the quantification and comparison of data.

3.4 Evaluation Result and Analysis

Through statistics, analysis and comparison, the evaluation experiment results of spatial layout model are shown in Table 4.

Table 4 Evaluation experiment results of spatial layout model

The evaluation index	Traditional urban road greening landscape space	Spatial layout model of urban road greening landscape based on

		layout model	discrete probability
Environmental assessment	The excess rate of pollutant discharge	1.2%	0.08%
	Coordination between traffic and ecological environment	97.4%	98.5%
	The rationality of urban pattern	reasonable	reasonable
Function evaluation	Road network connectivity	98.7%	99.3%
	Road function clarity rate	87%	94%
	Road network hierarchy	B grade	A grade
The aesthetic evaluation	Color balance	R:G:B=2:5:1	R:G:B=2:4:1
	Road greening ratio	92%	98%
	The degree of coordination of road features	good	optimal
The comprehensive score		93.5score	97.8score

Through the analysis of data in Table 4, the experimental conclusion can be drawn: in terms of ecology, connecting and combining the scattered green landscape system through the road green way is an effective means to maintain the balance of urban ecosystem and improve the urban ecological environment. In contrast, the two spatial layouts are reasonable, but the designed model has lower pollution and higher coordination.

In view of function, the road connects the starting point and the end point, which is the framework of urban structure. It has the characteristics of accessibility and the landscape is easy to feel. Therefore, the road landscape plays an important role in organizing the urban landscape. The connection of road landscape can form an overall urban landscape, so that people can get a clear image of the city.

Through the comparison, it can be seen that the road network connectivity and road function clarity of design model is 0.6% and 7% higher than that of traditional model.

In view of aesthetics, the road landscape is the place where a city gives people the most direct and frequent feelings. The beauty of road landscape lies not only in the aesthetic of its image, but also in the aesthetic of its function. People often get the feeling of beauty and the pleasure of body and mind from these places. The scores of the two models are obtained from multiple perspectives, and the green landscape space model based on discrete probability is 4.3 points higher than that of traditional model.

Plants have always played an essential role in the design of urban green space and it is necessary to pay special attention to their diversity [19-26].

4 Conclusions

The urban road landscape provides a safe, convenient, comfortable and beautiful road system for people living in the city, in which the modern concept of human-oriented and sustainable development is also reflected. The urban road not only needs to meet the basic functional needs of road, but also meet the needs of people for the road shape and beautiful environment.

References

1. Yao W.; Polewski, P.; Krzystek, P. Semantic Labelling of Ultra Dense Mls Point Clouds in Urban Road Corridors Based on Fusing Crf with Shape Priors[J]. ISPRS - International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, 2017, XLII-2/W7:971-976.
2. Yang, T.; Kuang, W.; Liu, W.; et al. Optimizing the layout of eco-spatial structure in Guanzhong urban agglomeration based on the ecological security pattern. Geographical Research, 2017, 36(3):441-452.
3. Frick, A.; Tervooren, S. A Framework for the Long-term Monitoring of Urban Green Volume Based on Multi-temporal and Multi-sensoral Remote Sensing Data. Journal of Geovisualization and Spatial Analysis, 2019, 3(1):6.
4. Qian, W.; Zhong, X, Z., Ping W. An Assessment of Ecosystem Services of Urban Green Spaces Based on i-Tree. Journal of Landscape Research, 2019, 11(01):57-60.
5. Ryu, H.; Park, I. K.; Chun, B. S.; et al. Spatial statistical analysis of the effects of urban form indicators on road-traffic noise exposure of a city in South Korea. Applied Acoustics, 2017, 115:93-100.
6. Dong, R.; Zhang, Y.; Zhao, J. How Green Are the Streets Within the Sixth Ring Road of Beijing An Analysis Based on Tencent Street View Pictures and the Green View Index. International Journal of Environmental Research & Public Health, 2018, 15(7):1367-1368.
7. Yang, Y.; Jia, L.; Yong, Q.; et al. Understanding structure of urban traffic network based on spatial-temporal correlation analysis. Modern Physics Letters B, 2017, 31(22):1750230.
8. Liu, H. Optimal Design of Shortest Path Algorithm for Urban Traffic Network under Roundabout Restriction. Journal of China Academy of Electronics and Information Technology, 2019, 14(04): 90-96.
9. Domingo, M.; Thibaud, R.; Claramunt, C. A graph-based approach for the structural analysis of road and building layouts. Geo-Spatial Information Science, 2019, 22(1):59-72.
10. Jia, Y. U.; Wen, J.; Chen, Y.; et al. Spatial configuration of urban shelters based on simulation using emergency evacuation agent-based model:A case study in Jing'an District,Shanghai. Acta Geographica Sinica, 2017, 72(8):63-65.
11. Boaga, J., Ghinassi, M.; D'Alpaos, A.; et al. Geophysical investigations unravel the vestiges of ancient meandering channels and their dynamics in tidal landscapes. Sci Rep, 2018, 8(1):1708.
12. Deren, L. I.; Hanruo, Y. U.; Xi L I. The Spatial-Temporal Pattern Analysis of City Development in Countries along the Belt and Road Initiative Based on Nighttime Light

Data. Geomatics & Information Science of Wuhan University, 2017, 42(6):711-720.

