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Research Article

The Interaction between Public Environmental Art Sculpture and Environment Based on the Analysis of Spatial Environment Characteristics

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The interaction with the public and the coordinated change with the environment are more important in public environmental art sculpture. To be more accessible to the public, public environmental art sculptures should be integrated with the environment and interact with the public. Paying close attention to the scale and volume design of sculpture is one of the elements that embody and express the connotation of works, as well as one of the objects that sculpture, as a member of environmental elements, must study and analyze thoroughly. Based on this, this paper investigates the relationship between sculpture and environment in public environmental art through an examination of space environment characteristics, with the goal of creating a public space environment in which public art sculpture, the environment, and people are all in sync. The improved AFSA (artificial fish swarms algorithm) model is used to optimize the landscape ecological pattern. The landscape index can be predicted and analyzed more accurately using a dynamic model of landscape pattern from remote sensing and a geographic information system. Experiments show that this algorithm's prediction accuracy has significantly improved, providing a solid foundation for landscape ecological management and planning.

1. Introduction

Sculpture is a very important link in urban development and an important part of environmental art. Because of the influence of the location and other factors, sculptures placed outdoors show certain permanent characteristics, so it is very important to properly handle the relationship between sculptures and the environment. As a part of the development of mainstream art, this creative form tries to break the historical gap between life and art [1]. Sculptors can use any medium including clay, stone, sound, light, and sound to create environmental sculptures. There is an inevitable connection between public art sculpture and the space environment. Sculpture must be structurally coordinated with the surrounding environment, and the coordination between the designed works and the space of public culture should also be considered [2, 3]. Only in this way can the public environment art sculpture and the environment promote each other, create a tacit atmosphere for each other, and then increase the charm of the whole space.

Sculpture can refine the cultural information in the environment's main body, allowing for the creation of a matching scheme of theme, content, and even formal structure, resulting in a harmonious and interdependent relationship between them [4]. Thus, art sculpture in the public environment belongs to the urban public form, is an art created and designed for a specific urban environment, is an artistic practice that occurs and unfolds in public places or public spaces, and maintains a mutually complementary and benign interactive relationship with other environmental elements, resulting in an integrated and organically unified overall urban environment [5, 6]. However, many public art sculptures have lost their aesthetic value due to a variety of factors. Instead of becoming beautiful scenery, they have polluted the environment and have become unfamiliar or even trash in urban areas. As a result, public

environmental art sculpture in the cultural area should be capable of enhancing the environment and space atmosphere of the entire cultural area, and good sculpture works can evoke memories of not only the sculpture works themselves, but also the entire cultural area [7]. It is, however, also the most easily overlooked location. The integration with the surrounding environmental space, which is the display of integrated environmental space, is the goal of public environmental art sculpture. People need art sculptures in the public environment to enrich their lives, and sculpture is the best carrier for displaying the atmosphere of cultural areas.

Environment includes human environment and material environment [8], which is not only the bearing space of public environmental art sculpture, but also the living space of citizens [9]. The art sculpture in public environment with proper location, vivid image, and reasonable scale is an important landscape element of urban space environment, which can play the role of unified coordination and guidance of landscape [10]. In the end, contemporary public space art sculpture is an artistic expression form in the urban space environment, which is an important part of the urban space environment and has an impact on it. Whatever the theme, type, or form of the sculpture, it must adapt to the functions and characteristics of the surrounding space environment, as well as properly reflect those characteristics, in order to render and contrast the urban space environment, adjust the urban color, and enhance the visual feeling of public beauty [11]. Sculpture places a greater emphasis on public interaction and coordinated changes in the environment. It differs in content from previous environmental sculptures that emphasized theme and memorial, but it makes reasonable conception and design to create a space that interacts and coordinates with the public and the environment, based on the artist's imagination and various factors of environmental space.

