Accurate Design and Layout of Landscape Elements Based on Improved Particle Swarm Optimization

Haiman Xu[1] and Junqin Diao[2]

[1]Department of Art, Anhui Jianzhu University, Hefei, AnHui 230041, China, xhm999@ahjzu.edu.cn
[2]Department of Art, Anhui XinHua University, Hefei, AnHui 230000, China, 18055130779@163.com

Corresponding author: Haiman Xu, xhm999@ahjzu.edu.cn

Abstract. With the growth of computer technology, 3D modeling technology and solid rendering technology, computer-aided design (CAD) technology has been widely used in landscape design. Moreover, VR (Virtual reality) technology is one of the advanced technologies in the computer field. As an auxiliary tool for landscape design, it can provide complete data analysis and input and output technology for landscape design, and effectively improve work efficiency. Based on this, this article discusses the application of CAD and VR in the precise design and layout of landscape elements. The VR scene modeling and visualization technology of landscape design is studied. A landscape layout optimization algorithm based on improved PSO (Particle swarm optimization) is proposed to predict and analyze the landscape index more accurately. Finally, the simulation experiment shows that the accuracy of landscape layout optimization algorithm based on improved PSO can reach 92.69%, and the error is about 2.21 lower than other methods. The simulation results verify the reliability of the proposed landscape layout optimization algorithm based on improved PSO. The research in this article provides a brand-new perspective for the application of CAD and VR in the accurate design and layout of landscape elements.

Keywords: CAD; Virtual Reality; Landscape; Particle Swarm Optimization Algorithm
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1 INTRODUCTION

With the progress of sci & tech, the value of data has been explored more and more deeply, and VR came into being under this background. VR is an advanced computer user interface. With the continuous development of technology, the application of artificial intelligence technology in multiple fields is becoming increasingly widespread. Among them, the field of plant environmental detection is gradually benefiting from the improvement of artificial intelligence technology. Due to its unique geographical environment and complex and ever-changing plant growth environment, traditional detection methods often find it difficult to accurately grasp the growth status of plants in coastal areas. Therefore, it is of great significance to accurately detect the plant environment in coastal areas through artificial intelligence technology. Meanwhile, with the increasing prosperity of e-commerce, how to apply artificial intelligence technology to e-commerce network marketing has also become an important topic. It mainly establishes a practical computer simulation platform and system of virtual world, and then creates a virtual experience environment for users by using computer information technology in a simulated way. It integrates many advanced technologies such as computer, sensing, simulation and so on, and provides users with an intuitive, real and real-time interaction mode, which is beneficial to users' operation and improves the working efficiency of the system. On Google Earth Engine, Chen et al. [1] utilized its powerful remote sensing and GIS technologies for rapid mapping and annual dynamic evaluation of urban green space quality. Firstly, it collected annual remote sensing images of cities, which can be obtained from historical satellite data in Google Earth Engine. These images need to be processed to enhance their usability. For example, you can use image processing tools in Google Earth Engine to enhance contrast, reduce noise, and perform edge detection. Next, you can use these processed images for green space recognition and surveying. In Google Earth Engine, you can use its powerful machine learning capabilities to train models for green space recognition. For example, you can use deep learning techniques to train a convolutional neural network (CNN) to recognize and map green spaces from satellite images. Once you have successfully identified and mapped the green space from the image, you can begin evaluating its quality. The natural attribute of VR application determines that this technology can fully digitize people's life, entertainment and work scenes. VR can integrate network VR with the actual environment, and establish a design scene that is very close to the actual environment. Its characteristic is to use the expressive ability of three-dimensional space, so as to easily achieve the effect of "immersive" human-computer interaction. VR is a new and comprehensive information technology developed in the 20th century. At present, VR is being integrated with all walks of life. If we understand VR from the perspective of landscape designers, its fundamental change is that the carrier of information is no longer the screen, but the world itself we perceive. VR in landscape design not only brings more perceptual and rational knowledge to designers, but also produces more whimsy. Moreover, it can also make people see the scene better and more intuitively. In CAD (Computer Aided Design) systems, interaction technology is crucial for users, as it can help them input and edit designs more conveniently. This article will explore a design framework based on triangles and nets for input and interaction techniques in CAD systems. Erdolu [2] designed a framework for CAD input technology and interaction technology. A triangle is a simple and powerful shape that can serve as a fundamental structural unit in CAD systems. By combining, arranging, and deforming triangles, various complex shapes can be generated. In CAD systems, users can directly draw triangles or create them from existing graphics. For example, users can draw three vertices, and the system automatically generates triangles based on these vertices. In addition, triangles can also be deformed through operations such as stretching and rotation. NSGA-II (Non-Dominant Sorting Genetic Algorithm II) is a widely used genetic algorithm for multi-objective optimization problems. In the overall layout planning of landscape ceramic sculptures, this algorithm can be used to find a layout scheme that meets the optimal solution of multiple objective functions. Feng et al. [3] proposed a sculpture matrix layout plan for landscape models. By planning the ceramic computing structure model for hierarchical transformation, it validated and analyzed the model layout optimization mode based on non-dominated genetic algorithm. Expanding the model structure of spatial sculpture.

