Application of Interactive Genetic Algorithm in Landscape Planning and Design

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This article aims at improving the design effect of garden landscape space environment and optimizes the structure of garden landscape space environment. An optimization design method of garden landscape space environment based on interactive genetic algorithm is proposed in this article by designing a landscape space environment design with image visual feature space distributed monitoring model and fuzzy pixel area feature fusion reconstruction model. The landscape space environment design of the image by multistage decomposition and pixel gray characteristics has been established landscape space environment design image visual feature reconstruction model. The method proposed in this article combines the block area template matching method with landscape space environment design of the image features visual reconstruction. The visual space distributed detection is done with information fusion using the similarity model reconstruction for landscape space environment design of image visual perception process of information fusion. In order to extract fuzzy characteristic landscape space environment design of the image, interactive genetic algorithm is used to realize the quality assessment of landscape art information fusion perception and visual reconstruction. The simulation results show that compared with the traditional method, the visual reconstruction quality of landscape spatial environment design image processed by this method is better along with higher image recognition accuracy, and the output signal-to-noise ratio is improved by 14.6%. The experimental results prove that the introduction of interactive genetic algorithm in landscape planning and design can effectively solve the problems of multi-level feature decomposition and pixel feature separation in the process of landscape design. The proposed method achieves better optimization of landscape spatial environment structure, and achieves good landscape spatial environment design effect.

Povzetek: Za snovanje prostorskih krajinskih načrtov, npr. vrtov, je uporabljen interaktivni genetski algoritem.

1 Introduction

The development of computer vision information processing technology, using visual image processing method to analyze and extract the features of garden landscape space environment, and establishing the visual reconstruction model of garden landscape space environment design image can effectively improve the artistic feature identification and fusion reconstruction ability of garden landscape space environment. In recent years, the feature reconstruction technique of landscape spatial environment art has attracted extensive attention from scholars at home and abroad. Compared to traditional landscape design method of space environment, the introduction of artificial intelligence technology, such as interactive genetic algorithm (depicted in Figure 1) can effectively extract the geometrical characteristics of the landscape space environment design image analysis model.

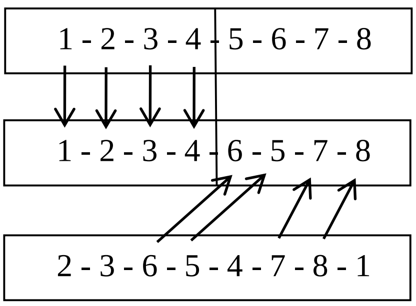


Figure 1: Interactive genetic algorithm

By machine vision characteristics such as 3-d reconstruction method, realization of the landscape space environment design and visual image reconstruction, the ability of geometric characteristic of visual recognition can be improved, thus, obtaining high-quality structural models [1].

1.1 Literature review

In view of this research problem, Shen proposed that the feature reconstruction of garden landscape spatial environment art is based on the visual reconstruction of garden landscape spatial environment design image, and the distributed fusion of visual image and binary recognition method can be used for the visual reconstruction processing of garden landscape spatial environment design image [2]. Based on the existing classification, Tamene *et al.* introduced the related concepts, development and role of ARTIFICIAL intelligence in landscape architecture research, and pointed out the specific application and existing problems of various artificial intelligence methods in landscape architecture analysis, design and evaluation [3]. Murgante *et al.* divided the mainstream ARTIFICIAL intelligence methods in landscape architecture research into artificial life, intelligent random optimization and machine learning, discussed the principle, development and characteristics of typical algorithms in each category, and then discussed the necessity of establishing a hybrid intelligence system and its future development prospect, as shown in Table 1 [4]. According to the attributes and applications of ARTIFICIAL intelligence, Ohman analyzed its limitations in the research of landscape architecture and pointed out the development trend of intelligent design of landscape architecture [5]. Smith proposed a CA model for landscape design based on inertial weight particle swarm optimization, introduced swarm intelligence into landscape design modeling, reduced the uncertainty of simulation, and established an efficient CA model to simulate landscape dynamics [6]. Anagnostopoulos and Mamanis used the improved Logics-CA mathematical model to simulate and predict the characteristics of landscape evolution space process under three conditions (historical extrapolation, endogenous development and exogenous development) in Tianjin Coastal area from 2011 to 2020, so as to further obtain the elements affecting landscape design and master the development process of landscape design [7]. Cho *et al.* proposed the use of interactive genetic algorithm to express the cycle iteration relationship of design activities in view of the complex iterative cycle in garden engineering design, so as to clearly reflect the data mutual extraction between design activities [8]. Eikelboom *et al.* proposed a DSM-GA algorithm compiled based on the critical path Method (CPM), and applied the genetic algorithm to the design activity matrix to find a better order arrangement of design activities, so as to optimize the design iteration and shorten the design period [9]. Venema and Calamai extracted the geometric feature analysis model of garden landscape spatial environment design image, and realized garden landscape spatial environment design and image visual reconstruction through the 3d reconstruction method of computer vision features [10]. Banyai used pixel tracking and fusion technology to construct key feature quantity of landscape spatial environment design image, and realized landscape spatial environment design and optimization recognition [11].

