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Computer-Aided Design AND APPLICATIONS

Intelligent Urban Landscape Design Based on Deep Learning

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Abstract. Urban landscape design occupies an important position in the development of urban modernization, which not only reflects the economic strength of a country but also highlights the national concept of sustainable development and ecological development of urban construction and landscape design. In the process of accelerating the progress of The Times, urban development needs to combine the needs of wisdom and information technology and transform them into intelligent urban design and construction. Landscape designers need to improve their own intelligent design ideas and highlight the scientific, rational, and practical nature of urban landscape design. Based on the above background, this paper studies the intelligent landscape design process from the perspective of deep learning and explores the application effect of CAD technology optimized by deep learning in intelligent landscape design. First of all, combined with excellent domestic and foreign cases, the key factors of urban landscape design are analyzed, the application of digital information technology in landscape construction and design is understood, and the design method is briefly analyzed. Secondly, the deep learning neural network algorithm is added to achieve more scientific and accurate design assistance with its own learning ability and information processing ability. Using the advantages of self-judgment and self-learning of neural networks, the generating effect of landscape design is improved. Finally, a deep learning algorithm is used to optimize CAD tools, and a new point cloud feature extraction and enhancement method is used to improve the edge blur problem of traditional CAD design. Improve the effect of CAD generation of intelligent landscape scenes in three-dimensional space. The research results show that the deep learning algorithm can optimize the modelling, drawing and processing process of intelligent landscape design, and the CAD-aided design combined with the two can also provide a more intelligent design scene.

Keywords: Deep Learning; Intelligent; Landscape Design; CAD Technology; Feature Extraction
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1 INTRODUCTION

Modern landscape design is a subject covering a wide range of social sciences. Many landscape architects combine ecosystems with modern urban development and offer a variety of perspectives. Landscape architects need to design according to the changes in urban scale ecosystem, conceptualize the world into a high-dimensional design theory, and regard the ecological environment as an inherent feature of the city. Abdalla et al. [1] explored the impact of CAD tools in the early landscape design process, combining the concept of intelligent landscape design. It evaluates how these tools can be combined with intelligent landscape design to drive innovation and development in landscape design. In this study, five key criteria were utilized to provide a bidirectional and systematic mapping of research-based tools that support the conceptual design process and commercial CAD methods. Intelligent landscape design emphasizes the use of advanced technology and data analysis to optimize design solutions and improve design sustainability, interactivity, and practicality. The CAD tool is one of the important means to achieve these goals. Through in-depth research on reviewed materials, cross-mapping digital software, and current commercial programs, we have elaborated on the practical application and potential value of CAD tools in early landscape design. By utilizing AI algorithms and machine learning techniques, intelligent landscape design software can automatically analyze a large number of design cases and site data, extract design patterns and trends, and provide designers with design inspiration and proposal suggestions. Through the CAD tool, designers can create and modify design proposals more quickly, utilize real-time rendering and visualization technology to present design effects and communicate more intuitively with clients and other stakeholders. In addition, intelligent landscape design software can also combine advanced technologies such as environmental simulation and data analysis. Provide designers with real-time feedback on lighting, climate, pedestrian flow, and other aspects, helping them optimize design solutions and improve the practicality and sustainability of their designs. For most designers, urban landscape design must incorporate ecological change, that is, ecology as one of the urban infrastructures. And it is applied in places where people interact as part of the main body. The focus of Bianconi et al. [2] is on the core role of visual perception in measuring landscape quality in intelligent landscape design. In this process, geographic reference images along the road will be used as an important source of open-source big data. Through advanced artificial intelligence systems, we are able to train algorithms to identify and quantify various landscape elements present in images. In each image, AI systems evaluate the positive or negative characteristics of the path, and ultimately, a comprehensive landscape quality index is generated by summarizing all big data values. In the context of intelligent landscape design, it aims to define and optimize a digital-based landscape quality assessment process and standards. To verify the accuracy and effectiveness of this method, they tested it in multiple case studies and combined anonymous questionnaires to collect public perception data on landscape quality. Firstly, by intelligently analyzing geographic reference images, we can more accurately capture and evaluate multiple dimensions of the landscape, including natural features, cultural landscapes, and spatial layout. In addition, by transforming perceptual data into information and further inferring the synthesized knowledge paths in the map, we can more intuitively understand and express the perceptual quality of the landscape. Combined with intelligent landscape design, this method demonstrates enormous potential and value. This not only helps designers make wiser decisions during the design phase but also provides the public with a clear and understandable framework for landscape quality assessment. Such cognitive concepts continue to expand and deepen in modern development, and the landscape design theories of complexity, relevance and continuity have been deeply integrated into the current field of urban landscape design.

