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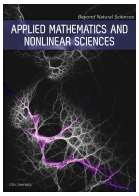

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The Spatial Form of Digital Nonlinear Landscape Architecture Design Based on Computer Big Data

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Abstract

Condensing the multi-dimensional digital model of green urban design, and constructing a digital method system of it progressively layer by layer. Based on this research background, the dissertation designs the spatial form of landscape architecture based on the data visualisation of nonlinear technology. The article uses the colour zoning method to design the actual scene of the garden landscape with nonlinear parameteriszation. The simulation result analyses that the proposed nonlinear algorithm has realised the efficiency improvement purpose of landscape architecture design.

Keywords: Landscape design, extensive data analysis, nonlinearity, feature extraction, spatial form design.
AMS 2010 codes: 34A34

1 Introduction

Before the emergence of landscape ecology, the status of landscape architecture belonged to architecture. Landscape design serves the construction and provides a place for leisure and entertainment in the crowded city. With the emergence of landscape ecology, the discipline of landscape architecture has gradually moved towards a self-independent development path. Landscape architecture in this period went hand in hand with architecture and urban planning, and each developed in its professional field [1]. This separation of disciplines destroys the diversity of places and humans to a certain extent. Due to the fragmentation of disciplines in the Chinese context,

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part of the landscape design is still attached to architecture, and the landscape is fragmented and homogeneous. Design pursues single issues such as form, function, style, and ecology within the discipline, and the limitations brought about by the separation of disciplines are becoming increasingly apparent.

Nonlinear science is regarded as "another revolution" in the history of science in the 20th century. It has almost spread to all fields of natural sciences, humanities, and social sciences and is changing people's traditional views of the real world. The scientific community believes that the research of nonlinear science has great scientific significance, and nonlinearity is the source of complexity and variety in nature [2]. The development of nonlinear science has also caused profound changes in philosophy and methodology. Our contribution to its exploration is creating a new subject field. Still, the more far-reaching significance is that it has brought about a significant change in the outlook on nature, the outlook on science, the methodology, and even thinking. Nonlinear interaction has a more intrinsic and essential meaning than linear interaction. Linear interaction is only a highly simplified and approximate treatment of nonlinear interaction. Information technology closely related to nonlinear science is developing rapidly, making today's society a transformation from a post-industry to an information society. Information technology is based on computer, communication and control technology. In recent years, information technology has developed database technology, artificial intelligence, expert system, remote sensing technology, geographic information system, global positioning system, computer-aided decision-making system, automatic control technology, monitoring technology, multimedia technology, computer network technology and other applications. And these technologies have widely influenced all aspects of people's lives.

With the continuous advancement of ecological landscape construction and improved living environment, people's quality standards for landscape construction are constantly improving. So we need to carry out multi-dimensional nonlinear landscape design. Combining the functional positioning of the landscape to optimise the structure of multi-dimensional nonlinear landscape design can improve its urban design. The multi-dimensional nonlinear landscape design method is of great significance in improving the rationality of architectural design and improving the living environment of human settlements [3]. The planning and design of landscape construction based on its development orientationand government policy-oriented factors can help us improve the spatial expression ability. The article uses computer vision with structured image analysis and parameter simulation methods to optimise multi-dimensional design. This paper proposes a multi-dimensional nonlinear landscape design method based on parameterised models to improve the quantitative analysis ability.

2 Multi-dimensional nonlinear landscape image analysis

2.1 Multi-dimensional nonlinear landscape image sampling

To achieve a multi-dimensional nonlinear landscape design, we need to perform model parameter analysis and feature extraction. We construct a dynamic feature distribution model of multi-dimensional nonlinear landscape images through block matching detection and fusion recognition of multi-dimensional nonlinear landscape images [4]. The article combines the fuzzy associated feature point detection method to optimise the extraction of multi-dimensional nonlinear landscape data. We combine fuzzy feature extraction methods to optimise the collection and feature recognition of multi-dimensional nonlinear landscape images. This article uses the pixel feature point area reconstruction method for multi-dimensional nonlinear landscape image processing and information fusion. The geometric invariant moment generation model for constructing a multi-dimensional nonlinear landscape image is

$$Dif(C_1, C_2) = \min_{\upsilon_i \in C_1, \upsilon_j \in C_2, (\upsilon_i, \upsilon_j) \in E} \omega[(\upsilon_i, \upsilon_j) + F_E] \tag{1}$$