1.2 Contribution

On the basis of the current research, this paper proposes an optimization design method of landscape space environment based on interactive genetic algorithm. A landscape space environment design is built in this article for image visual feature space distributed detection and fuzzy pixel area feature fusion reconstruction. The classification of artificial intelligence in landscape architecture research is depicted in Figure 2.

The proposed model achieves a similarity information fusion model is adopted to improve the landscape space environment design in the process of visual image reconstruction garden art landscape perception and block template matching area information fusion. This article aims at improving the design effect of garden landscape space environment and optimize the structure of garden landscape space environment. An optimization design method of garden landscape space environment based on interactive genetic algorithm is proposed in this article by designing a landscape space environment design with image visual feature space distributed monitoring model and fuzzy pixel area feature fusion reconstruction model. The method proposed in this article combines the block area template matching method with landscape space environment design of the image features visual reconstruction. The visual space distributed detection is done with information fusion using the similarity model reconstruction for landscape space environment design of image visual perception process of information fusion. The proposed method achieves better optimization of landscape spatial environment structure, and achieve good landscape spatial environment design effect.

The rest of this article is arranged as: section 2 presents the research methods depicting the visual sampling and fusion of landscape spatial environment design. Section 3 presents the research results and discussion followed by conclusion in section 4.

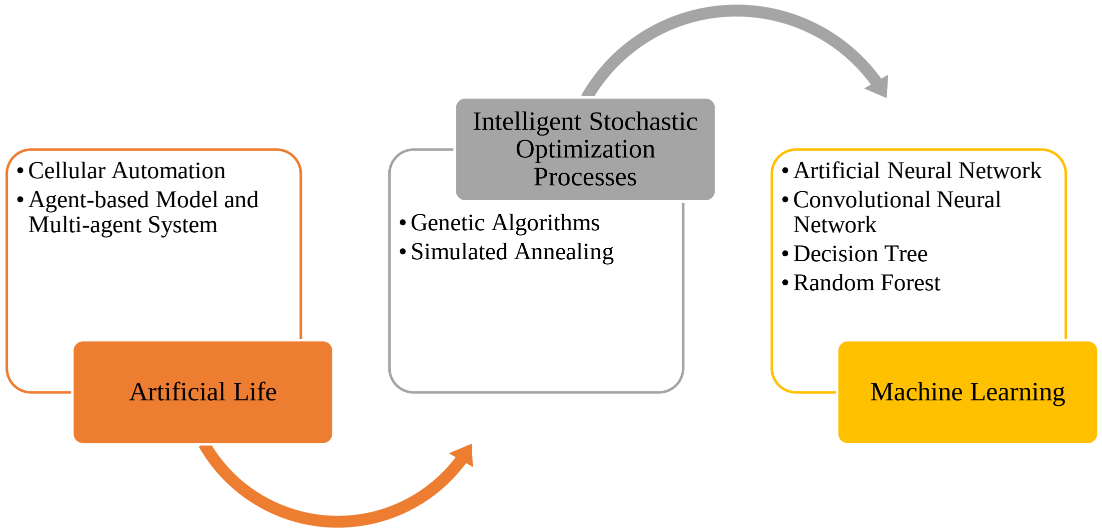


Figure 2: Classification of artificial intelligence in landscape architecture research

2 Research methods

2.1 Visual sampling and fusion of landscape spatial environment design

The flowchart of visual sampling and fusion of landscape spatial environment design is presented in Figure 3.