At present, with the continuous progress of robot computing design and manufacturing (CDRF) and deep reinforcement learning (DRL) technology, research in these two fields is gradually integrating and demonstrating enormous application potential in the field of intelligent landscape design. Felbrich et al. [3] have promoted a higher degree of autonomy and intelligence in robot construction in intelligent landscape design. Through this framework, they utilize model-free DRL algorithms such as TD3 and SAC to train robot agents, enabling them to autonomously plan and construct various landscape structures. This infrastructure combines the tools, standards, and algorithms of CDRF, as well as the learning mechanism of DRL, providing a comprehensive solution for robot construction in intelligent landscape design. In the context of intelligent landscape design, we conducted two case studies. The case study focuses on using DRL technology to train robot agents for intelligent block stacking. These advantages are part of the training and execution process through parameter modelling routines, enabling robot agents to perform complex landscape construction tasks more accurately. To achieve this goal, it proposes a distributed control and communication infrastructure for industrial CDRF applications. During the 3D printing process, robot agents can adjust printing parameters in real time to adapt to different landscape materials and design requirements. By comparing the learning success rates of different algorithms, the universal applicability of this computational design environment in intelligent landscape design has been demonstrated. Landscape refers to the landscape space in a part of the region, whether it is the open space inside the city or the rural structure outside the urban structure. With the rapid development of Internet technology, information data shows explosive growth. Using these data to conduct in-depth analysis and research on landscape architecture has become the key driving force for industry innovation. In intelligent landscape design, Guo et al. [4] focused on the overall planning of large-scale design and conducted an in-depth analysis of the current situation at the regional scale. These 3D models not only have high visualization effects but also can quickly respond to design changes through parameterization adjustments. By utilizing big data and artificial intelligence algorithms, it first performs differential information estimation on the point cloud data of the 3D model, calculates the normal vector and curvature of the point cloud data, and captures subtle changes in the model. In order to further improve the accuracy and efficiency of design, big data landscape algorithms are used to intelligently detect geometric features and image feature points. When further processing the 3D model, we further refine the coarsely segmented clustering 3D model into more refined and regular parts. When dealing with complex projects, landscape planners not only need to face diverse building object layouts but also need to consider the collaboration and integration between multiple components of the project. Meanwhile, we utilize panoramic imaging technology to deeply analyze the geometric structure information of the internal point cloud, ensuring that every detail of the design meets practical needs and aesthetic standards. It can be traced back to the 1960s and 1970s, and its main source is the empirical assumptions made by landscape architects and planners in accordance with the realistic environment. This change has been echoed in the development of the industrial economy and social modernization.

Hussein [5] delved into the benefits and potential applications of integrating augmented reality (AR) technology into intelligent landscape design education. This program not only includes the basic knowledge of traditional landscape design but also incorporates the latest concepts and technologies of intelligent landscape design. During the experiment, students used this AR application for practice and received real-time guidance and feedback from the instructor. The questionnaire covers students' acceptance of AR technology, their views on intelligent landscape design education, and their experiences and gains in learning intelligent landscape design through AR applications. The experiment focuses on fourth-year students in the Department of Architecture at the University of Port Said, and designs and develops a mobile device-based AR application. It aims to create a richer and more valuable educational environment, provide more attractive learning experiences, and deepen students' understanding of the intelligent landscape design process. A series of exercises were designed around this application, aimed at guiding students to understand and apply the principles of intelligent landscape design through practical operations. Students generally believe that learning intelligent landscape design through AR applications is not only more interesting and intuitive but also helps them better understand and master complex design principles and techniques. Later, landscape design as a design theory appeared in the subject teaching. Influenced by some advanced and leading landscape architecture practices, landscape design has been positioned as a medium that can be understood and intervened in contemporary cities. The quality of technology development in intelligent landscape design is also influenced by process quality and factors used in the development process. Imani and Asefi [6] aim to explore in depth the key factors in how to effectively enhance (EE) intelligent landscape design technology in Design Process Improvement (DPI). In the process of data collection, we conducted a detailed analysis of the process of intelligent landscape design, the design review mechanism, the perspective of the design team, and the observations of researchers on the development of production, conceptualization, and communication technology in the Department of Public Information's initiatives. Quantitative analysis provides us with objective and measurable data, while qualitative analysis helps us gain a deeper understanding of how various factors interact in the process of intelligent landscape design. Given the increasing importance of intelligent landscape design in architectural design education, extensive exploration was first conducted on major databases to identify and determine the core factors affecting the development of intelligent landscape design technology in DPI. In addition, we also pay special attention to the unique data collection and analysis methods in intelligent landscape design, such as using sensors to collect environmental data and using AI algorithms for intelligent decision-making. This discovery can be attributed to the positive performance of conceptualization, communication, and production technologies in intelligent landscape design. It can guide the urban environment to integrate with the building, and gradually update over time. It can be seen that landscape designers must absorb advanced knowledge and combine other related disciplines in their own continuous learning process to improve their views on landscape design. Detailed design concepts, innovative spatial thinking, use of characteristic landscape materials and natural ecological protection planning are all basic abilities required of relevant practitioners.