$F_E = \frac{\ln I}{\ln D}$ represents the sampling point of multi-dimensional nonlinear landscape image features. We use the virtual scene space vision planning method to simulate multi-dimensional nonlinear landscape design parameters

to construct the spatial regional distribution model of multi-dimensional nonlinear landscape images [5]. Multi-dimensional nonlinear landscape regional fusion is performed in the gradient direction and combined with the template matching method to obtain the edge information of the multi-dimensional nonlinear landscape image as:

$$G_x(x,y,t) = \frac{\partial u(x,y,t)}{\partial x} \tag{2}$$

$$G_y(x,y,t) = \frac{\partial u(x,y,t)}{\partial y} \tag{3}$$

We decompose the edge information of the landscape image into two components along the gradient direction. The article uses $X_{i,j}$ to represent the edge pixel distribution set of the rational distribution of the landscape at the central pixel point (i, j). At the same time, we use the visual feature distributed reconstruction method to make multi-dimensional nonlinear landscape parameterised design decisions [6]. The length $L = x_{\max} - x_{\min}$, width$W = y_{\max} - y_{\min}$, and height $H = z_{\max} - z_{\min}$ of the landscape area distribution. We use the template block region matching method, traverse all sub-blocks, and combine high-resolution information fusion technology to simulate multi-dimensional nonlinear landscape parameters to obtain the scale-space:

$$M_{i,j} = med(X_{i-1,j-1} \cdots X_{i,j} \cdots X_{i+1,j+1}) \tag{4}$$

Then there are:

$$F_{i,j} = \begin{pmatrix} 1, |X_{i,j} - M_{i,j}| \geq T \\ 0, |X_{i,j} - M_{i,j}| < T \end{pmatrix} \tag{5}$$

The article combines the frame matching method to perform multi-dimensional nonlinear landscape block detection and feature matching, and the inter-frame pixel set is I_c. The adjacent frame is denoted as $NF_c = \{n : c-k \leq n \leq c+k\}$. We established a multi-dimensional nonlinear landscape parameter template matching model to obtain the plane pheromone of nonlinear landscape design as $G(x,y,t)$. among them:

$$u(x,y,t) = G(x,y,t) \tag{6}$$

Multi-dimensional nonlinear landscape image sampling in multi-scale space. We perform nonlinear landscape design based on the image sampling results.

2.2 Parametric simulation of multi-dimensional nonlinear landscape design

The thesis uses the virtual space visual planning method to simulate multi-dimensional nonlinear landscape design [7]. Combining the distribution characteristics of each pixel to perform multi-dimensional nonlinear landscape image similarity analysis, the expression of the spatial and regional feature matching model for landscape design is:

$$F = \widetilde{p}(x,y) = p(x,y)\left(\frac{\upsilon(x)}{\upsilon(y)}\right)^{1/2} \tag{7}$$

The matrix X is used to express the neighboring phase points and establish the entropy weight feature distribution set to realise the parameterised design of a multi-dimensional nonlinear landscape. We obtain the pixel covariance function of the multi-dimensional nonlinear landscape under the multi-scale eigendecomposition mode as:

$$\begin{aligned} p(x,y) &= \tfrac{k(x,y)}{\upsilon(x)} \\ \upsilon(x,y) &= \sum_y k(x,y) \end{aligned} \tag{8}$$

We take the pixel point i as the centre to perform the affine invariant region segmentation of the multi-dimensional nonlinear landscape image [8]. According to the number of observations in the training set, the

training function satisfies $0 \le \omega(i,j) \le 1$ and $\sum_{j\in\Omega} \omega(i,j) = 1$. Initialise the prior shape to obtain the parameter distribution matrix of the multi-dimensional nonlinear landscape design:

$$D = \begin{bmatrix} I_x^2 & I_x I_y \\ I_x I_y & I_y^2 \end{bmatrix} \tag{9}$$

Based on the parameter simulation results of multi-dimensional nonlinear landscape design, regional reconstruction is carried out. The parameter vectorisation feature extraction of multi-dimensional nonlinear landscape design is carried out by combining the RGB feature decomposition method.