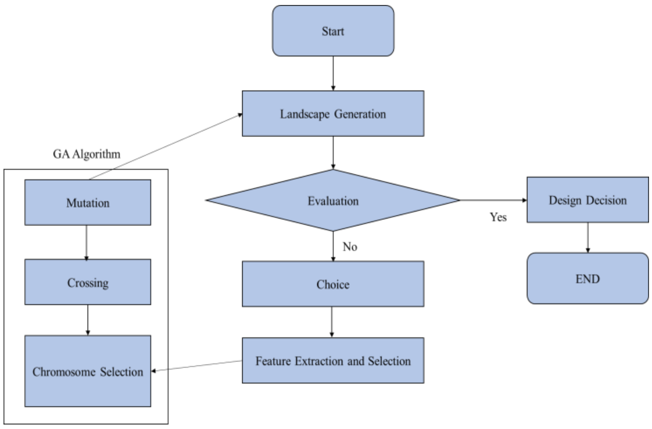


Figure 3: Flowchart of landscape spatial environment design

The system provides the genetic operation applications in urban landscapes for evolving the input variabilities in position of walls, their heights and building structure. The weighted estimate of feature matching is done using spare features for image reconstruction which is detailed in further subsection.

A. *Landscape space environment design image collection*

In order to achieve the landscape space environment design based on interactive genetic algorithm (GA) and visual image reconstruction, to build landscape space environment design of the image pixel space fusion model. The feature matching method is adopted to improve the landscape space environment design and

image feature detection [12], for the sparse feature of the landscape space environment design image reconstruction. The Atanassov extension method was used to match feature points of landscape spatial environment design images, and the template matching model for visual reconstruction of landscape spatial environment design images was constructed, as shown in Figure 4.

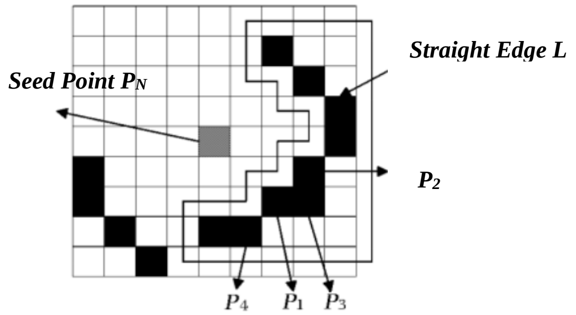


Figure 4: Template matching model of landscape space environment design

Assume that landscape space environment design of the image gray of pixel sets (I, j), as a pixel center, sharpening template block combination method is used to construct landscape space environment design of the image characteristics of visual reconstruction model. For the first k is the belt in the acquisition of landscape space environment design of the image grey value I_{swk}, in gray pixel distribution characteristics of space, The gradient characteristic components of the corresponding landscape spatial environment design image are as follows:

$$P_{rk} = \left(\frac{\sum_{j=1}^{c} I_{swk}(1,j)}{c}, \frac{\sum_{j=1}^{c} I_{swk}(2,j)}{c}, \ldots, \frac{\sum_{j=1}^{c} I_{swk}(1,j)}{c}, \ldots, \frac{\sum_{j=1}^{c} I_{swk}(r,j)}{c}\right) \quad (1)$$

$$P_{ck} = (\frac{\sum_{i=1}^{r} I_{swk}(i,1)}{r}, \frac{\sum_{i=1}^{r} I_{swk}(i,2)}{r}, \ldots, \frac{\sum_{i=1}^{r} I_{swk}(i,j)}{r}, \ldots, \frac{\sum_{i=1}^{r} I_{swk}(i,c)}{r}) \quad (2)$$

Where C is the column number of LGB vector quantization matrix of landscape spatial environment design image, and R is motion fuzzy feature quantity. Based on the fusion reconstruction method of fuzzy pixel regional features, the pixel set of artistic feature distribution of landscape spatial environment was obtained, and the information reconstruction and three-dimensional perception of landscape spatial environment design image were carried out to improve the ability of environment design.