Forests, as an important component of ecosystems, not only provide a series of key social and ecological services to humans but also attract people's attention with their unique natural factors and visual aesthetic characteristics. In the context of intelligent landscape design, Jahani et al. [7] employed a human perception-based approach to evaluate the aesthetic quality of forest environments. In order to implement this method, the landscape attributes of 72 Helca stage broad-leaved forest landscapes were first defined and quantified. Multiple landscape aesthetic quality models were constructed using machine learning techniques, and the optimal model was determined through comparative analysis. Further analyzing the main influencing factors of the MLP model, we found that the number of species, tree density and distribution, canopy density, altitude, and distribution of Alnus subcordata have a significant impact on the aesthetic quality of forest landscapes. After rigorous testing and analysis, we found that the MLP model performs well in predicting the aesthetic quality of broad-leaved forest landscapes, with an R^2 value of up to 0.878, significantly better than RBFNN ($R^2=0.809$) and SVM ($R^2=0.829$). These findings provide an important reference for intelligent landscape design, enabling designers to make targeted planning and design based on these key factors. This result indicates that The MLP model has higher accuracy and reliability in capturing and simulating the aesthetic characteristics of forest landscapes. In the economic development and information technology progress, landscape design is also developing in the direction of intelligence. Intelligent concepts will solve various problems in urban landscape design and construction. Using front-end network technology and computer-aided design, intelligent landscape design operation and management are carried out to build a better life for urban residents. Intelligent design includes various tools such as information technology, big data technology, and network technology, which are applied to landscape design, public space design, and road planning and design to meet people's needs for modern life. Among them, deep learning and CAD design have become the core technologies of intelligent transformation in landscape design. Artificial neural networks and generative adversarial networks in deep learning can improve the generating effect of plane design through their own generator and discriminator. The three-dimensional virtual environment formed by CAD can also make the landscape design effect more unrestrained in this way of combining virtual and reality. At the same time, the computing capabilities of these two core technologies are extremely convenient, enabling landscape designers to better propose creative and visually impactful design drawings, and computer-aided CAD design software has good effects in modification, graphic rendering, image generation, and three-dimensional image processing.

2 DEVELOPMENT STATUS

With the acceleration of digital transformation in the field of landscape architecture, the integration of big data technology and artificial intelligence technology has injected new vitality into this ancient art. Jing et al. [8] aim to systematically summarize and analyze the practical applications of machine learning in landscape architecture at home and abroad in recent years, expand to the perspective of intelligent landscape design, and look forward to future development trends. It introduces the application background of machine learning in intelligent landscape design and explores its applicability. In intelligent landscape design, machine learning technology plays an indispensable role in extracting site information, landscape evaluation, and scheme self-generation. Conduct a comprehensive evaluation of landscape quality, ecological value, social benefits, etc. This helps designers to more accurately grasp the core elements of landscape design and improve design quality. Through deep learning algorithms, we can train models to automatically extract this information from remote sensing images, providing detailed site data support for landscape designers. Machine learning technology can automatically identify and analyze key information such as vegetation types, topography, and hydrological features in the site. By training deep learning models, we can enable them to learn the laws and characteristics of excellent landscape design, and automatically generate landscape design solutions that meet the requirements. The development of deep learning technology has provided the possibility for the self-generation of intelligent landscape design solutions. This can not only improve design efficiency but also provide designers with new design inspiration.

The Computer-aided design (CAD) software in landscape architecture not only completely changes traditional landscape design methods, but also provides designers with unprecedented creative tools. In the context of intelligent landscape design, the functions of computer-aided design software have been further expanded and enhanced. It can also be integrated with intelligent data analysis tools to help designers accurately plan and design based on actual site conditions and user needs. Especially with the rise of intelligent landscape design concepts, the application of this software has become more extensive and in-depth. This software supports fast modelling and rendering, can present visual effects of design, and can be combined with intelligent environment simulation tools. In addition, intelligent landscape design emphasizes the use of advanced technology and data analysis to optimize design solutions and improve the sustainability, interactivity, and practicality of the design. Simulate the performance of different design schemes in terms of sunlight, wind direction, pedestrian flow, etc., in order to help designers optimize design schemes, and improve the practicality and sustainability of the design. At the same time, this software can also automatically generate design schemes that meet the requirements of users and site conditions, greatly improving design efficiency and quality. Traditional 2D drawing software such as AutoCAD and SmartDraw provide rich object libraries to enhance graphics. The software can use AI algorithms to learn and analyze a large number of design cases, extract design patterns and trends, and provide designers with design inspiration and proposal suggestions [9]. In intelligent landscape design, the selection and identification of plants are crucial. To solve this difficult problem, Quoc et al. [10] proposed applying advanced machine-learning techniques to plant species identification in intelligent landscape design. Even for professionals such as conservationists, farmers, forestry workers, and landscape architects who deal with plants on a daily basis, species identification can be a tedious and time-consuming task. The traditional method of determining plant species through field observation requires a profound knowledge of botany, which is a huge challenge for non-professionals. It adopts a traditional shallow recognition structure that captures the morphology and texture information of leaves by extracting the feature histograms of directional gradient (HOG) vectors. CNN can automatically learn complex feature representations from leaf images and achieve efficient classification through a multi-layer network structure. To verify the effectiveness of these two methods, they conducted experiments on the flax leaf dataset and the Swedish leaf dataset. This method has achieved significant results in the field of image recognition and demonstrated higher recognition accuracy in our experiments. By comparing the experimental results, it was found that deep convolutional neural networks (CNNs) exhibit higher accuracy and robustness in plant species recognition.