2. Related Work

The research and creation of foreign public environmental art sculptures are very mature, the supporting facilities for sculptures in cities are perfect, and the developed countries in Europe and America are the most developed areas of public environmental art sculptures in the world. In major cities in Europe and America, there are almost all familiar sculptures as important urban cultural landscapes. Literature [12] holds that public environmental art sculpture is a kind of public sculpture art form that relies on outdoor public space in urban public space and can be appreciated by the general public. Whether it is western "environmental sculpture" or what Chinese scholars call "public environmental art sculpture," its foothold is the interaction between the social function of sculpture and the public, and its main content is to integrate the media of public environmental art sculpture into the daily life of the general public and serve the general public. Literature [13] holds that an excellent public sculpture often becomes the symbol of a city's public culture. However, due to the different places where sculptures are set and the different human environment, the public responsibilities of artistic sculptures are also different. Literature [14] holds that in terms of expression techniques and forms, outdoor sculpture should not only coordinate with the architectural appearance, but also play a role in enriching the active environment and space atmosphere. Literature [15] holds that urban space is a space composed of entities and a stage for people's daily life. It can exist between buildings, a street, a downtown area, even the whole city, or a larger urban space. Literature [16] holds that the restriction of space environment on public environment art sculpture is mainly manifested in two aspects, namely, the setting location and control elements of public environment art sculpture. Literature [17] holds that human factors are the comprehensive embodiment of emotional forms, environmental atmosphere, decorative effects, spatial feelings, and other aspects in environmental space, and finally, the human environment of urban environmental space is formed through these aspects.

The ecological pattern of a landscape is an important aspect of landscape ecology. Landscape ecological pattern analysis and evaluation can provide a solid foundation for landscape ecological management and planning, and it is the key to successful landscape ecological planning [18]. Various nonlinear data processing technologies are used to predict various landscape indexes based on the landscape pattern dynamic model of RS (remote sensing) and GIS (geographic information system) and landscape ecology as the theoretical basis. The surface is reconstructed from an undirected point set using a distance field isosurface extraction algorithm proposed in [19]. Because this nonlinear algorithm includes a complicated normal consistency check and isosurface extraction process, the model reconstruction process takes a long time. The surface is reconstructed using a noisy directed point set as input in the literature [20], but the reconstructed result still contains noise. Literature [21] uses a Voronoi diagram to decompose the scanned data before using Delaunay triangulation to reconstruct the mesh model. This method can accurately fit the scanned data point set, but ideal reconstruction results for noisy models and sharp features are difficult to achieve. To solve this problem, literature [22] proposed a user-assisted reconstruction algorithm. He requested that users place restrictions in areas that are unstable or imperfect, whether inside or outside. Literature [23] used distributed memory parallel processing to speed up the reconstruction of Poisson's surface, resulting in a good speedup ratio and little loss in reconstruction results. For a large number of point cloud data, literature [24] proposes a 3D surface reconstruction method based on principal component analysis. The three-dimensional surface of the pipeline is reconstructed using the principal component analysis method, and its accuracy is effectively improved, meeting the accuracy requirements of engineering survey. This reconstruction method, on the other hand, is appropriate for first-order surface continuity of the measured object.

3. Research Method

3.1. Research on the Interactive Relationship between Public Environmental Art Sculpture and Environment. Sculpture is a form of art that exists in a specific location. The combined

visual and psychological effects of sculpture with the indoor and outdoor environment demonstrate the mutual penetration and integration of artistic and scientific functions. As a result, the sculpture must be appropriate for the environment, meaning that its volume, shape, and material must conform to the specific environment and space in order to produce the desired effects. Depending on the specific purpose of sculpture creation, the desired effect can be harmonious or antagonistic. Sculpture, in its role as art, provides a finishing touch to the outdoor environment, enhancing people's visual experience. The limitations in the process of sculpture creation are greater for indoor sculpture than for outdoor sculpture. Indoor sculptures are limited by regional functions, such as commercial, office, and residential areas, in addition to being suitable for lighting. Sculptures are differentiated by their regional functions.

The interaction of emotional communication of public environmental art sculpture is mainly carried out among three elements, namely, the subject, the object, and the interactive media, namely, the self-emotion of the designer of public environmental art sculpture, the attitude toward sculpture, the understanding of materials and the presentation of design ideas, etc. That is, the appreciators and acceptors of the public environmental art sculpture of the object, these audiences are bound to add their own feelings to the public environmental art sculpture and feel the creator's feelings; that is, the media public environment art sculpture itself, the public environment art sculpture is like a symbol, which conveys the designer's subject emotion to the audience object, and is the interactive medium and link between the subject and object.

The foundation of the 3D urban landscape model is the D-Digital City Information System. One of its key features is that it can manage terrain structure (digital elevation model), terrain texture (digital orthophoto scene), 3D artificial building structure information, and artificial building texture information. Furthermore, the system includes 3D urban model visualization technology, which employs virtual reality to represent transmission stereo models or virtual stereo models on a screen. The data model of 3D digital city is shown in Figure 1:

In different environments, sculpture gives people different visual feelings and different psychological experiences. Designers are required to pay attention to the interaction between sculpture and natural environment, coordination, and unity. Only when sculpture works become the carrier of nature, can they bring permanent artistic vitality to sculpture works, specifically when creating environmental sculptures, taking the characteristics of the natural environment as a starting point, and enriching the essence and connotation of sculptures by using relevant elements in the environment, so as to achieve the expected design effect.