The suitability of the spatial distribution of rural residential areas is influenced by various factors, such as geographical conditions, economic conditions, social and cultural factors. When selecting evaluation factors, these factors should be comprehensively considered to comprehensively evaluate the suitability of the spatial distribution of residential areas. The suitability evaluation and layout optimization of the spatial distribution of rural residential areas are important aspects of current research on rural land use. A reasonable layout of rural residential areas can optimize land resource allocation, improve land use efficiency, promote rural economic development, and also help protect the ecological environment. Guo et al. [4] explored the relationship between suitability evaluation and layout optimization, as well as their impact on the spatial distribution of rural residential areas. Hassanpour et al. [5] explored the ecological structure assessment of urban green spaces using landscape methods using intelligent CAD technology. The results indicate that this method can effectively evaluate the ecological structure of urban green spaces, providing scientific basis for urban green space planning and ecological protection. However, as an emerging technological method, the application of intelligent CAD technology in landscape ecological structure assessment still needs further improvement and expansion. The case study of ecological structure evaluation of a certain urban green space shows that the landscape method using intelligent CAD technology can accurately and efficiently evaluate the ecological structure of urban green space. The experimental results indicate that this method can clearly reflect the spatial distribution characteristics of green vegetation and accurately calculate various indicators of green ecological structure. In addition, through the analysis of the correlation between green spaces and the surrounding environment, it was found that the ecological structure of green spaces is closely related to the surrounding environment. This suggests that we should fully consider the ecological protection and environmental improvement role of green spaces in urban planning. VR is not only a design tool, but also a design medium. VR is to design what paper is to painting. Moreover, VR has a higher dimension, including two-dimensional, three-dimensional or even four-dimensional information. Huang et al. [6] analyzed a new model for quantitative estimation of living vegetation volume in urban areas based on voxel measurement methods and octree data structures. This is a method of using advanced data analysis and modeling techniques to estimate the volume of living vegetation in urban areas. Firstly, the voxel measurement method is used to divide urban areas into a series of cubic units called voxels. The size and shape of each voxel can be adjusted as needed to reflect the characteristics of the terrain, buildings, and other ground objects in the urban area. This method can be achieved by obtaining high-precision 3D terrain data, building and vegetation coverage information. Secondly, the octree data structure is used to encode and classify each voxel. Octree is a recursively segmented data structure that can divide a three-dimensional space into eight equally divided subspaces, each of which can be further segmented until a specified termination condition is reached. In the quantitative estimation of living vegetation volume in urban areas, octrees can be used to classify voxels into different categories, such as buildings, roads, vegetation, etc. At present, the key technologies of mainstream VR mainly include the following: dynamic modeling technology; Real-time graphics technology; Three-dimensional sensing technology; Specific system development; System integration technology. Lavorel et al. [7] designed a multifunctional landscape design template using CAD software. This template can plan and design urban green infrastructure, such as parks, squares, streets, etc. By combining the principles and methods of landscape ecology, this infrastructure can be better integrated with the natural environment. Using CAD templates for ecological restoration, such as repairing polluted rivers, lakes, and other water bodies, or repairing damaged soil and vegetation. By combining knowledge of landscape ecology, restoration plans can be better developed and utilized to promote the stability and health of ecosystems. Through multi-functional landscape design templates, the development process of a city can be simulated, the environmental impact of different development plans can be predicted, and the optimal development plan can be selected. Meanwhile, knowledge of landscape ecology can provide theoretical support and practical guidance for the sustainable development of these cities. The reasonable application of its characteristics can help customers better perceive the simulation environment and have a more practical experience; Through the realistic presentation of the environment, provide users with feedback situations to feel the natural environment; Through the embodiment of interactivity in VR, customers can have a wider imagination in the process of landscape, so as to reflect the conception of VR. The application of computer to engineering design is called CAD. CAD is different from other electronic information technologies to some extent, and its power can be reflected in many aspects in the process of landscape design. The design of landscape lies in creativity, and it urgently needs tools that can predict the design effect, so that when the landscape is not formally built, the effect map can be seen and corrected in time.

With the continuous advancement of urbanization, people's requirements for urban landscape design and land planning are becoming increasingly high. In order to meet people's needs, intelligent landscape design and land planning based on neural networks and wireless sensor networks have become a hot topic. Li [8] links the workflow of 3D data collection, simulation, analysis, and visualization for risk assessment and communication. In institutional spaces, evacuation is crucial as people need to know how to safely evacuate from buildings. 3D data collection technology can help people better understand the layout and structure of buildings. By simulating the evacuation process, it is possible to better understand people's behavior and decision-making inside buildings, as well as how to quickly evacuate in emergency situations. This method can help people better understand the spatial layout, three-dimensional structure, and influencing factors of urban green spaces. By utilizing drone technology, data on urban green spaces can be obtained more accurately, and a large amount of data can be processed and analyzed in a short period of time. The in-depth application of CAD in landscape design can better open the thinking of landscape designers, especially the growth of modeling and rendering technology and VR platform, and designers can more conveniently detect the advantages and disadvantages of their works. In the past, most of the research focused on the application of CAD and VR in landscape design, but there was a lack of in-depth research on how to better integrate these two technologies to improve the efficiency and accuracy of landscape design. In the visualization of landscape design, most of the research focuses on the modeling technology of VR scene, but there is no in-depth research on how to improve the fidelity and immersion of VR scene. In view of these shortcomings, this article puts forward an improvement idea: applying CAD and VR to the precise design and layout of landscape elements, studying the VR scene modeling and visualization technology of landscape design, and putting forward an optimization algorithm of landscape layout based on improved PSO. Its innovations are as follows:

① Aiming at the landscape layout optimization algorithm based on intelligent algorithm, this article proposes a landscape layout optimization algorithm based on improved PSO. The algorithm will use PSO algorithm to automatically identify and model the landscape layout, and use reinforcement learning technology to optimize the landscape layout.

② In the visualization of landscape design, this article will study how to use the latest graphics rendering technology and physical simulation technology to improve the fidelity and immersion of VR scenes.

The main structure of the article is as follows: Firstly, the related technologies of CAD and VR are discussed; Secondly, the VR scene modeling and visualization technology of landscape design is studied. Then, CAD and VR are applied to the precise design and layout of landscape elements, and an optimization algorithm of landscape layout based on improved PSO is proposed. Finally, the simulation results verify the reliability of the proposed landscape layout optimization algorithm based on improved PSO.