In the cutting-edge field of intelligent landscape design, the application of artificial intelligence (AI) engines is gradually demonstrating its enormous potential. Although AI has been widely applied in fields such as architecture and urban planning, such as floor layout optimization, volume model generation, and image quality evaluation. The rise of deep learning (DL) and its branches, Generative Adversarial Networks (GANs), in particular, has brought new possibilities for the creative design of garden landscapes. Senem et al. [11] elaborated on innovative research using GAN technology to generate front-end and back-end garden layouts. By introducing various GAN engines, such as Deep Convolutional Generative Adversarial Network (DCGAN), we aim to explore a method that can automatically learn and generate diverse, high-quality garden layout designs. These images not only have qualitative attributes such as design concepts and aesthetic value but also contain quantitative evaluation data such as functional and structural ratings. There is still significant research space in the specific field of garden landscape design, especially in the intelligent design of two-dimensional garden layouts. Through learning and analyzing these data, its AI engine can gradually understand and master the inherent laws and aesthetic standards of garden design. These generated layouts can serve as a source of inspiration for landscape architects, helping them quickly iterate and optimize design solutions. The research results indicate that garden layouts generated using GANs not only have high diversity and creativity but also can meet the needs of designers and users to a certain extent. In the context of intelligent landscape design, the accuracy and scientificity of architectural style positioning, as a key link in the overall design process, are particularly important. Xia et al. [12] proposed a residential architectural style classification and prediction method that combines intelligent technology and explored its potential application in intelligent landscape design. These elements not only cover the exterior features of the building, such as the curvature of the volume, the shape of the roof, and the richness of colour tones but also include site economic factors such as building height. Due to the complexity and ambiguity of architectural styles, traditional methods often rely on the subjective judgment of designers, which to some extent limits the innovation and efficiency of design. Through the learning and optimization of algorithms, we have found that the current real estate styles can be roughly divided into 8 categories. These elements provide an important data foundation for style positioning in intelligent landscape design. Through in-depth interviews and questionnaire surveys with frontline designers and project planners, they extracted key morphological elements and site economic factors that affect the classification and positioning of architectural styles. In intelligent landscape design, they utilize these classification results and prediction models to achieve more intelligent style positioning. This can not only greatly improve design efficiency, but also ensure the compatibility between design style, site environment, and owner needs.

The basic goal of sustainable design for building environments is not only to optimize building performance but also to minimize the impact of buildings on the environment while promoting harmonious coexistence between landscape and architecture. In order to achieve this goal, modern architects have begun to widely adopt intelligent landscape design and a series of advanced digital design environments, such as computer-aided design (CAD), building information modelling (BIM), and emerging intelligent landscape design tools. Yu et al. [13] pointed out the technical barriers and preparatory factors faced by multiple countries in implementing sustainable design. The existing digital design tools still need to be strengthened to support sustainable design and intelligent landscape design. We delved into their views on the relationship between sustainable practices and the ability of digital design environments to support these practices. These technologies enable architects to implement sustainable design principles more deeply, making optimal decisions on the ecological, energy characteristics, and landscape integration of buildings. This model not only helps us better understand the challenges architects face in sustainable design processes but also provides valuable references for future research and practice. It is particularly noteworthy that although architects generally recognize the importance of sustainability, most people may not consider building performance analysis (BPA) and intelligent landscape design as their core responsibilities. The study of forest landscape preferences plays a crucial role in promoting forest landscape protection, quality improvement, and sustainable utilization. Traditional preference research methods often overlook objectivity from the perspective of plants and photo media. Zeng et al. [14]

used the Deepsentbank tool to conduct an emotional analysis of forest landscape photos, revealing the complex emotional responses of the public towards forest landscapes. The public tends to prefer forest landscapes with flat views, which may be because flat views better showcase the vastness and tranquillity of forests. From the perspective of intelligent landscape design, this study not only provides a deep understanding of public forest landscape preferences but also provides valuable references for future forest landscape planning and design. Using geotagged forest landscape photos published by forest reconstructors on the "2BULU" application, we conducted an in-depth exploration of the public's forest landscape preferences. The study also innovatively introduced eight forest landscape scenes, including single plant combinations, details, whole, forest diameter, and within the forest, to gain a more comprehensive understanding of the impact of different landscape types on public attractiveness. Although the internal landscape of forests has certain preferences, the public has lower preferences for individuals, details, and the overall landscape. Research has found that forest trail landscapes have a high preference. This means that in forest landscape recreation, the trail is not only a pathway connecting various landscape nodes but also a key element in improving tourist experience and satisfaction. Zhang et al. [15] proposed an innovative landscape evaluation framework based on real-time emotions. This framework combines advanced facial expression recognition techniques with semantic segmentation techniques for changing landscapes. This method generates a large number of real-time data points, up to 5 million, providing us with rich correlation data between emotional responses and landscape changes. The introduction of this method enables us to capture subtle changes in the landscape from different angles and accurately evaluate how these changes affect the emotional response of the public. Through the collaboration of deep learning algorithms, it successfully analyzed these data and found that it can more finely classify visual variables and track subtle emotional responses. Among all predictive factors, the proportion of grass has been proven to be the most significant predictor of emotional perception. To validate the effectiveness of this framework, we conducted a case study using panoramic videos converted from Google Street View images to simulate the constantly changing scenes of urban green spaces. This discovery is of great significance for intelligent landscape design, as it reveals the important role of vegetation coverage and type in influencing public emotional responses. The proposed framework is not only highly adaptable but also human-centred, allowing the public to perceive the emotional environment of the building instantly.