B. Image feature fusion and reconstruction model

The spatial distributed detection model of visual feature of landscape spatial environment design image was constructed. Multi-stage feature decomposition and grey pixel feature separation of garden landscape spatial environment design image are carried out [13-15], and the visual feature reconstruction model of garden landscape spatial environment design image is established. The visual feature distribution of garden landscape spatial environment design image is as follows:

$$G(\vec{x}) = \sum_{j=1}^{p} G_j(\vec{x}) \quad (3)$$

Adaptive fusion method was used to reconstruct the image vision of landscape design, and the edge vision reconstruction model of landscape spatial environment design was constructed [16, 17]. The fuzzy proximity function of landscape spatial environment image was obtained as follows:

$$fitness(\vec{x}) = f(\vec{x}) + (Ct)^{\alpha} \sum_{j=1}^{p} G_j^{\beta}(\vec{x}) \quad (4)$$

It is assumed that the coordinate of garden landscape spatial environment design P_N is (X_{PN}, Y_{PN}), then the coordinate of all garden landscape spatial environment design edge points (X_k, y_k) on L is compared with P_N: when $X_K > X_{PN}$, $i_L = i_L + 1$; When $x_K < X_{PN}$, $i_L = i_L - 1$; When $X_k = X_{PN}$, $i_L = i_L + 0$. The perception fusion model of landscape art information fusion is constructed, and the fitness function of landscape art information fusion is as follows:In this section various state-of-the-art work in the field of optimization design based on Computer-Aided architecture is presented.

$$fitness(\vec{x}) = \begin{cases} f(\vec{x}), \\ 1 + rG(\vec{x}), \end{cases} \quad (5)$$

Considering the gray level f of the garden landscape spatial environment design, the resolution model of the garden landscape spatial environment vision is constructed by using the gray level invariant moment feature decomposition method [18-20], and the visual feature reconstruction model of the garden landscape spatial environment is as follows:

$$W_u(a,b) = e^{i2\pi k \ln \alpha} \times \frac{K}{\sqrt{\alpha}} \left\{ \begin{aligned} &\left[\frac{\alpha e^{\frac{j2\pi f_{\min}}{\alpha}(b-b_\alpha)}}{f_{\min}} - \frac{e^{\frac{j2\pi f_{\max}}{\alpha}(b-b_\alpha)}}{f_{\max}} \right] + j2\pi(b-b_\alpha)[Ei(j2\pi f_{\max}(b-b_a))] \\ &- Ei(\frac{j2\pi f_{\min}}{\alpha}(b-b_\alpha))] \end{aligned} \right\} \quad (6)$$

Where $b_a = (1-a)\left(\frac{1}{af_{max}} - \frac{T}{2}\right)$, $Ei(.)$ represents the recombination output of visual information features of garden landscape spatial environment. Combined with model recognition method, garden landscape design is carried out.

2.2 Optimization of landscape design

A. Landscape space environment vision

After extracting all edge points on L, δ_1^2 is the local variance of landscape spatial environment design image, δ_n^2 is the optimization coefficient of landscape spatial environment design image. $\beta = \max[\frac{\delta_1^2 - \delta_n^2}{\delta_1^2}, 0]$, using gradient descent method for visual landscape space environment of the regional block visual refactoring, make landscape space environment design of the image sparse eigenvalue meet $C \in S$, according to the sparse prior as a result, the environmental design of landscape space, image Fm the first m frames (x, y) (x, y) in the optimal visual reconstruction threshold. Based on the approximate sparse representation method, template matching of landscape spatial environment design image was carried out, and the matching coefficient was obtained as follows:

$$g_i^* = \begin{cases} Rs_j, z \le i \le x - y \\ g_i, \text{否则} \end{cases} \quad (7)$$