3 Multi-dimensional nonlinear landscape design optimisation

We combined the RGB feature decomposition method to perform parameterised segmentation of multi-dimensional nonlinear landscape models [9]. The thesis extracts the fuzzy degree matching feature quantity of the multi-dimensional nonlinear landscape image. The estimated value of the parameters of the salient feature points in the inner and outer areas of the target edge of the landscape image is:

$$NLM[g(i)] = \sum_{j\in\Omega} \omega(i,j) g(j) \tag{10}$$

Based on the idea of metric learning, the three-dimensional feature reconstruction parameters of multi-dimensional nonlinear landscape images are uniformly distributed [10]. That is, the pixel sequence satisfies $n \in N(0, \sigma_n^2)$. The paper uses a parameterised model for structural analysis to find the second moment of multi-dimensional nonlinear landscape design:

$$\mu_{pq} = \sum_{m=1}^{M} \sum_{n=1}^{N} (x - \dot{x})^p (y - \dot{y})^q f(x,y) \tag{11}$$

We use first-order moments m_{01} and m_{02} to denote the edge blur characteristics of multi-dimensional nonlinear landscape images, respectively [11]. We use the block fusion technology to obtain the edge template area of the landscape design that satisfies the normal distribution in the $n_c \times n_r$ sub-blocks to obtain the fine-grained feature point extraction results of the landscape image:

$$I_1 = \frac{n_{20} n_{02} - n_{11}^2}{n_{00}^4} \tag{12}$$

$$E_m^{ij} = \sum_{k=0}^{255} e_{mk}^{ij} \tag{13}$$

$$e_{mk}^{ij} = \begin{cases} -p_k \log p_k & p_k \neq 0 \\ 0, & p_k = 0 \end{cases} \tag{14}$$

p_k is the vectorised dimension of the spatial data of the landscape image; $m = 1, 2, \cdots, N$. We extract parameterised models of multi-dimensional nonlinear landscape views [12]. The vector quantisation feature set of the multi-dimensional nonlinear landscape image obtained based on the parameterised model method to achieve the multi-dimensional nonlinear landscape design is:

$$p_{ij}(A) = \begin{cases} \frac{\omega_{ij}}{\omega_i}, & i \neq j e_{ij} \in A \\ 0 & i \neq j e_{ij} \in A \\ 1 - \frac{\sum\limits_{j:e_{ij}\in A} \omega_{ij}}{\omega_i}, & i = j \end{cases} \tag{15}$$

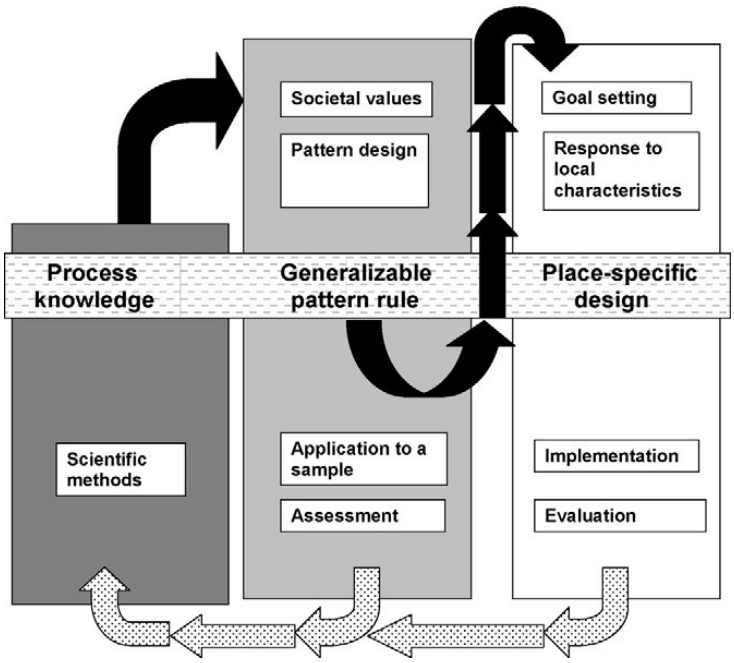

Fig. 1 Landscape design implementation process

We use the block template matching method to perform the parameterized segmentation of the multi-dimensional:

$$x(k) = [x_1(k), x_2(k), \cdots, x_m(k)], i = 1, 2, \cdots, m \tag{16}$$

k is the sampling node of multi-dimensional nonlinear landscape data; $x_i(k)$ is the data stream. The realisation process of the whole model is shown in Figure 1.

4 Experimental test analysis

The experiment adopts a Matlab simulation design. The sample pixel scale of landscape images is 100$\sim$ 600. The pixel distribution of the landscape image is 300 $\times$ 300. The modulus of metric learning is 100. The number of iterations is 1200. The descriptive statistical analysis results of the correlation parameters are shown in Table 1.

Table 1 Descriptive statistical analysis results

Number of samples	Landscape relevance	Similarity coefficient	Contribution level	Blur factor
100	0.723	0.456	0.775	0.532
200	0.434	0.556	0.565	0.545
300	0.531	0.434	0.454	0.554
400	0.534	0.643	0.554	0.545
500	0.422	0.434	0.324	0.544
600	0.345	0.454	0.455	0.434

According to the descriptive statistical analysis results in Table 1, multi-dimensional nonlinear landscape image sampling is performed. We use the virtual scene space visual planning method to simulate multi-dimensional nonlinear landscape design parameters to achieve landscape optimisation design [13]. The design effect results

are shown in Figures 2–4. Analysing Figures 2–4, we know that our multi-dimensional nonlinear landscape design method has a better effect.

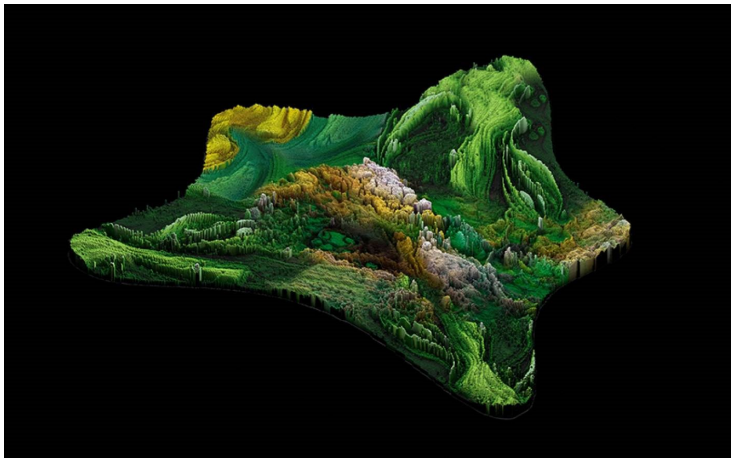

Fig. 2 The design results of the park landscape parameterised structural features

Fig. 3 Parameterised results of architectural landscape design

The test regression analysis value and test value, and other parameter results are shown in Table 2. Analysing Table 2 shows that we adopt the method of this paper to carry out multi-dimensional nonlinear landscape design with better visual feature expression ability. The parameter distribution structured fitting accuracy is high.

5 Conclusion

This paper proposes a multi-dimensional nonlinear landscape design method based on a parameterised model to extract a multi-dimensional nonlinear landscape view model. We use parameteried model methods to achieve multi-dimensional nonlinear landscape design. The article uses the computer vision image analysis method to carry out multi-dimensional nonlinear landscape design and constructs a parametric analysis model of multi-dimensional nonlinear landscape design. We combine fuzzy feature extraction methods to optimise the col-