3 INTELLIGENT LANDSCAPE DESIGN AND CAD-AIDED DESIGN

3.1 Intelligent Landscape Design Based on Deep Learning Neural Network Algorithm

Since the concept of a smart city was put forward, the primary problem to be solved in social construction is the environmental problem in urban development and planning. People pay more and more attention to urban landscape design and the intelligent development of urban management so that landscape design and internal facilities have been upgraded. In this context, intelligent landscape design meets the needs of society. Some developed countries have also put forward relevant design ideas, formulated architectural design theories about intelligent cities, and set off the upsurge of smart cities around the world.

China is a developing country, and the construction of smart cities is relatively late, but the development momentum has risen significantly in recent years. By summarizing the experience of Western countries, the intelligent landscape design concept with its own social characteristics is put forward. In landscape construction and planning, the use of new materials and new resources is a common problem in urban development. For example, the implementation of intelligent landscape equipment to solve the problem of environmental pollution, the saving of landscape resources through high-tech, and then solving the shortage of energy supply. In addition, predictive technology and sensing equipment can also be used to improve people's comfort requirements in daily life and build a living space suitable for human life from an all-round perspective.

Deep learning mathematical models deal with relevant computational problems through connections between neurons, and they are also the starting point for computer learning training.

Until the breakthrough of various algorithms such as artificial neural networks and generative adversarial networks, in the later training, deep learning added multiple neural network structures and gradually changed its own defects. Traditional deep learning algorithms need to deal with a large number of weight calculations, and their convergence speed and calculation accuracy are poor. At the same time, this sudden gradient descent algorithm is also prone to the problem of local difference. In this study, we focus on analyzing the generative adversarial network algorithm in deep learning and complete the connection of neural units through three parts: input layer, fade layer and output layer. Before the initial research, we used deep learning algorithms and traditional data extraction methods to capture relevant feature points of intelligent landscape design maps. The feature point extraction effect is shown in Figure 1.

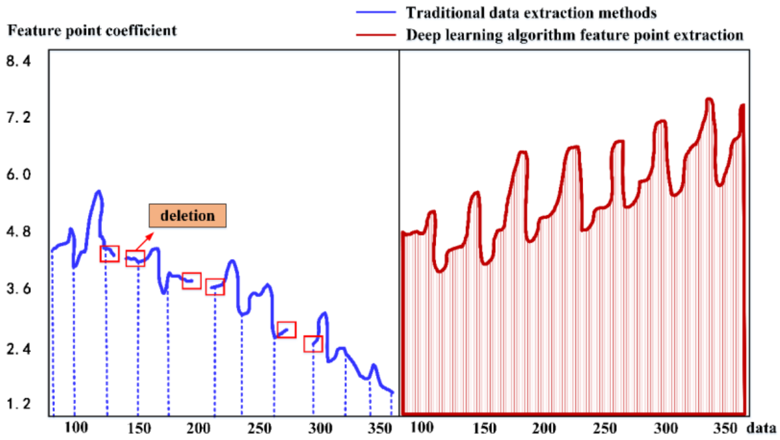

Figure 1: Effect of feature point extraction under different algorithms.

As can be seen from Figure 1, the traditional data extraction method to obtain an intelligent landscape design scheme has the defect of feature point capture. The data of the formed feature points are fluctuating and missing. The deep learning algorithm is used to process the dynamic data, and the stable data change effect is shown in the process of feature point extraction, and the data form is also very complete. Landscape design plans, as important content for designers to complete concept presentations and program communication, are often scientific and artistic. Using a deep learning algorithm, realistic landscape design plane images can be generated. With the help of a deep learning neural network, we use a generator and discriminator to make the design information reach the best state, take a specific landscape design scheme as the input object, and finally complete the output of graphic design drawings in the training model according to the discriminator's extraction of sample features. Firstly, the hierarchical structure model of intelligent landscape design is determined, and the corresponding feature matrix formula is set as follows:

$$A = (a_{ij})_{x\times x} \tag{1}$$

When comparing multiple elements and features, the quantization method is used to describe the weight coefficient. When there is a large amount of data and neural units, the matrix formula constructed changes as follows:

$$a_{ij} > 0; \frac{1}{a_{ij}} = a \tag{2}$$

The weight matrix and neuron nature need to meet the following conditions:

$$a_{ij}a_{ik} = a_{jk}, 1 \le i, j; k \le x \tag{3}$$

Since intelligent landscape design needs to meet many requirements in practical applications, we need to carry out consistency tests on the weight matrix. When the test results meet the requirements of the index, it is considered that the established matrix can be applied in the calculation process to a certain extent:

$$CR = CI / RI = \frac{\lambda_{\max} - n}{n-1} / RI \tag{4}$$

Among them, n Represents the maximum eigenvalue of the weight coefficient. In the intelligent landscape design system formed by a deep learning algorithm, for the relationship between surfaces and points in three-dimensional space, we convert them into plane coordinate vectors:

$$Ax + By + Cz - D = f(x) \tag{5}$$

In the formula, D Represents the distance between the coordinates and the origin. According to the least square method, the fitting formula of the local plane normal vector is derived as follows:

$$P = \arg\min \sum_{i=1}^{n} ((x_i - m)^T n)^2 \tag{6}$$

At this time, according to the formula, it can be seen that the deep learning algorithm adds the vector to the training data to find the optimal solution generation path. In image classification and image task processing, a neural network is used to complete the judgment of output results. First, image features, which are elements such as texture and edge of landscape design-related content, are extracted. Set the input value and the correlation function, and the process of continuous judgment is expressed by the following formula:

$$(f * g)(x) = \int_i f(x) g(X - t) dt \tag{7}$$

When the calculation result of the formula is a discrete object, the calculation summation form in the neural network needs to be transformed:

$$(f * g)(i) = \sum_a f(a) g(i - a) \tag{8}$$

When the input data is a two-dimensional vector, the function needs to meet the numerical requirements on the interval:

$$(f * g)(i, j)_b = \sum \sum_a f(a, b) g(i - a, j - b) \tag{9}$$

The image results of intelligent landscape design need to be traversed in a two-dimensional system, which is prone to blur edge pixels during image edge calculation. Therefore, we need to fill in the input data:

$$(n_j - k_h + 1) \times (n_w - k_w + 1) \tag{10}$$

The shape features of the input data are changed, and the image size obtained by calculation can be expressed by the following formula:

$$F = \frac{f(x) - K + 2p}{o^2} \tag{11}$$

$$F_o = \frac{F_{in} - M + p(X)}{s} + 1 \tag{12}$$

The deep learning connection layer needs to map the output results to a new space for data detection and regression, at which time each neuron receives the output task of the previously hidden layer, and the calculation is taken as a new result, its derivation formula is:

$$o_1 = w_{11} X_1 + w_{12} X_2 + w_{13} X_3 + b_1 \tag{13}$$

$$o_2 = n_{21} X_1 + n_{22} X_2 + n_{23} X_3 + c_2 \tag{14}$$

Among them, o_1 and o_2 As input data to the connection layer, b_2 and c_2 Is the output result. Finally, the activation function is added to the data training to improve the accuracy of feature judgment. The activation function formula is defined as:

$$s(X) = \frac{1}{1+e^{-x}} \tag{15}$$

Since the intelligent landscape design scheme of deep learning planning has a two-dimensional plane layer, we also need to convert it into a three-dimensional modelling output form in the future and improve the effect of the model in the transformation.

3.2 Deep Learning Optimization in Intelligent Landscape Design

The design scheme and parameters need to be modified in the drawing of the planar landscape design. The intelligent landscape design scheme generated based on a deep learning algorithm combined with CAD technology can have a good presentation effect. At the same time, a variety of materials and elements will be used in landscape design and architecture, and the design requirements will also change according to the changes in the scene. CAD technology has a powerful drawing and element rendering function, and its performance effect is outstanding. However, traditional CAD technology is prone to edge blur in graphic design rendering, so we need to add a deep learning algorithm to optimize this. By using a deep learning algorithm, the feature data of CAD CAD can be processed in the form of local feature points, which can be easily affected by noise, complex structure, and so on. The CAD design structure was changed after the local feature processing of the deep learning neural network was added, and its internal composition is shown in Figure 2.

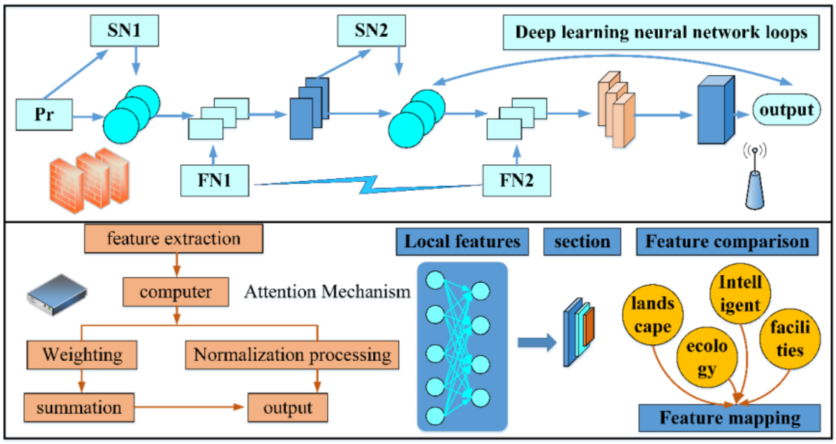

Figure 2: Deep neural networks and internal composition of CAD.

It can be seen from Figure 2 that the learning centre network structure after optimizing the global features is output in the continuous training of feature points. At the same time, the attention mechanism is added to enhance the connection between the internal elements. Although there are some local calculations, the results are not affected by the global features. Therefore, the freedom of space is increased, the original two-dimensional image is normalized according to the spatial coordinates, and the display of a three-dimensional landscape design is finally realized. In order to meet the algorithmic environment and network training configuration, we statistically represent relevant detailed parameters:

Environmental Configuration		Model Parameter	
Environment	Configuration	Parameter	Set-Up
CPU	Intel12900KF	Batch Size	64
CPU	NVIDIARTX3030Ti	Input Number Of Points	300
RAM	32G	Epoch	300
Operating System	Ubuntu20.04	Optimizer	SGD
Compiler Language	Python3.8	Learning Rate	0.001
Deep Learning Framework	Pytorch1.12	Momentum	0.9

Table 1: Algorithm Environment And Network Training Configuration Parameters.

As can be seen from Table 1, different types of CPU processors and read memory are used in the environment configuration, python is used to compile the language, and the number of feature point inputs and learning efficiency are adjusted to complete the system operation. Next, we compared the edge effect changes of landscape design images formed by CAD before and after deep learning optimization, as shown in Figure 3.