The scale and form of environmental sculpture must be appropriate for the location of the sculpture, be consistent with the behavior and psychological activities of people in that location, and attempt to establish some sort of connection with the general public. The sculpture's form and theme are related to the public's behavior and psychology, resulting in a relaxed and interesting atmosphere. The ability to grasp the scale is a direct expression of the designer's own design thinking and design ability in the design of public environmental art sculpture. It may reflect the designer's intuitive understanding and grasp of the designed space. People can usually judge scale instinctively, so in a space with an inappropriate scale design, people will make incorrect judgments about the space itself and the size of objects in the space, lowering the environment's appeal. A good use of scale, on the other hand, can make a space feel beautiful.

In the design of public environment art sculpture, it is necessary to pay attention to the spatial relationship of various elements in the urban environment, grasp the hierarchy and identifiability of space, and make people feel comfortable physically and psychologically when they move in outdoor space, thus improving the utilization quality of space.

Excellent public environment art sculpture can stimulate people's aesthetic taste and artistic yearning, attract many citizens and tourists to watch and play, then condense the indispensable popularity of space places, and create a lively atmosphere. Therefore, clearly establish sculpture as a new concept of cultural image, and it can start from two aspects; first of all, improve the artist's cultural accomplishment, so that the artist can clearly realize that the sculpture and skills are full of cultural spirit. Secondly, realize that sculpture has various themes and different functions. Whether they are monuments of historical figures or portraits of important figures, they all have cultural meanings and are carriers of culture. Therefore, people should not underestimate the cultural significance of urban landscape sculpture. It often has an imperceptible cultural character, which exerts a subtle influence on people and becomes an indispensable connotation in social culture.

3.2. Layout Planning of Artistic Sculptures in Public Environment Based on the Analysis of Spatial Environment Characteristics. Different working processes for dynamic analysis of landscape ecological pattern depend on the objects, scales, and objectives, but the basic processes are as follows: objective determination, information collection, model establishment, preliminary scheme, scheme evaluation, planning formation, and management. The creation of models and the optimization of schemes are the most important aspects of ecological planning. Starting with the behavior of constructing a single fish and progressing through the local optimization of each individual in the fish school, AFSA (artificial fish swarms algorithm) imitates the foraging, clustering, and rear-end chasing behavior of fish. Obtain the global optimum.

The improved AFSA idea is adaptive to the environment during the searching process of artificial fish, such as foraging, clustering, and rear-end collision. Its purpose is to speed up the convergence speed and improve the accuracy of the algorithm. In this paper, the variable step size method is adopted, and the artificial fish adjusts the moving step size

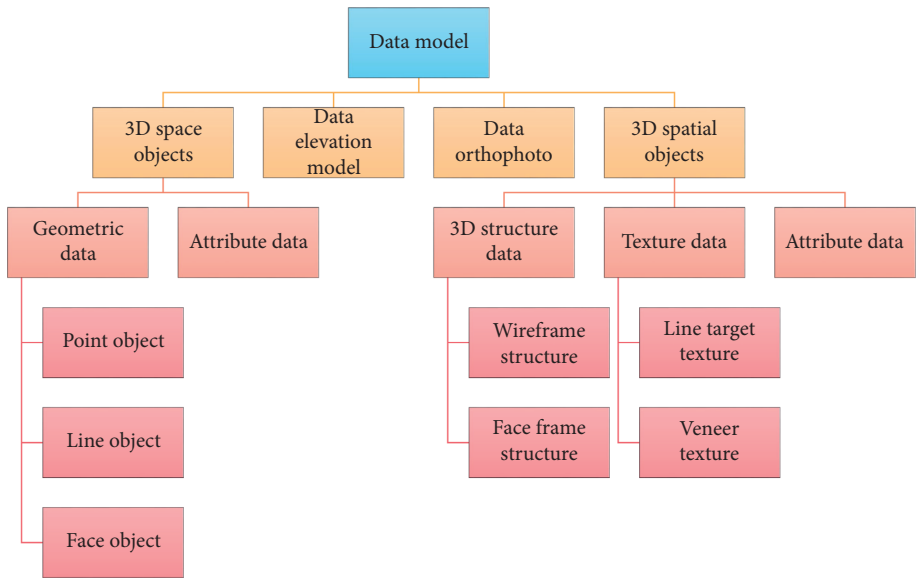

Figure 1: Data model of three-dimensional digital city.

according to the current environmental severity. The variable step size formula is as follows:

$$\text{step} = \frac{Y_m - Y_i}{Y_m - Y_w} \times \text{step}. \tag{1}$$

The current food concentration of artificial fish is Y_i, the maximum food concentration in the field of vision is Y_m, and Y_w is the lowest food concentration in the field of vision. This improved step size can get faster optimization speed in the initial stage of searching and reduce the probability of skipping the optimal value in the later stage, which can make more detailed optimization.