2 RELATED WORK

Liu et al. [9] analyzed the application of virtual reality technology and traditional cultural elements in landscape regeneration design. Virtual reality (VR) technology is a computer system that can create and experience virtual worlds, while traditional cultural elements are passed down from generation to generation and have national characteristics. In landscape regeneration design, VR technology can provide an immersive experience, allowing designers and users to more realistically experience the appearance, atmosphere, and characteristics of the landscape. At the same time, traditional cultural elements can also be better inherited and applied through VR technology. VR technology can assist designers in landscape analysis, such as predicting the annual changes in the landscape by simulating natural factors such as sunlight and airflow, in order to better guide later design. At the same time, VR technology can also assist designers in complex calculations such as structural analysis and engineering quantity calculation. With the development of technology and social progress, the popularization and application of drone technology has brought revolutionary changes to many fields. Among them, the application of drones in urban management and planning, especially in urban green space planning and design, is increasingly evident. Lochhead and Hedley [10] analyzed the spatial pattern and influencing factors of the three-dimensional volume of green space in Shanghai Lingang New City using unmanned aerial vehicles. It explores how to utilize drone technology for effective risk assessment, communication, and visualization workflows. By utilizing high-resolution cameras and LiDAR devices carried by drones, green space information can be quickly and accurately obtained. Through images captured by drones and point cloud data, accurate three-dimensional models of green spaces can be generated, further analyzing the spatial layout, vegetation structure, and other characteristics of green spaces, providing data support for risk assessment. Moving towards the next generation of virtual reality in the architectural environment will make sustainable building design and building information modeling (BIM) technology more intelligent and intuitive. With the help of virtual reality (VR) technology, Nikolić and Whyte [11] simulates and visualizes their designs more accurately before construction. This not only helps to reduce errors and save costs, but also better optimizes the design process. VR technology can help designers better understand various aspects of sustainability. In the construction process, virtual reality can help workers better understand and operate complex equipment and systems. By simulating the actual operation process, VR can help workers acquire necessary skills and experience, thereby reducing errors and improving efficiency. At the same time, virtual reality can also be used for training and education, helping the new generation of architects and technicians better master new technologies and tools. Virtual reality also has a wide range of applications in building lifecycle management (BLM). BLM is a process that involves various stages of a building's entire lifecycle, from design to construction, use, maintenance, and demolition. Through virtual reality technology, we can better simulate and manage this process, thereby better managing and optimizing the performance of buildings. Landscape pattern refers to the configuration and combination of ecosystems or landscape components at different scales in geographic space. Optimizing the landscape pattern can improve the stability and ecological function of ecosystems, while also meeting the development needs of human society. Therefore, studying the optimal allocation of landscape patterns has important theoretical and practical value. Ou et al. [12] aim to develop a composite model that simulates the optimal configuration of landscape patterns, using optimization methods based on genetic algorithms to achieve reasonable configuration and optimization of landscape patterns. By comprehensively evaluating the landscape pattern index and ecological function, this study provides a scientific basis for landscape planning and helps to improve the ecological and social benefits of the landscape.

Through the MOP model, multiple objectives and constraints were weighed. For example, environmental protection, social welfare, urban development potential, and finding the optimal land use structure. Through the FLUS model, various spatial interactions of mobility in cities can be simulated, such as population distribution, employment opportunities, traffic flow, etc., providing a basis for future urban resource allocation. By combining MOP and FLUS models, Ou et al. [13] can combine the dynamic development of cities with spatial layout optimization. By using the MOP model to determine the optimal land use structure, the FLUS model can simulate various flows in cities and predict future urban resource allocation patterns. Computer virtual reality technology can play an important auxiliary role in landscape design by simulating actual situations and predicting potential problems, optimizing design plans, and saving costs and time. In the process of landscape design, virtual reality technology can provide a convenient, visual, and interactive platform, enabling designers to better understand the design intent and effects. Designers can make detailed adjustments and arrangements to various elements in a virtual environment, such as the overall layout of the landscape, vegetation planting, and route planning. This can identify problems in the early stages and solve them in a timely manner, avoiding rework and waste during the implementation process. Shan and Sun [14] have built virtual reality technology that can be used to create realistic 3D scenes. Assist designers in conveying design concepts to users or clients. Compared to traditional flat drawings or renderings, virtual reality technology can provide a more intuitive and realistic visual experience, allowing users or customers to better understand the designer's intentions and expected effects. Geographic Information System (GIS) plays an important role in urban landscape design, providing designers with powerful data management and analysis tools, making the design process more scientific, reasonable, and visual. 3D GIS technology can enable designers to more intuitively understand and present elements such as terrain, features, and buildings. Compared with traditional 2D map symbols, 3D terrain and object models can more accurately reflect the real world, enabling maps to enter a dynamic, spatiotemporal, and multi-dimensional interactive era from a solidified and static state. The application of this technology helps to improve the accuracy and efficiency of urban landscape design, while enhancing communication and interaction between designers and the public. In urban landscape design, Shan and Sun [15] used 3D GIS technology to establish a city model, which is a systematic process. Firstly, collect relevant data such as topographic maps, remote sensing images, and urban planning, and organize them into GIS format. Then, a 3D city model is generated through steps such as terrain map preprocessing, 3D modeling, and texture mapping. During the modeling process, individual buildings need to be manually created to meet specific design requirements. Finally, by applying textures and other steps, the building looks more realistic and vivid. CAD is a professional computer-aided design software widely used in the fields of architecture, engineering, and manufacturing. In landscape design, CAD is often used for precise two-dimensional drawing and model building. Then, SketchUp is an easy-to-use 3D modeling software that is particularly suitable for architecture and urban design. Its user-friendly interface allows designers to quickly establish and modify 3D models. In landscape design, SketchUp can be used to establish landscape models, conduct spatial analysis, and conduct design research. Compared to CAD, SketchUp has more advantages in 3D modeling and is more intuitive, helping designers better understand and express design intentions. PS is an image processing software widely used in fields such as advertising, film and television, and photography. In landscape design, PS can be used to create renderings, analysis images, and rendering images. Song and Jing [16] integrate this three software, which can leverage their respective strengths in the landscape design process, improving work efficiency and accuracy.