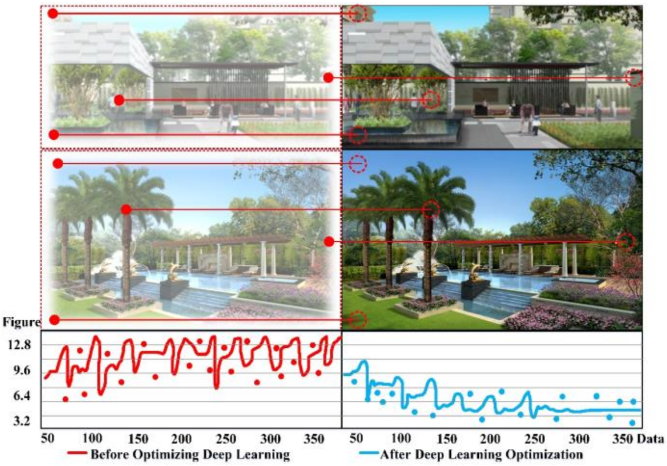

Figure 3: Comparison of edge effects of landscape design images formed by CAD before and after deep learning optimization.

As can be seen from Figure 3, the intelligent landscape design scheme generated by CAD technology after adding deep learning optimization is obviously clear on the edge. It can be seen that this algorithm can solve the noise problem in image processing. At the same time, the virtual scene generated by CAD auxiliary technology can also meet people's intelligent experience needs, create interactive and shared public areas, and use sensory design modes to enrich the play experience of the masses. Subsequently, we analyzed the research results and experimental effects of intelligent landscape design under deep learning.

4 ANALYSIS OF APPLICATION RESEARCH RESULTS

4.1 Research Result

Using deep learning neural networks can generate more scientific and realistic landscape design plans. Different from the traditional supervised model, deep learning combines design elements internally to achieve the best state in a balance and adds different intelligent landscape design requirements to extract sample features to complete data training. In order to further verify the effectiveness of the algorithm, the spatial layout effect in intelligent landscape design is compared and analyzed. Space layout can meet the needs of different landscape collocations, which plays an important role in improving the quality and aesthetics of architectural landscape design. Landscape design samples were randomly selected to compare the proportion of plants, landscape and human activity areas in landscape layout before and after optimization:

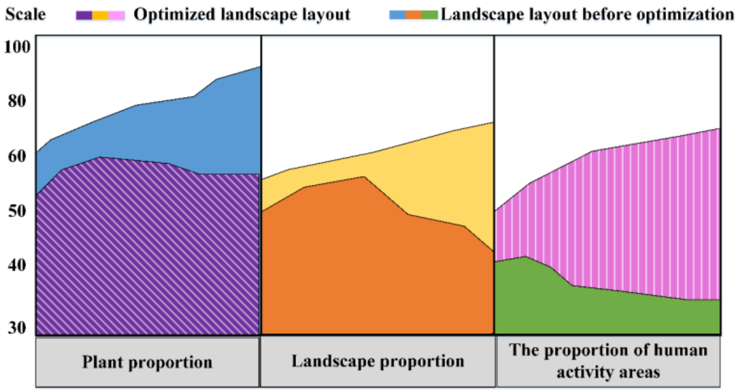

Figure 4: The proportion of plants, landscape, and human activity areas in the landscape layout before and after optimization.

As can be seen from Figure 4, there are too many plants and too few human activity areas in the landscape design scheme before the optimization of the deep learning algorithm, and this layout is obviously irrational. After optimization by a deep learning algorithm, plants and human activity areas in the intelligent landscape design plan map each other, and their respective proportions meet the requirements of intelligent urban landscape design. The diversity of plant configuration and the collocation of landscape equipment can make the masses feel comfortable. To this end, we used a questionnaire survey to interview some people and explore the changes in the satisfaction of the people with intelligent landscape design before and after optimization with a deep learning algorithm, as shown in Figure 5.

As can be seen from Figure 5, people are more satisfied with the intelligent landscape design scheme optimized by a deep learning algorithm. In addition, the intelligent landscape design scheme formed by the deep learning algorithm can also complete the transfer of style, that is, the specified style is applied to the image, in order to improve the quality of landscape design.

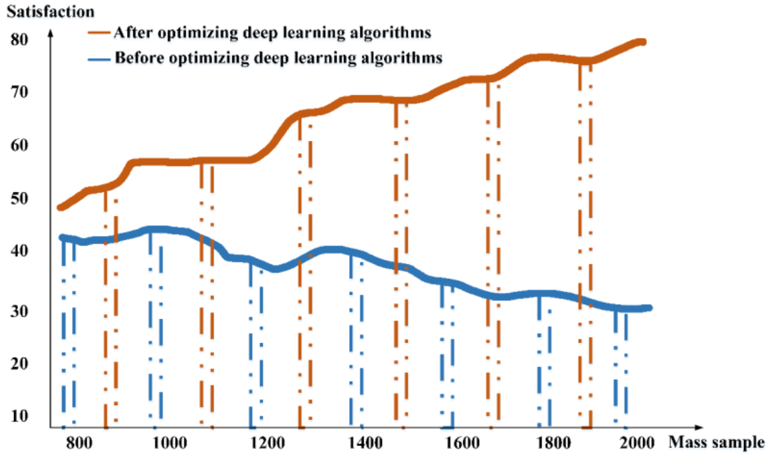

Figure 5: Comparison of public satisfaction before and after deep learning algorithm optimization.