Fig. 4 Result of parameter design of a country house

Table 2 Regression analysis value and test value

Variable name	Mean	Standard value	F test value
Landscape planning structure	0.456	1.432	0.456
Habitat satisfaction level	0754	1.544	0.656
Environmental risk factor	0.467	1.676	0.265
Ecological improvement level	0.435	1.545	0.645
Landscape construction scale	0.567	0.545	0.367
Decision evaluation value	0.365	0.567	0.655
Overall planning configuration efficiency	0.545	0.545	0.345
Regression standard deviation	0.567	0.753	0.655

lection and feature recognition of multi-dimensional nonlinear landscape images. The analysis shows that we have a solid ability to express visual characteristics of multi-dimensional nonlinear landscape design using this method. Moreover, the landscape design effect obtained by this method is better.

References

[1] Giblin, B., Cataneo, M., Moews, B., & Heymans, C. On the road to per cent accuracy–II. Calibration of the nonlinear matter power spectrum for arbitrary cosmologies. Monthly Notices of the Royal Astronomical Society., 2019. 490(4): 4826-4840

[2] Scaife, C. I., Singh, N. K., Emanuel, R. E., Miniat, C. F., & Band, L. E. Non-linear quickflow response as indicators of runoff generation mechanisms. Hydrological Processes., 2020. 34(13): 2949-2964

[3] Scaife, C. I., Singh, N. K., Emanuel, R. E., Miniat, C. F., & Band, L. E. Non-linear quickflow response as indicators of runoff generation mechanisms. Hydrological Processes., 2020. 34(13): 2949-2964

[4] Kimberley, A., Bullock, J. M., & Cousins, S. A. Unbalanced species losses and gains lead to nonlinear trajectories as grasslands become forests. Journal of Vegetation Science., 2019. 30(6): 1089-1098

[5] Sulaiman, T., Bulut, H. & Atas, S.Optical solitons to the fractional Schrödinger-Hirota equation. Applied Mathematics and Nonlinear Sciences., 2019. 4(2): 535-542

[6] Kaur, D., Agarwal, P., Rakshit, M. & Chand, M. Fractional Calculus involving (p, q)-Mathieu Type Series. Applied Mathematics and Nonlinear Sciences., 2020.5(2):15-34.

[7] Chon, H., & Sim, J. From design thinking to design knowing: An educational perspective. Art, Design & Communication in Higher Education., 2019. 18(2): 187-200

[8] Toubeau, J. F., Iassinovski, S., Jean, E., Parfait, J. Y., Bottieau, J., De Grève, Z., & Vallée, F. Nonlinear hybrid approach for the scheduling of merchant underground pumped hydro energy storage. IET Generation, Transmission & Distribution., 2019. 13(21): 4798-4808

[9] Abramczyk, H., Brozek-Pluska, B., Jarota, A., Surmacki, J., Imiela, A., & Kopec, M. A look into the use of Raman

spectroscopy for brain and breast cancer diagnostics: linear and nonlinear optics in cancer research as a gateway to tumor cell identity. Expert review of molecular diagnostics., 2020. 20(1): 99-115

[10] Alam, M. N. K., Roussel, P., Heyns, M., & Van Houdt, J. Positive nonlinear capacitance: The origin of the steep subthreshold-slope in ferroelectric FETs. Scientific reports., 2019. 9(1): 1-9

[11] Callaghan, C. T., Bino, G., Major, R. E., Martin, J. M., Lyons, M. B., & Kingsford, R. T. Heterogeneous urban green areas are bird diversity hotspots: insights using continental-scale citizen science data. Landscape Ecology., 2019.34(6): 1231-1246

[12] Heidari, A., Esposito, J., & Caissutti, A. The quantum entanglement dynamics induced by non–linear interaction between a moving nano molecule and a two–mode field with two–photon transitions using reduced von neumann entropy and jaynes–cummings model for human cancer cells, tissues and tumors diagnosis. Int J Crit Care Emerg Med., 2019.5(2): 071-084

[13] Maier, R., & Robson, K. Exploring university-to-college transfer in Ontario: A qualitative study of nonlinear post-secondary mobility. Canadian Journal of Higher Education/Revue canadienne d'enseignement supérieur., 2020. 50(1): 82-94