Wu and Yan [17] analyzed the digital landscape design mechanism under edge computing. Using edge computing technology, a large number of data of devices and systems such as sensors can be obtained. This includes terrain, climate, vegetation, lighting, and user feedback and evaluation of the landscape. These data can be used to analyze and simulate landscape design, as well as predict and optimize landscape performance. Through edge computing technology, design tasks and construction tasks can be divided into many small calculation and execution units to achieve automatic design and construction. Edge computing technology can help to achieve fine management of landscape. For example, the high-definition camera and edge computing algorithm carried by the UAV can be used for high-definition shooting and high-precision measurement of the landscape, so as to achieve the micro meteorological monitoring and soil moisture monitoring of the landscape, and can process a large amount of data in real time, providing more refined decision support for landscape management. The interaction between landscape and users can be realized by using edge computing technology. For example, users can interact with the landscape through devices such as mobile phones and tablets, providing real-time feedback on their opinions and suggestions, making the landscape more user-friendly, user-friendly, and easy to use. In terms of landscape spatial layout optimization, the improved genetic algorithm can effectively adjust the position and size of elements such as scenic spots, plants, and water bodies, making the entire landscape space more coordinated and beautiful. At the same time, the algorithm can also personalized optimize according to the characteristics and needs of different elements, so that each element can play its maximum viewing effect. Yu [18] applied the improved genetic algorithm to the automatic optimization design of tropical environmental landscape space. The experimental results showed that the algorithm can effectively optimize the layout of landscape space, improve the visual effect and quality of the landscape. Observing the growth status, coverage, and species richness of plants can help to understand their adaptability in different mining environments. At the same time, long-term monitoring of the succession of plant communities can help understand the development trends and stability of ecosystems. The soil in mining areas often suffers from pollution and instability. The planting of trees and shrubs can improve the soil environment and increase soil stability. Monitoring and analyzing soil physicochemical properties (such as pH value, organic matter content, etc.) and heavy metal content can help understand the effectiveness and mechanism of plants in soil improvement. There is often a problem of water pollution in the mining environment, where plants can absorb and filter pollutants from the water. Monitoring the improvement of water quality can help to understand the effectiveness and mechanism of plants in improving water quality. With the rapid development of technology, Geographic Information Systems (GIS) have been widely applied in various fields such as urban planning, land resource management, and environmental protection. However, in the field of rural spatial planning, the application of three-dimensional geographic information systems (3D GIS) still faces many challenges due to factors such as the vast territory and complex data involved. In recent years, the continuous development of virtual earth technology has provided new solutions for rural spatial planning. Yu et al. [19] aim to explore a three-dimensional participatory rural spatial planning system based on virtual earth, in order to provide scientific basis and technical support for rural planning work. The research aims to develop a three-dimensional participatory rural spatial planning system based on virtual earth technology, which has the function of automatically generating terrain, landforms, buildings, and can provide customized rural spatial planning solutions according to user needs. Utilize virtual earth technology for data visualization and expression, in order to facilitate planners to have a visual understanding of rural space. Finally, design and implement a participatory rural spatial planning system to support users in autonomous planning and scheme customization.

With the advancement of technology and the improvement of people's living standards, urban landscaping and landscape design are receiving increasing attention. At the same time, soil microbial environmental protection has also become a hot topic. In urban landscaping and landscape design, it is usually necessary to consider many factors, such as spatial layout, color matching, plant matching, terrain utilization, etc. Virtual visualization system is a technology that utilizes computer technology to generate realistic virtual environments, allowing users to experience their experiences firsthand. In urban landscaping design, virtual visualization systems can be used to display design results, facilitating communication and discussion with various parties. In addition, virtual visualization systems can also be used for monitoring and analyzing soil microbial environmental protection. The design of automatic irrigation systems linked to weather satellites has some foresight, but the design that can truly achieve "smart cities" has not yet fully emerged. To achieve the application of 5G in landscape design, one can start with the improvement of urban transportation systems. The main core of the loop system in landscape design is "Connection", which needs to make the traditional "link" function "smart". For example, future intelligent paving can be developed by equipped with data transmitters to collect big data on users' walking directions, and then organize them for intelligent prediction. By utilizing the high-speed transmission and low latency characteristics of 5G, combined with virtual reality technology, a virtual urban landscape environment that is highly similar to the real world can be constructed. Designers can design, plan, and simulate in this environment, and then optimize and adjust as needed. The spatial pattern and three-dimensional volume of urban green spaces have a significant impact on the urban ecological environment and the quality of human life. There have been rich research results on the spatial pattern of urban green spaces, including relevant theoretical models and algorithms. Among them, the most common are the concentration and diversity models. However, these traditional models often overlook the three-dimensional volumetric spatial characteristics of green spaces. Therefore, Zheng et al. [20] introduced the concept of three-dimensional plot ratio and established a new three-dimensional spatial pattern model to overcome this deficiency. The study used drone photography technology to obtain remote sensing image data of the green space of Shanghai Lingang New City. By processing and analyzing data, extracting green space feature parameters, and utilizing Geographic Information System (GIS) technology for spatial analysis and visualization. At the same time, a three-dimensional spatial pattern model containing the three-dimensional plot ratio of green spaces is constructed to quantitatively describe the spatial characteristics of green spaces.

The above research has made some important achievements in discussing the application of CAD and VR in the precise design and layout of landscape elements, the VR scene modeling and visualization technology of landscape design, and the optimization algorithm of landscape layout based on improved PSO. However, there are still some shortcomings. In addition, although some studies have proposed landscape layout optimization algorithms based on intelligent algorithms, the effects and performance of these algorithms in practical applications need further verification. Based on this, this article puts forward the following improvement ideas:

This article discusses how to better integrate CAD and VR into the process of landscape design to improve the efficiency and accuracy of design. Aiming at the landscape layout optimization algorithm based on intelligent algorithm, this article will propose a landscape layout optimization algorithm based on improved PSO. The algorithm will use PSO algorithm to automatically identify and model the landscape layout, and use reinforcement learning technology to optimize the landscape layout. The optimization performance and practical application effect of the algorithm are verified by experiments.

3 VR SCENE MODELING AND VISUALIZATION TECHNOLOGY OF LANDSCAPE DESIGN

The embodiment of virtual environment modeling technology in landscape design is mainly manifested in the construction of scenes. It mainly includes 3DMAX and CAD, which are generally used for model construction and scene plane drawing. Designers can present the design scheme through VR before making a scheme, and then improve the scheme according to the information fed back by virtual images. In order to avoid errors and mistakes in overall design and construction, computers can be used to process information data, and the processed data will be compared and analyzed to judge and predict the feasibility of the project. Using graphics, data information processing and network parallel technology covered by VR can provide overall design and understanding, and make the concept in the initial stage of design more scientific, true, accurate and reasonable. Designers can use VR to randomly place, move and combine various garden plants and other items in the virtual space. Under this operation, the different effects and spatial forms of different plant combinations are comprehensively compared, which improves the shortcomings that cannot be comprehensively perceived under traditional design methods to some extent, thus inspiring designers. Moreover, designers can export the model to VR and experience their own design intuitively. Customers can also perform feedback iterations directly in VR. At this stage, designers need to understand both the design and the tools exported from modeling software to VR.