13. Wang, S.; Dexin, Y. U.; Wang, S.;et al. Connectivity characteristics of urban road network elements based on improved degree[J]. Journal of Traffic & Transportation Engineering, 2018, 18(2):77-80.
14. Pan, H.; Lu, X.; Lei, K. A comprehensive analysis of heavy metals in urban road dust of Xi'an, China: Contamination, source apportionment and spatial distribution. Science of the Total Environment, 2017, 609:1361-1369.
15. Huang, L.; Yang, Y.; Zhao, X.; et al. Sparse Data-Based Urban Road Travel Speed Prediction Using Probabilistic Principal Component Analysis. IEEE Access, 2018, 6:1.
16. Turek, W.; Siwik, L.; Byrski, A. Leveraging rapid simulation and analysis of large urban road systems on HPC . Transportation Research Part C Emerging Technologies, 2018, 87:46-57.
17. Zhang, X.; Chen, J.; Huang, J.; et al. Multi-level spatial structure analysis of urban agglomeration in the Beijing-Tianjin-Hebei region based on spatial clustering algorithms. Progress in Geography, 2017, 36(11):50-51.
18. Shi L.; Xi R. B. Research on the application and development of computer virtual technology in urban landscape planning and design. Automation & Instrumentation, 2018, 4(6): 32-38.
19. Masoumi SM, Kahrizi D, Rostami-Ahmadvandi H, Soorni J, Kiani S, Mostafaie A, Yari K. Genetic diversity study of some medicinal plant accessions belong to Apiaceae family based on seed storage proteins patterns. Molecular biology reports. 2012 Dec;39(12):10361-5.
20. Kakaei M, Kahrizi D. Study of seed proteins pattern of brassica napus varieties via sodium dodecyl sulfate polyacrylamid gel electrophoresis. International Research Journal of Biotechnology. 2011;2(1):026-8.
21. Vanaei H, Kahrizi D, Chaichi M, Shabani G, Zarafshani K. Effect of genotype, substrate combination and pot size on minituber yield in potato (Solanum tuberosum L.). American-Eurasian Journal of Agricultural and Environmental Sciences. 2008;3(6):818-21.
22. Zirgoli MH, Kahrizi D. Effects of end-season drought stress on yield and yield components of rapeseed (Brassica napus L.) in warm regions of Kermanshah Province. Biharean Biologist. 2015 Dec 1;9(2):133-40.
23. Molsaghi M, Moieni A, Kahrizi D. Efficient protocol for rapid Aloe vera micropropagation. Pharmaceutical biology. 2014 Jun 1;52(6):735-9.
24. Ghobadi M, Khosravi S, Kahrizi D, Shirvani F. Study of water relations, chlorophyll and their correlations with grain yield in wheat (Triticum aestivum L.) genotypes. International Journal of Agricultural and Biosystems Engineering. 2011 Jun 26;5(6):353-6.
25. Zare I, Mohammadi G, Sohrabi Y, Kahrizi D, Khah EM, Yari K. Effect of different hydropriming times on the quantitative and qualitative characteristics of chickpea (Cicer arietinum L.). African Journal of Biotechnology. 2011;10(66):14844-50.
26. Rostami-Ahmadvandi H, Cheghamirza K, Kahrizi D, Bahraminejad S. Comparison of morpho-agronomic traits versus RAPD and ISSR markers in order to evaluate genetic diversity among Cuminum cyminum L. accessions. Australian Journal of Crop Science. 2013 Mar;7(3):361-7.

Yang Yao, she was born in 1979, a female who is a master of environmental art of Chongqing University, and teaching in Chongqing Jiaotong University. She currently delves into the teaching and study of environmental art and landscape design on so on. In recent years, he has presided over or researched more than 10 provincial and ministerial scientific research projects and more than 10 educational reform topics. Moreover, she has published more than 20 academic papers in important journals such as core journals, including 1 SCI search, 1 EI search, and 2 Chinese core articles; she edited 2 textbooks for the 13th Five-Year Plan and 2 published works; she also won 3 national invention patent items, 1 new utility patent, and 3 appearance design patents.