In order to automatically adapt to the phenomenon of fish aggregation, view gradually decreases with the increase of iteration times, and the adaptive formula of view is as follows:

$$\text{view} = V_{\max} \frac{(V_{\max} - V_{\min}) \times k}{it \max} \times \text{step}, \tag{2}$$

where $V_{\max}$ and $V_{\min}$ are the maximum and minimum value of view, k is the current iteration number, and it max is the maximum iteration number. At the initial stage of optimization, each artificial fish swims in a larger field of vision, expanding the search range of the algorithm and then gradually decreasing, so that the fish can search in a more detailed field of vision.

The shared function is used to correct the fitness value of individuals in the population to ensure the diversity of the population. The shared function is formed by the combination of coding difference and fitness difference. Assuming that there are two individuals x_i, x_j, the coding value distance between them is $d_1(x_i, x_j)$, and the fitness distance between them is $d_2(x_i, x_j)$, then the shared function $S(x_i, x_j)$ can be expressed as

$$S(x_i, x_j) = \begin{cases} 1 - \dfrac{d_1(x_i, x_j)}{a_1}, & d_1 < a_1, d_2 \geq a_2, \\ 1 - \dfrac{d_2(x_i, x_j)}{a_2}, & d_1 \geq a_1, d_2 < a_2, \\ 1 - \dfrac{d_1(x_i, x_j) d_2(x_i, x_j)}{a_1 a_2}, & d_1 \geq a_1, d_2 \geq a_2, \\ 0, & \text{other}, \end{cases} \tag{3}$$

where a_1 and a_2 are the niche radius. Incorporate the shared function into the fitness function of the individual to obtain the fitness function of the individual after correction:

$$\overline{f}(x_i) = \frac{f(x_i)}{\sum_{j=1}^{N} S(x_i, x_j)}, \tag{4}$$

where $\overline{f}(x_i)$ represents the revised individual fitness function, $f(x_i)$ represents the original individual fitness function, and N represents the total number of individuals.

When local search is carried out by subgroup, the worst fish X_w in subgroup learns from the best fish X_b in the group or subgroup. When learning, random replacement operators are used, and the two pixels are used as the upper left corner and the lower right corner to generate rectangular ranges, and the gene information of the learning target fish X_b in this range is intercepted and used to replace the genes corresponding to the worst fish X_w in the current subgroup to complete the update operation, as shown in Figure 2.

According to the fitness function, when the worst fish swarm X_w in the subgroup does not get better fitness after

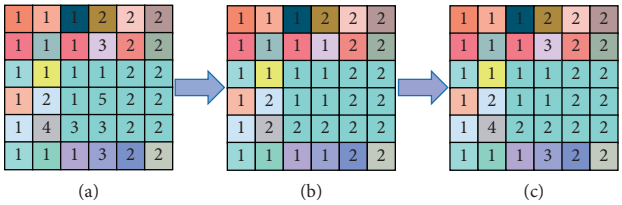

Figure 2: Update operation. (a) Worst fish. (b) Optimal fish school. (c) Worst fish after update.

updating operation, it is mutated, and the mutation operation flow is shown in Figure 3.

After the mutation, it is judged whether the area of landscape transfer exceeds the control of the probability matrix of landscape pattern transfer. If not, the mutation actually occurs; otherwise, the mutation does not actually occur.

When the point cloud dataset is added to the octree according to the set maximum depth, the octree is established. The node function of each node o of octree O is defined as

$$F_o(q) = F\left[\frac{q - oc}{ow}\right]\frac{1}{ow^3}. \tag{5}$$

The center of node o is oc, and the width of node o is ow.

Given a sampling point p, calculate the key sequence xyz of sampling point p and the sorted key sequence. The xyz key sequence of sampling point p is calculated from high to low. At $d\,(1 \le d \le D)$ depth:

$$x_d = \begin{cases} 0, & p, x < C_{\mathrm{dx}}, \\ 1, & \text{otherwise}. \end{cases} \tag{6}$$

D value sequence at depth xyz is defined as

$$x_1 y_1 z_1 x_2 y_2 z_2 L x_D y_D z_D. \tag{7}$$

It is easy to know that xyz sequence specifies the path from the following node to the current node, so when the depth is D, $3D$ bits are needed in total. At present, 32 bits can be used to represent k to allow that maximum depth of 10.