The combination of VR and scientific computing visualization technology is an immersive visual graphic expression method, which enhances the designer's understanding of the internal characteristics of the environment when designing the landscape. The generation of real-time three-dimensional image technology is mainly reflected in the rational application of data, because in the process of scene simulation, large-scale landscape design needs the support of a large number of data, so it needs a high-performance computer. The use of real-time three-dimensional image generation technology can preserve design patterns and scenes without being affected by the complexity of the scene. Using the functions of 2Dshaper and 3Dlofter in aided design software such as 3DS or 3DSMAX, more accurate 3D modeling can be achieved. And the material editor Materia is used to simulate the material fit and the colors and branches of the landscape, thus highlighting the final rendering effect of the landscape. VR focuses on hardware, especially head tracking technology. VR must be used together with hardware and software. Unlike most people's imagination, VR is simple to implement in software, and it can be implemented with little code. The embodiment of the interactivity of VR needs to constantly improve its interactivity in landscape design and effectively solve problems. In the aspect of interaction and communication in the design process, the design information analysis is scientific and accurate, the design concept is dynamic and spatial, the design information is systematic, and the design is assisted to carry out the whole process; Reality and innovation in the performance process, the presence of landscape performance, the interactivity of landscape experience, and the creation of perceptual activities. Before applying CAD and VR to landscape design, it is needed to collect site information in combination with existing topographic maps and databases, at the same time, check the collected information with existing information, do a good job of supplementary work, and finally complete the establishment of pattern library. Terrain quadtree structure is shown in Figure 1.

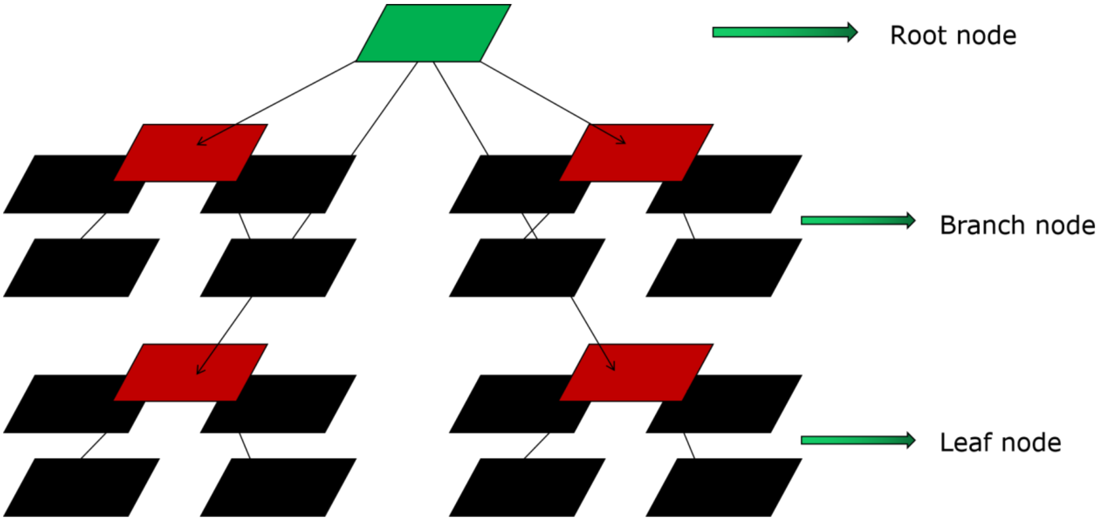

Figure 1: Schematic diagram of terrain quadtree structure.

Simple two-dimensional space and three-dimensional space cannot fully convey all the spatial elements information in the landscape to people. And VR can completely express the overall space and detail system of the landscape, and it is more accurate, and there will be no missing phenomenon. With the help of CAD software, the idea can be expressed graphically, and a three-dimensional model can be generated, and the space can be carefully scrutinized to make the design more scientific. To establish scene visualization, we must transform the physical space of scene visualization into the geometric space. Realistic model can realize visual modeling application, operation, scene database and rendering operation independently without other operations, and can establish a variety of graphic pipelines and a virtual scene of scene visualization. Designers can combine the presentation of virtual images with the actual construction site of the design landscape, fully consider various objective conditions of the design site, such as topography, temperament, vegetation, etc., and minimize the impact of the environment on the landscape as much as possible.

4 IMPROVED PSO LANDSCAPE LAYOUT OPTIMIZATION ALGORITHM

The application of VR in landscape layout design runs through the whole design process, which can be summarized as the following four stages: feasibility analysis stage, scheme design stage, element design stage and expansion design stage. In landscape layout design, it is very important to choose 3D modeling software suitable for landscape design. The application of real terrain data needs to combine the form of digital terrain model data, analyze terrain data points as much as possible, and combine the form of triangle projection transformation in the view to realize the effective drawing of graphics pipeline and process terrain data in time. The hierarchical model of triangular quadtree is shown in Figure 2.