Deep learning and neural networks are applied in visual image analysis and processing, and the processed image features are input, and then sampling and generation are completed through data training. Intelligent landscape design can often reflect the relationship between landscape roads, water system distribution, ecology and humans. This ideal landscape design style has greater practical value.

4.2 Analysis of Application Research Results

The intelligent landscape design usually goes through the following processes: First, the two-dimensional plane plan is drawn by relevant software, then the two-dimensional plane image is input as the data of three-dimensional modelling, and finally the rendering and scene construction is completed in the three-dimensional modelling scene. CAD technology can transform a two-dimensional plan so that the image is displayed in three-dimensional space while retaining the colour and intuitive image of the original design. There are many image schemes involved in intelligent landscape design. Traditional CAD technology is prone to problems such as edge blur and poor rendering effects in rendering. To this end, we add a deep learning algorithm for optimization and reduce the noise interference to the image through feature point extraction processing. Compared with other edge feature extraction methods, CAD technology optimized by deep learning algorithm can completely extract landscape design features and evenly distribute these data points in the spatial range. We will add the design drawing before and after optimization of the deep learning algorithm and show the generated effect, as shown in Figure 6.

As can be seen from Figure 6, there are only black and white elements in the original design drawing, and the feature points of intelligent design are also fuzzy. The CAD modelling system optimized by deep learning algorithm can render the initial design drawing and generate 3D. The intelligent equipment contained in it meets the needs of the masses for modern life. At the same time, we also found that in order to improve the intelligence of landscape design, it is also necessary to collect a variety of intelligent equipment libraries. Using the detailed classification of data management improves the efficiency of design scheme generation. And add a variety of intelligent devices such as sensors in landscape design, so that digital life and human beings have deep contact. The landscape area is connected to the Internet to improve service efficiency through data and service platforms, and the landscape design content is determined according to the action trajectory and life preferences of the surrounding people.

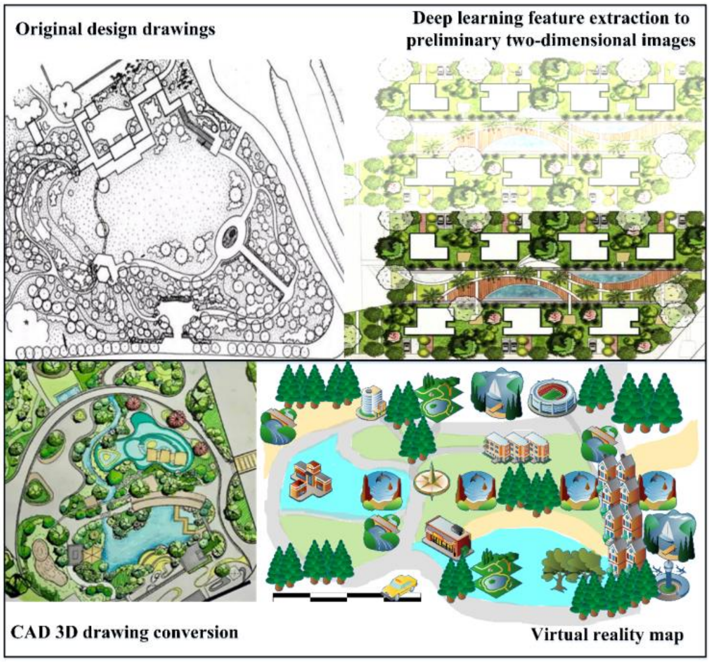

Figure 6: Design drawings and generation effects before and after deep learning algorithm optimization.

5 CONCLUSIONS

With the development of the social economy, we need to implement the concept of intelligence in the construction of urbanization. Landscape designers should take the initiative to explore and create design schemes to make regional design more in line with human needs for modern life. With the creation of science and technology and digitalization, the space environment is a people-oriented and ecological priority. In intelligent landscape design, it is necessary to build a mature and perfect intelligent equipment system, highlighting the integration and refinement of equipment management. And conform to the development trend of the information age, to provide people with convenient services. Based on the above environment, this paper uses a deep learning algorithm to study the intelligent landscape design scheme and combines it with CAD technology to improve the presentation effect of intelligent landscape design. Firstly, the structure of the deep learning algorithm is analyzed in the research, and it is applied in the generation of intelligent landscape design plans. Through the judgment and training of feature points, select the relevant elements that meet the requirements of intelligent landscape design, and automatically generate the plane design. Secondly, the deep learning algorithm is added to the CAD system optimization to improve the edge ambiguity in the process of 2D flat to 3D conversion. Moreover, the existing feature extraction algorithm is improved to make the virtual scene of intelligent landscape design more authentic. Finally, the effectiveness of the algorithm is verified through public interviews and investigations, and the collocation of intelligent equipment and ecological environment is paid attention to in actual use. The research results show that the deep learning algorithm has good calculation and output performance in the generation of intelligent landscape design schemes and improves the interaction between intelligent landscape design and the masses after combining with CAD technology.

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