All sample points use xyz key sequence as sorting key. According to the coding principle, the xyz key sequence closer to the origin is smaller, and the xyz key sequence farther from the origin is larger.

4. Result Analysis and Discussion

The image was analyzed by RS and GIS technology, and the landscape elements were divided into seven landscape types, including cultivated land, garden, woodland, sandy wasteland, urban and construction land, water area, and unused land, based on the improved AFSA neural network research model of ecological landscape spatial pattern planning. Rasterize the image, with each raster measuring 300 m × 300 m. The remaining 20% of the sample is used as verification data, and the rest is used to train the improved AFSA model, yielding the corresponding landscape index prediction results. Several times, change the training times. The output results are stable, and the calculation results are shown in Figure 4.

The results show that the error values of the simulated output and expected output of the improved AFSA model samples are within ±4%, while the accuracy of the unmodified AFSA is generally ±6%. The training error of BP neural network can be controlled within ±7%. It shows that the output of the improved AFSA model is more accurate. The error is smaller. It provides a more accurate landscape pattern index. Provide scientific and powerful theoretical basis for the optimization of landscape pattern, and make the optimization of landscape pattern more reasonable.

Among all art forms, public art in the form of urban sculpture is the most likely to receive widespread public support. However, due to the nature of free public art appreciation and the characteristics of civilians, urban sculpture is no longer just a symbol of social status, but also reflects the public's deep meaning from the side. Nonetheless, urban sculpture is not a tool to solve social reality problems, nor is it a tool to blindly cater to and imitate the interests of the upstarts of the industrial and commercial circles. The degree of satisfaction is used to express people's recognition, and the method proposed in this paper is used to optimize the architectural landscape. Figure 5 depicts people's varying attention to square and pedestrian street evaluation factors, while Figure 6 depicts people's satisfaction with the optimized architectural landscape space. This paper assumes that the degree of satisfaction is divided into five different levels, and the corresponding score is 1~0.

The results of all evaluation factors are generally consistent after this algorithm has been optimized, as shown in Figure 6. People give more than "satisfactory" ratings to most architectural landscape evaluation factors, indicating that they are more satisfied with the Huaqiang North architectural landscape's optimized spatial layout. At the same time, it demonstrates that this algorithm is capable of achieving good architectural landscape spatial optimization. This demonstrates that the square satisfaction is the highest. The reason for this is that the square is the focal point for people's leisure activities, and its amenities and green space are well designed. However, on a pedestrian street, various shop decoration styles have their own merits, which are dazzling and easily cause aesthetic fatigue, and the vegetation greening rate along the street is low, resulting in low satisfaction.

Markov model is constructed by using Markov module of the software, and the transition probability matrix among various landscape types from 2020 to 2025 is generated, so as to predict the number transition of future landscape pattern in the county, which is used as the control condition in AFSA mutation operation to ensure that the optimized result of landscape pattern is consistent with the actual situation. The results are shown in Figure 7.

It can be seen from Figure 7 that forest land is the most active landscape type in the future evolution trend of county. The possible transfer area between building land and other landscapes is equally large, and the transfer amount is obviously larger than the transfer amount. The possible transfer area between sandy land and other landscape types is small,