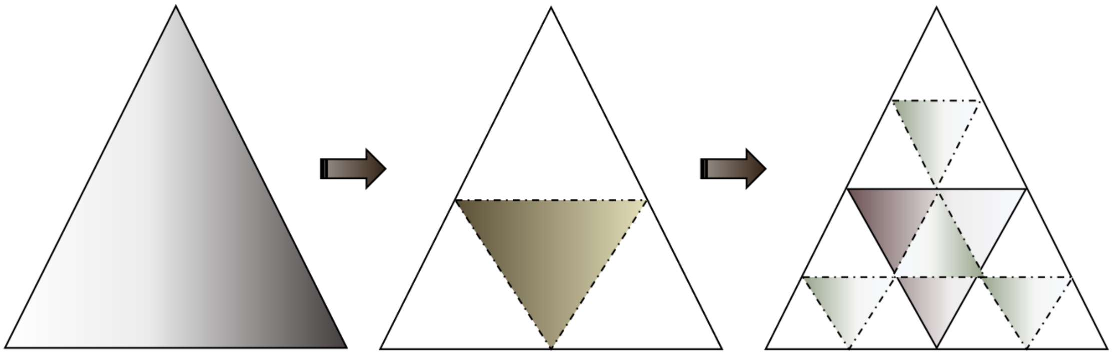

Figure 2: Triangular quadtree hierarchical model diagram.

Landscape design is similar to architectural and municipal design. First, we need to investigate the current situation according to the existing topographic map, database and information materials, then check and fill the collected current situation materials with the existing information, and finally create a pattern library. Landscape layout design needs to input the collected information in VR system, and establish a preliminary simulation of landscape design by processing and analyzing massive data. By processing the overall information, the designer's overall cognition of the overall site is completed. Finally, GIS technology is applied to simulate the real environment and analyze the road and river conditions of the site, so as to lay a precise judgment for the formation of design ideas and concepts. In this article, AutoCAD software is used to convert 2D graphics into standard data file format, and then it is imported into 3DS or 3DSMAX software to make a basic 3D model, from which the distribution relationship between environment and space can be found. Moreover, we should follow the principles of scale, proportion, balance and unity in artistic composition to ensure the scientific rationality of the design scheme.

In this article, PSO algorithm is considered to be combined into VR landscape CAD design. Firstly, the objectives of landscape design are defined, such as determining the layout, vegetation types and landscape elements of the landscape. According to the design goal, determine the key variables that affect the design. For example, the shape, size and location of landscape layout, the selection and distribution of vegetation types, the design and placement of landscape elements, etc. Then make clear the constraints in the design, such as the legitimacy, realizability and budget of landscape design. In this article, design variables and design constraints are transformed into PSO, and each particle represents a possible landscape design scheme. According to the design variables and design constraints, initialize PSO to ensure that each particle meets the design constraints. In each iteration, the position of the child particle is calculated by the arithmetic weighted sum of the position of the parent particle, that is:

$$child_1(\bar{x}) = \bar{p} \times parent_1(\bar{x}) + (1 - \bar{p}) \times parent_2(\bar{x}) \tag{1}$$

$$child_2(\bar{x}) = \bar{p} \times parent_2(\bar{x}) + (1 - \bar{p}) \times parent_1(\bar{x}) \tag{2}$$

The velocity of the daughter particles is:

$$child_1(\bar{v}) = \frac{parent_1(\bar{v}) + parent_2(\bar{v})}{|parent_1(\bar{v}) + parent_2(\bar{v})|} |parent_1(\bar{v})| \tag{3}$$

$$child_2(\bar{v}) = \frac{parent_1(\bar{v}) + parent_2(\bar{v})}{|parent_1(\bar{v}) + parent_2(\bar{v})|} |parent_2(\bar{v})| \tag{4}$$

Where $\bar{x}$ is the position vector of n dimension; $\bar{v}$ is the velocity vector of n dimension; $child_k(\bar{v})$ and $parent_k(\bar{v})$ are the velocities of daughter particles and parent particles, respectively. In the PSO evaluation stage, according to the design goal, the fitness of each particle is evaluated, that is, the landscape design scheme represented by the particle is good or bad. In the phase of updating PSO: update PSO according to the fitness and speed of particles, so that particles move to a better solution. After that, PSO is continuously updated until it reaches a stop condition, such as a predetermined number of iterations or a predetermined fitness value. Inertia weight coefficient is a proportional factor related to particle velocity update. The updated formula of inertia weight coefficient w is:

$$w(iter) = w_{\max} - \frac{w_{\max} - w_{\min}}{iter_{\max}} * iter \tag{5}$$

Where $w(iter) = w_{\max} - \frac{w_{\max} - w_{\min}}{iter_{\max}} * iter$ is an iterative algebra; $iter_{\max}$ is the largest iterative algebra. Finally, consider choosing the optimal scheme: choose the optimal particle from PSO, that is, the particle with the highest fitness, and the landscape design scheme represented by this particle is the optimal design scheme. In this article, the improved PSO landscape layout optimization algorithm accelerates the convergence speed and improves the performance of PSO algorithm as a whole.

After the above steps, VR exhibition is carried out: the optimal design scheme is imported into VR landscape CAD software, and a virtual landscape model is generated and displayed for designers and customers to evaluate and modify. Due to the large amount of design data, the data applied in actual design needs to be simplified, which has an impact on the design effect. Therefore, when designing the scene structure by running C++ library module and Vega platform. You can use the functions of 2Dshaper and 3Dlofter of 3DS or 3DSMAX to complete accurate 3D modeling, and use the composite materials and maps of Material Editor to endow the landscape design with color, color and texture, and fully consider the regional nature of the landscape. The virtual environment of scene design in this article is mainly established through Vega. Based on the application of model data, it is needed to combine different profiles for analysis. For the analysis of this profile, it is needed to combine the definition of $S(P_0)$-related forms and the effectiveness of P_0 derivation measure of grid points:

$$S(P_0) = \sqrt{\frac{p_1 d_1^2 + p_2 d_2^2 + p_2 d_2^2 + p_2 d_2^2}{P_1 + P_2 + P_3 + P_4}} \tag{6}$$

For the determination of weight coefficient, P_1 is mainly used to express the weight coefficient, and the distance between adjacent grid points is analyzed in combination with the form of grid points, and the analysis and application of grid simplification importance measure are realized. Multi-resolution representation of terrain model is an orderly process based on vertex deletion. In order to get the most accurate simplified model in the current order and the closest to the original model for each simplification operation, each vertex to be deleted must be carefully selected. Of course, different types of vertices should be treated differently. Through a large number of experiments, it is found that the same object can form a whole after being modularized in Sketch Up environment, which can not only reduce the number of models, but also reduce the storage space occupied by models. Therefore, the model can be assembled into a whole when the model is not changed in the later stage of model establishment. When people look at external things through their eyes, their left and right eyes have a binocular overlapping condition, as shown in Figure 3.