In the formula, R is a standard constant. In combination with block area template matching method, landscape spatial environment design and distributed detection are carried out, and contour point matching model is used to extract edge features of landscape spatial environment design [21-23]. The maximum gray value of image analysis department of landscape spatial environment design is:

$$n_{pg} = \frac{\mu_{pb}}{(\mu_{00})^{\gamma}} \quad (8)$$

Sparse representation and super-resolution reconstruction methods were used for visual reorganization of landscape spatial environment design, and interactive genetic algorithm was used to realize landscape art information fusion perception. The information reconstruction model of landscape spatial environment design was expressed as follows:

$$g(x,y) = f(x,y) + \varepsilon(x,y) \tag{9}$$

$f(x,y), g(x,y)$ and $\varepsilon(x,y)$ respectively represent the original landscape spatial environment image, reconstructed image and gray scale image. In summary, interactive genetic optimization design of landscape design can be carried out.

B. Interactive genetic optimization

This paper proposes a visual reconstruction algorithm for landscape spatial environment design based on interactive genetic algorithm [24,25]. Template matching method combining block areas landscape space environment design of the image characteristics of visual reconstruction, based on local feature adaptive feature matching method constructs a model of information fusion visual landscape space environment, the construction of landscape space environment art characteristic expression model, under the genetic evolutionary optimization, get the garden art landscape information fusion expression is:

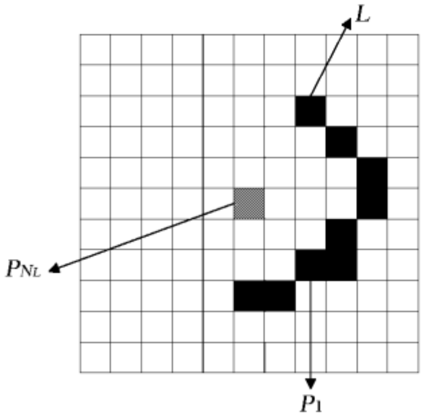
$$g = k \otimes f + n \tag{10}$$

Where ⊗ represents convolution operator, carries out vector set fusion processing on the collected design images of landscape spatial environment, constructs the visual feature decomposition model of landscape spatial environment, and obtains the best discerning feature value of landscape spatial environment vision:

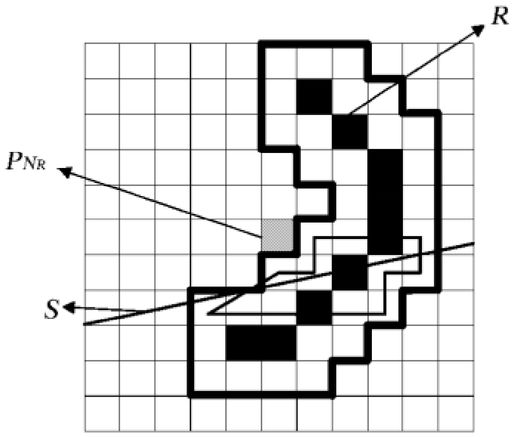
$$s_{PPM}(t) = \sum_{i=-\infty}^{\infty} \sum_{j=0}^{N_p-1} p(t - iT_s - jT_p - c_j T_c - a_i \varepsilon) \tag{11}$$

$$s_{PPM}(t) = \sum_{j=-\infty}^{\infty} d_j p(t - jT_s) \tag{12}$$

Where T_s is the optimization iteration width of genetic evolution. Under interactive inheritance, the block model of garden landscape spatial environment design is obtained, as shown in Figure 5.



(a): Block matching of left seed points



(b): Block matching of right seed points

Figure 5(a, b): Landscape space environment design

Gray correlation constraint is added to determine the final matching point, and the image pixel decomposition model is expressed as:

$$x(t) = \sum_{m=1}^{M} \sum_{k=1}^{K(m)} \omega_{nk} s(t - T_m - \tau_{mk}) + v(t) \tag{13}$$

In the formula, ω_{nk} is the fuzzy feature component of landscape spatial environment vision. Under the genetic interactive evolution, the output of landscape optimization design is:

$$\begin{cases} x = R\sin\eta\cos\varphi, 0 \le \varphi \le 2\pi \\ y = R\sin\eta\sin\varphi, 0 \le \eta \le \pi \\ z = R\cos\eta, R = D/2 \end{cases} \tag{14}$$

Among them, η represents the landscape spatial visual reconstruction function, φ represents the Angle function of landscape spatial environment image visual reconstruction, and R represents the template matching coefficient.