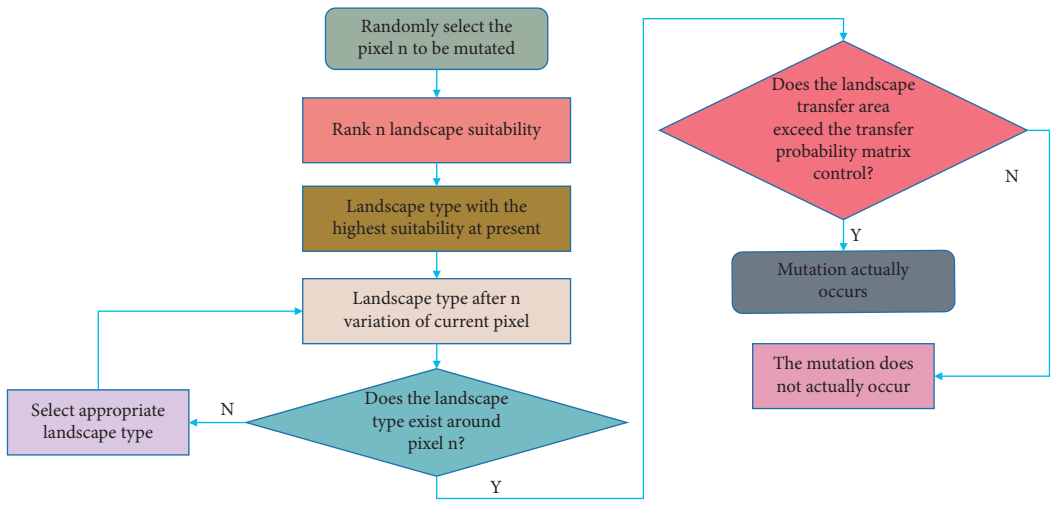

Figure 3: Operation variation.

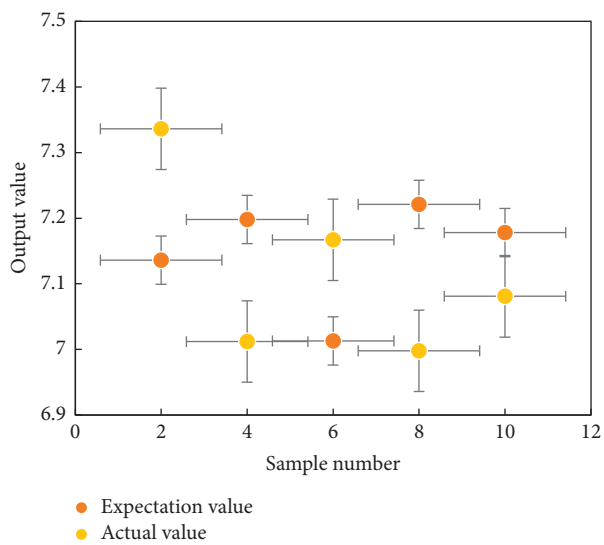

Figure 4: Comparison between simulation results and expected output.

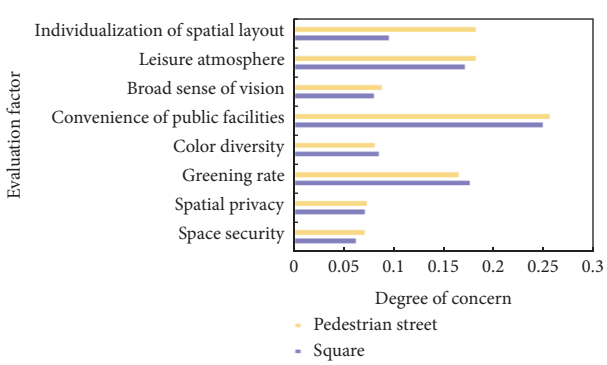

Figure 5: Different degrees of attention of evaluation factors of squares and pedestrian streets.

while that between sandy land and woodland is large. The landscape area of water body is small, the possible transfer area between water body and woodland and sandy land is

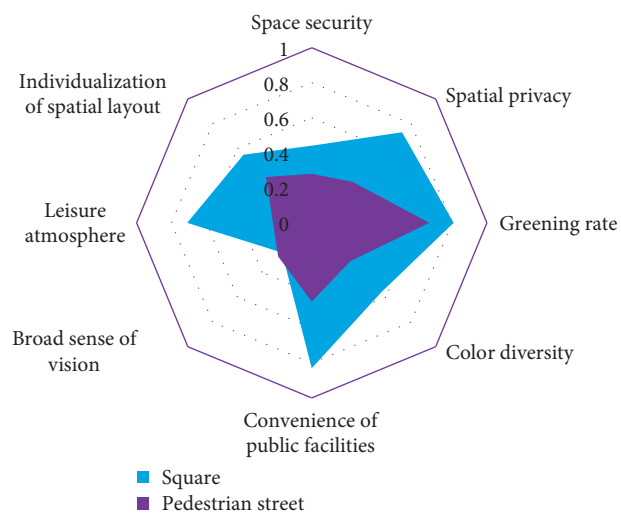

Figure 6: Satisfaction after optimization of architectural space.

large, and the transfer between water body and other landscapes is small. The possible transfer area of mountain landscape is the smallest among all landscape types.

Urban sculpture is a special material existence that exists at the level of form and acts on the level of image and meaning. They directly talk to our ideas and culture with external morphological features, which leads us to think about the spatial meaning, social life, and even human beings themselves. Therefore, the creation of urban sculpture should be based on people's visual psychological feelings.