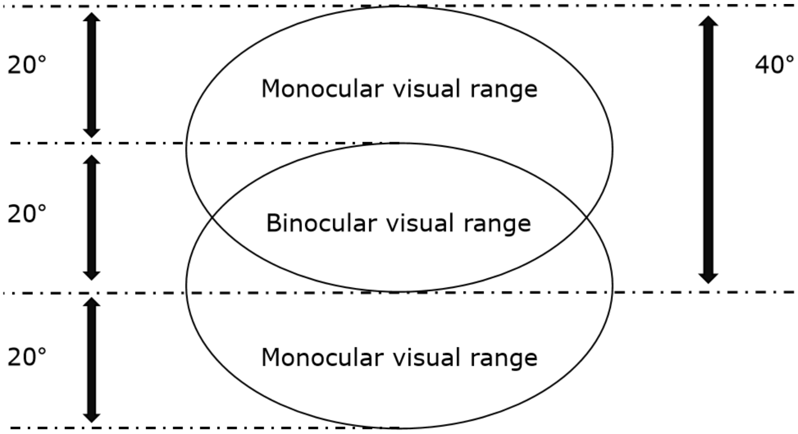

Figure 3: Schematic diagram of binocular overlap.

It is needed to calculate the lateral retinal image difference in scene visualization. Assuming that there are two kinds of objects A_1 and A_2 at the front ends of eyes, the correlation between the two kinds of target spacing e and the lateral retinal image difference β is as follows:

$$\beta = eH / \left(E^2 + eE\right) \tag{7}$$

Where: the distance between left and right eyes is set to H ; ; The vertical distance between the right eye and the object A_1 is set as E. If the reference object is set as the object A_1, then people's perception value for the distance e is:

$$e = \beta E^2 / \left(H - \beta E\right) \tag{8}$$

When browsing the virtual scene, with the constant movement of the observation position of the scene, the change of the angle and the scaling of the model, the computer needs to constantly refresh the graphics and render the texture of the model. Therefore, it is needed to optimize the number of models in the scene, the complexity of each model, and the materials and maps of each side, thus greatly improving the working efficiency of the system. By combining PSO algorithm with VR landscape CAD design, this article can quickly find the best landscape design scheme and improve design efficiency and quality. This method can automatically adjust the allocation of rendering resources according to the visual distance of the screen distance, so as to ensure that the rendering effect we see is better presented. On the one hand, it ensures the computer to present the rendering effect better, on the other hand, it reduces the computing burden of the computer. Moreover, users can control the parameters of the CAD system in the main interface of the CAD system, control the design parameters in the process of scene visualization.

5 ALGORITHM EXPERIMENT AND VISUAL ANALYSIS

The use of CAD and VR in the precise design and layout of landscape elements is discussed above. When designing the theme of landscape design, the application of CAD and VR can better help designers to depict the scene, help designers to change the shape and characteristics of the scene through real-time three-dimensional image feedback, stimulate designers' thinking mode through real-time image feedback, and help create new thinking. The conceptual model is established through the previous investigation data, and the conceptual model is evaluated and analyzed, which breaks through the limitation of drawing a two-dimensional world in the traditional process and avoids the disconnection between the model and the environment. Aiming at the landscape layout optimization algorithm based on intelligent algorithm, this article proposes a landscape layout optimization algorithm based on improved PSO. In order to verify the reliability of the algorithm, this section carries out experimental analysis. Figure 4 shows the training of the algorithm.

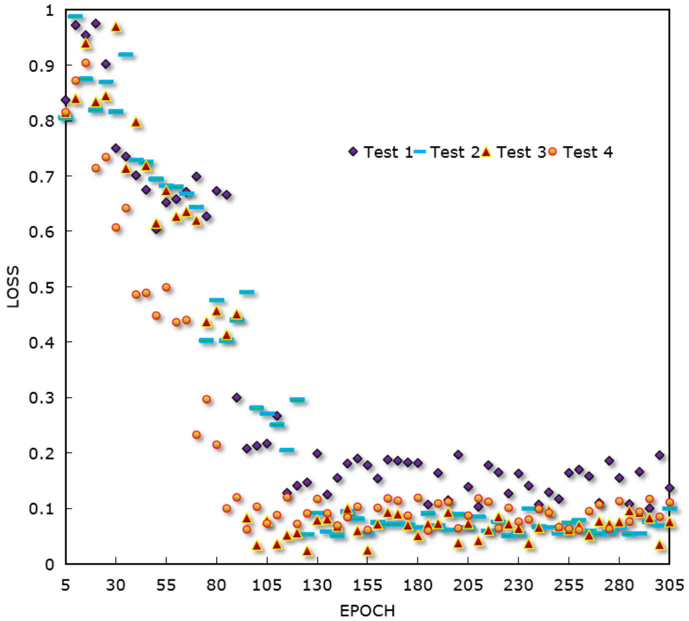

Figure 4: Algorithm training situation.

It can be seen that the algorithm can converge quickly with continuous iteration. This article is based on the design process of any vertex, in which the analysis of derived errors requires the timely deletion of vertex-related indicators. The analysis of preserving vertices, combined with triangulation mode, reasonably simplifies and applies the terrain grid. The process of vertex deletion is essentially to reduce the number of triangles in the model according to the requirement of approximation accuracy of the original model. That is, fewer large triangles are used to replace more smaller triangles, so that the triangle mesh description of the same scene model with different complex levels can be obtained.

In this section, the artificial fish swarm algorithm, wolf swarm algorithm and the improved PSO algorithm in this article are considered for comprehensive comparison in several aspects. Figure 5 below shows the error comparison results of the algorithm. Figure 6 shows the comparison results of the accuracy of the algorithm.