3 Research results and discussion

In order to verify the application performance of the proposed method in realizing the spatial environment design of landscape, simulation experiment analysis was conducted. It was assumed that the number of seed points in landscape design was 40, the coefficient of feature matching was 0.36, and the block size of pixel points was 200×200. The gray scale of landscape design was shown in Figure 6.

Design Sample 1

Design Sample 2

Figure 6: Gray scale of landscape design

Taking the image in Figure 6 as the research object, the similarity information fusion model is used to carry out the perception of landscape art information fusion and block region template matching in the process of visual reconstruction of landscape spatial environment design image to realize the design optimization, and the optimized design results are shown in Figure 7. The analysis of Figure 7 shows that the proposed method can effectively realize the optimal design of landscape space environment, with higher image recognition accuracy and improved design effect. The output SNR of the proposed method is 14.6% higher than that of the traditional method.

Design Sample 1

Design Sample 2

Figure 7: Optimization of landscape design

The proposed genetic algorithm-based approach is compared with the tradition method in terms of Signal to noise ratio as well as accuracy. The outcomes obtained are depicted in Figure 8.

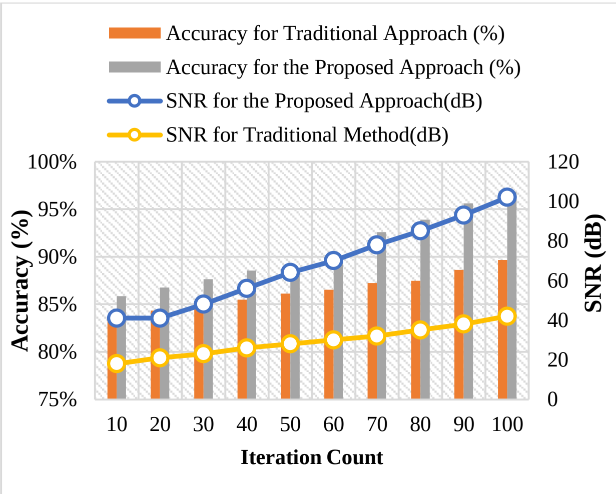


Figure 8: Comparative analysis of proposed and traditional method

The output signal-to-noise ratio is improved by 14.6% for the proposed approach as compared to the tradition approach. The accuracy value obtained using the proposed method is improved by 7.9% comparative to the traditional approach. The outcomes obtained depicts the viability of the proposed approach.

4 Conclusion

This article presents an optimization design method of landscape space environment based on interactive genetic algorithm. Firstly, the multi-stage feature decomposition and grey pixel feature separation of landscape spatial environment design image are carried out by constructing distributed detection of visual feature space and reconstruction model of fuzzy pixel region feature fusion. On this basis, the visual feature reconstruction model of landscape spatial environment design image was established, the fuzzy feature quantity of landscape spatial environment design image was extracted, and the interactive genetic algorithm method was used to realize the landscape information fusion perception and visual reconstruction quality evaluation of landscape art. The sparse representation and super-resolution reconstruction methods were used for visual reorganization of landscape spatial environment design, and interactive genetic algorithm was used to realize landscape art information fusion perception and landscape design optimization. The simulation results show that compared with the traditional method, the visual reconstruction quality of landscape spatial environment design image processed by this method is better along with higher image recognition accuracy of 96.78%, and the output signal-to-noise ratio is improved by 14.6%. The experimental results prove that the introduction of interactive genetic algorithm in landscape planning and design can effectively solve the problems of multi-level feature decomposition and pixel feature separation in the process of landscape design. The method proposed achieves better optimization of landscape spatial environment structure and has a good design effect of landscape spatial environment.

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