Through the visual observation of the optimization results, it can be seen that the landscape aggregation degree of the two optimization models has been obviously improved, and the fragmentation of each landscape type has been well controlled. The distribution of landscape pattern in the study area in 2020 and the landscape aggregation index, the average landscape suitability index, and the transfer area beyond the control of the transfer probability matrix are calculated. The results are shown in Figure 8.

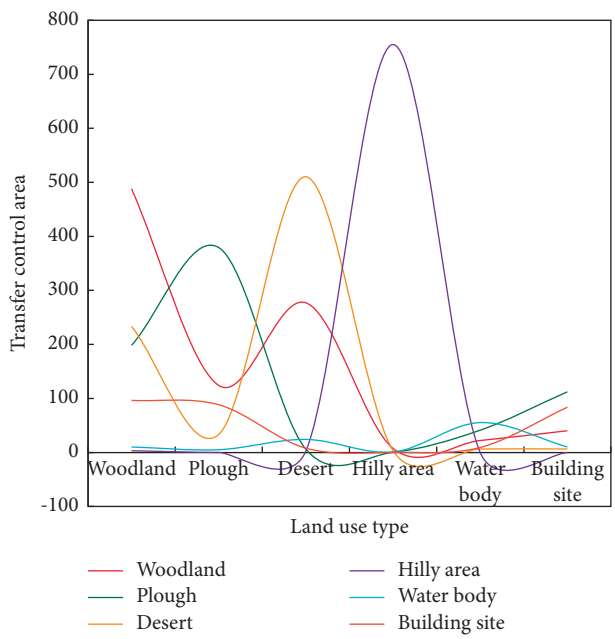

Figure 7: Landscape pattern transfer control area.

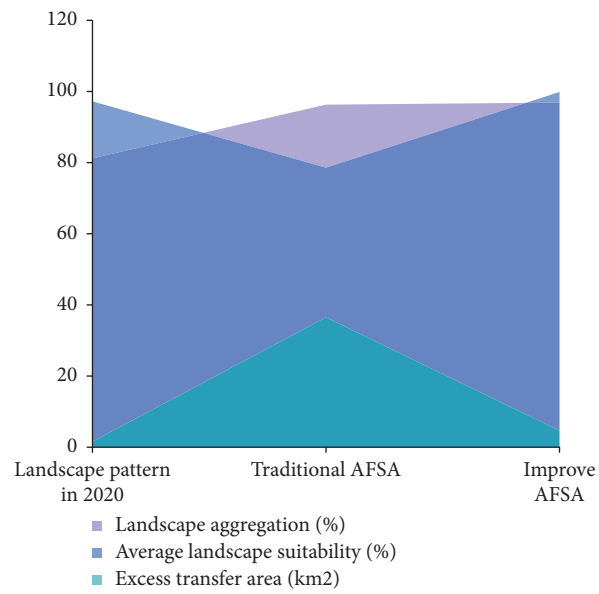

Figure 8: Comparison of indicators of landscape pattern optimization results.

Figure 8 shows how a higher landscape suitability index can ensure that county land is adapted to local conditions, prevent afforestation, reclamation of cultivated land, and other activities in areas with poor soil and water conditions, and play an important role in the rational use of county land. It differs from the transition probability matrix's control area in several ways. As a result of the excessive transfer area among some landscape types in the optimization results, there will be a disparity between the optimization results and the actual situation in the county, making the landscape pattern optimization scheme difficult to implement. As a result, the optimization algorithm must include control over the landscape pattern transfer probability matrix.

The experimental data used in this experimental system are the point cloud dataset provided by Poisson reconstruction algorithm official website, and the models used are bunny model and horse model. Analyze the horse dataset, and the specific situation of point average and area average generated by the horse dataset in the mixed parallel environment is shown in Figure 9:

However, modern cities no longer consider the division of urban space in a certain cultural or folk sense like ancient cities. Modern urban space is mainly divided by functional requirements, and then, it is designed and produced according to people's visual needs. For example, waiting rooms, mailboxes, guardrails, and other public facilities in modern urban streets are also important aspects to change the image of urban streets and shape the visual quality of cities, that is to say, in every street and public space of the city, starting from its functional requirements and human visual quality, from the aesthetic requirements of modeling and the unity of using functions.

The time-consuming results of various improved parallel algorithms are shown in Figure 10.