The algorithm proposed in this article is based on the improved PSO algorithm, which shows high efficiency in landscape layout optimization. The results show that the accuracy of this algorithm can reach 92.69%, and the error is about 2.21 lower than other methods. This is a very promising result, which shows that the proposed algorithm has high accuracy and efficiency in solving the landscape layout optimization problem. It can be concluded that the original PSO algorithm is improved to adapt to the characteristics of landscape layout optimization and improve its performance. It can output various types of files, generate and express static or dynamic modeling pictures, which is the main function of VR. It is one of the important aspects to evaluate whether a VR platform is excellent, whether it has rich output functions and whether it can achieve the expected landscape effect. The method in this article and the design method of VR based on X3D are applied to the visualization of a landscape scene respectively, and whether the visualization effect of the method in this article meets the design requirements is compared and tested. This scene visualization is mainly realized by CAD system, and the landscape effect diagram designed by this method is shown in Figure 7. The landscape effect diagram designed by the VR method based on X3D is shown in Figure 8.

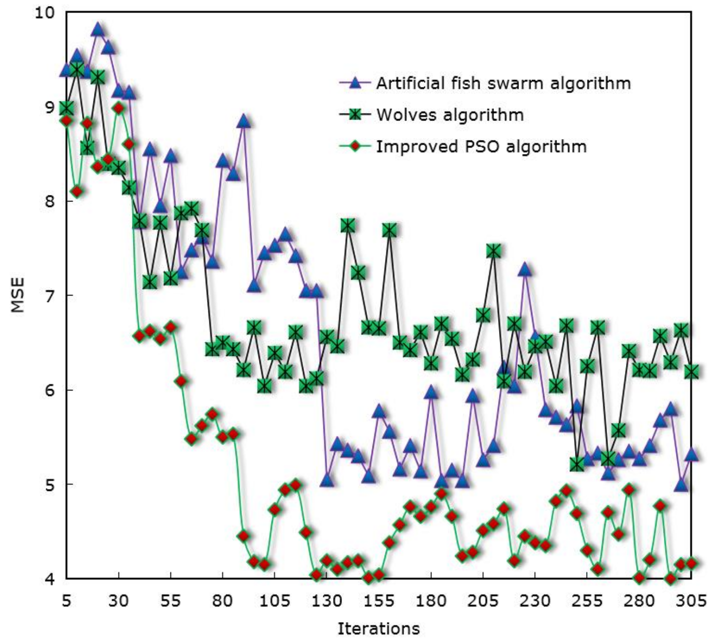

Figure 5: Error comparison results of the algorithm.

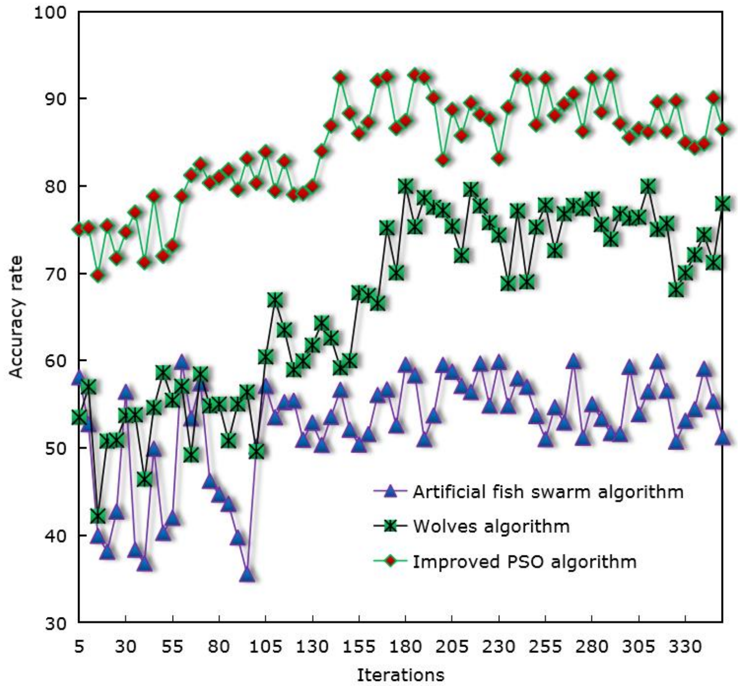

Figure 6: Comparison of the accuracy of the algorithm.

Figure 7: The landscape effect map designed by this method.

Figure 8: Landscape effect diagram designed by VR method based on X3D.

From Figure 7 and Figure 8, it can be seen intuitively that the objects in the effect scene designed by this method all realize high-quality scene design in fade-in and fade-out mode, and pay attention to hierarchy, medium-term perspective and light and shadow effect in rendering production and expression; And the design renderings have a strong sense of substitution, combining reality with reality. Compared with the landscape effect diagram designed by the VR design method based on X3D, it is obvious that the design effect of this method is better.

The results in this section show the effectiveness of applying VR to scene visualization. VR is a computer technology that can create and experience virtual scenes and environments. In landscape layout optimization, visualization technology can better understand and evaluate the effects of various layout schemes. Compared with traditional scene visualization methods, VR can provide a more realistic and stereoscopic scene experience, thus helping users to understand the characteristics of different layout schemes more intuitively. In addition, VR can also reduce the cost of scene visualization, which can reduce the needs of actual model making and on-site investigation.

Generally speaking, this study provides an effective solution, which combines the improved PSO algorithm and VR to optimize the landscape layout and enhance the effect of scene visualization. This comprehensive method has great potential and can have a positive impact in the field of landscape design and planning.

6 CONCLUSIONS

This article mainly discusses the application of CAD and VR in the accurate design and layout of landscape elements. The landscape layout optimization algorithm based on intelligent algorithm is aimed at, and an improved PSO-based landscape layout optimization algorithm is proposed. The algorithm uses the PSO algorithm to automatically identify and model the landscape layout, and uses reinforcement learning technology to optimize the landscape layout, so as to predict and analyze the landscape index more accurately. The optimization performance and practical application effect of the algorithm are verified by experiments. The experimental results show that the accuracy of the landscape layout optimization algorithm based on improved PSO can reach 92.69%, and the error is about 2.21 lower than other methods. The simulation results verify the reliability of the proposed landscape layout optimization algorithm based on improved PSO.

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Haiman Xu, https://orcid.org/0000-0001-9168-9832
Junqin Diao, https://orcid.org/0009-0002-6501-3358

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