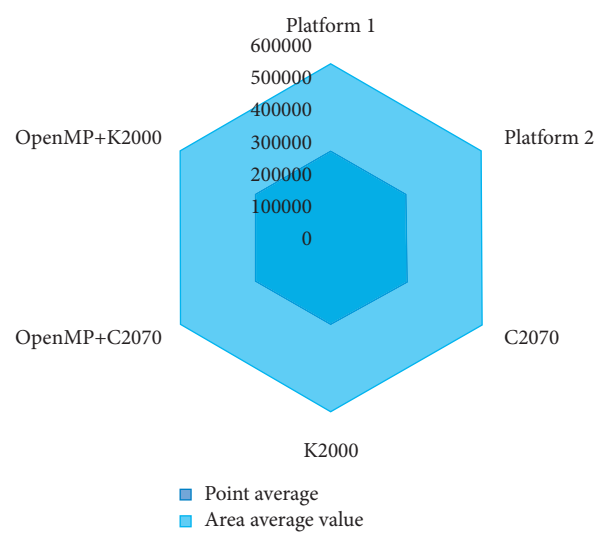

Figure 9: Experimental results of point average value.

To sum up, compared with simply using any kind of acceleration equipment, a higher acceleration ratio can be obtained through hybrid and degraded acceleration technology. This is because the research makes full use of the characteristics of various tasks in the algorithm and assigns tasks to appropriate processing equipment for processing. In this way, high performance can be obtained by using these two types of equipment together. Therefore, when accelerating and optimizing the algorithm, consider using a hybrid parallel acceleration model to optimize and improve the algorithm, and allocate the computing tasks reasonably to obtain better optimization results.

In urban space, sculpture, like buildings, trees, and decorations, is an element of a city. Urban sculpture is an

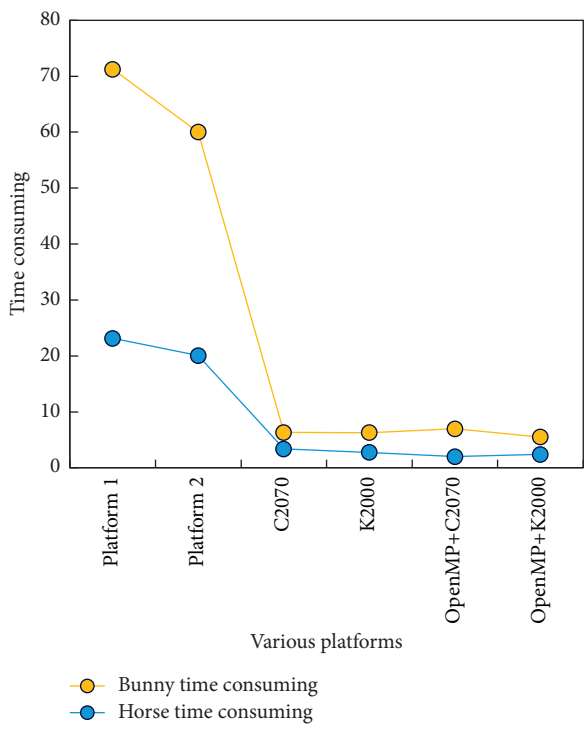

Figure 10: Time-consuming comparison of various platforms.

organic element that acts on the organizational structure of urban space. Unlike other elements, it has no specific function, so it will instead become the focus of a city in pure space. Only by paying attention to the necessity of this element can the city obtain a beautiful image and poetic praise.

Look for national characteristics and regional formal beauty in the overall beauty of the environment. Therefore, environmental sculpture should not only meet people's artistic quality requirements for their living environment, but also reflect people's constantly improving spiritual level in the cultural field. People's beauty of environmental art is no longer just the need for neatness and beauty, but the further pursuit of higher artistic realm and profound cultural connotation. Environmental sculpture is a kind of public art. It plays an important role in shaping the characteristics of the public environment and the humanistic environment of the city.

5. Conclusion

Public environmental art sculptures are not only an important part of people's daily lives, but they can also demonstrate the city's unique cultural charm. Because of their visual images, mature interactive public environment art sculptures can immerse the public in a deep cultural atmosphere in the urban environment. To improve the artistic value of sculpture, special attention should be paid during the design process to highlighting the city's uniqueness while also fully respecting local history and culture. The artistic sculpture of the public environment can be more closely combined with the city's root and thrive, fully demonstrating its unique city character, if sculpture planning is based on the analysis of spatial environment characteristics. Images are analyzed using RS and GIS technology. Improved AFSA can predict landscape indexes like category level and landscape level of landscape ecological pattern more accurately. It boosts the efficiency of landscape pattern optimization and provides a solid analytical foundation for achieving ecologically sound development.

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The author declares that there are no conflicts of interest.

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