Design and Optimization of Landscape Lighting in Urban Parks using Internet of Things Technology

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Abstract. With the continuous improvement of China's economic level, people have put forward new requirements for the quality of life, landscape lighting has become a basic function of lighting, people began to love the outdoor lighting, different places in the city have different effects of lighting. With the increasing number of large buildings and the expansion of the park landscape, the function of the time controller is gradually weakened. The introduction of intelligent lighting control system not only strengthens the function of saving energy, but also the control ability of lamps and lanterns becomes stronger. In response to the above, this paper investigates the information feedback problem of landscape lighting control system and applies the Internet of Things technology to urban park landscape lighting. A lighting control system based on Art-Net network protocol and DMX512 protocol is designed to realize the application of IoT technology in urban park landscape lighting. The experimental results prove that the method not only can upgrade the feedback function of the original DMX512 system without changing the existing infrastructure, but also solve the compatibility problem between the new RDM devices and the original DMX devices. The feasibility of the method was confirmed through experiments and successfully applied to the actual project with good operation. It is hoped that it will provide a reference for the development of intelligent lighting control system in China, and then promote its rapid development.

Keywords: Internet of Things; Intelligent Lighting; Urban Park Landscape
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1 INTRODUCTION

Computer assisted urban landscape lighting refers to the process of utilizing computer technology and AI algorithms to intelligently manage and design urban landscape lighting. With the continuous development of Internet of Things technology and AI algorithms, computer-aided urban landscape lighting has become an important component of smart city construction. Abdelhamid and Elfakharany [1] analyzed the intelligence of lighting control. Computer assisted urban landscape lighting achieves intelligent control of lighting through Internet of Things technology and AI algorithms, including automated control, remote control, intelligent induction control, and other methods. Basak [2] analyzed the intelligence of lighting data: computer-aided urban landscape lighting uses Internet of Things technology and AI algorithms to monitor and analyze real-time urban landscape lighting, including various indicators such as lighting brightness, color temperature, and illumination uniformity, in order to achieve intelligent management and adjustment of urban landscape lighting. Chai [3] has made efforts in the intelligence of lighting design. Computer assisted urban landscape lighting uses Internet of Things technology and AI algorithms to digitize and optimize urban landscape lighting, including automatic generation of lighting schemes, automated plant configuration, and other functions, in order to achieve personalized design and optimization of urban landscape lighting. In short, the intelligence of computer-aided urban landscape lighting has achieved the digitization, automation, and intelligent management and design of urban landscape lighting, thereby improving the efficiency and quality of urban landscape lighting, and also providing new development opportunities for urban landscape lighting design companies.

Based on this background, this paper divided into four main chapters. The first chapter describes the current development status of the landscape lighting market at home and abroad. The booming domestic landscape lighting industry is described and the current situation of landscape lighting control system is analyzed. The landscape lighting control protocols are introduced, and solutions are given from the technical level according to the actual needs, and the characteristics of the Art-Net protocol and the DMX512 protocol are introduced in detail. Chapter 2 builds the IOT technology lighting control system according to the equipment that can be provided by the market, and completes the testing and installation with successful completion. Chapter three illustrates the common lighting control algorithms, as a way to analyze the compatibility of RDM protocol and DMX512 protocol, propose a new method of protocol conversion, and the solution of light sensor data collection, test and implement the protocol of bidirectional control and the application of RDM module, in order to achieve the lighting design of urban park landscape, also need to collect and process the information of urban park landscape, so the collection of dimensional information of urban park landscape. Chapter 4 verifies the system simulation and analysis based on the above urban park landscape lighting design, the lighting installation and the actual operation status, and proposes solutions to the operation process, the faults that are prone to occur, so that the system of the whole project is stable and achieves the target effect. The results show that the lighting design driven by IoT technology can control each subsystem in a synchronous or asynchronous manner to achieve regional unified lighting management and realize the corresponding lighting effects, which can eventually realize the digital landscape lighting of the whole urban park landscape.

The innovation of this paper is based on IoT technology driven, for the current landscape lighting specific situation, this topic proposes a new digital control based landscape lighting information and control platform, combining remote control and landscape lighting control management, making full use of advanced 5G network, embedded control technology, through a unified access and control protocol design and development of a new remote centralized control system This system greatly improves the modern management level of urban landscape lighting and maximally meets the needs of managers for landscape lighting management under various conditions.

2 STATE OF THE ART

With the development of society, the country's economic strength is gradually increasing, the urbanization process is significantly accelerating, and how to use modern technology to reasonably plan and build the city's infrastructure is particularly important. Fialová et al [4] aim to explore the case study of the smart city model in Brno city. The research results indicate that it remains a model and reflection of a smart and sustainable city. Guo and Wang [5] used the architectural design tools in the parametric software to carry out parametric design of traditional landscape buildings and generate parametric architectural model. Convenient for subsequent optimization design. Parametric design can be carried out according to actual situations, such as building materials, building structures, building shapes, etc. Han et al [6] utilized geographic information tools in parameterized software to parameterize the geographical environment where traditional landscape architecture is located, generating parameterizable geographic information models for subsequent optimization design. The GIS (Geographic Information System) technology of parameterized software can be applied to the optimization design of traditional landscape architecture. Through methods such as parameterized architectural design, parameterized geographic information, parameterized landscape design, and parameterized optimization design, comprehensive optimization design of traditional landscape architecture can be carried out, improving the design quality and aesthetics of the building, while also reducing human factors and uncertainties in the design process. Jia [7] conducts research on multi-objective optimization through parameterized design in design practice to understand the operational techniques of parameterized planning in panoramic structural layout practice. In the planned practice approach, the design practice is taken as the object, and the main objectives are determined through extensive simulation calculations and data evaluation work. From the perspective of specific design models in the practical stage, a detailed discussion was conducted on parameterized landscape architecture design and its efficient, universal, and multi-objective characteristics, explaining sustainability and optimization. Practice has proven that parametric design can greatly improve design efficiency, shorten design cycles, and quantify relevant content in rational design. It has a rigorous logical algorithm process that brings new developments to design and has a strong driving force in this field. The purpose of Kim et al [8]'s research is to propose directions for designing and managing intelligent parks to achieve intelligent green cities, and to propose measures to cultivate related industries in the landscape field. By analyzing established cases of smart parks in new and existing cities, problems and improvement suggestions were identified.

In the planning of the intelligent lighting control system, the main design idea of Vathanam G et al. is that this intelligent control system must be bus-based, distributed, and highly intelligent. The functions of the control system are set up through software as a way to control the circuit and to control the energy consumption of the circuit. An input-output control system is established so that when there is a change in the input, the software immediately reacts to the output signal, thus providing intelligent control of the circuit. Lallawmzuali and Pal [9] can work faster and produce higher quality designs, thereby improving. When the intelligent lighting control system is combined with the property management system, fire management system, security control system and various automatic control systems in the park, intelligent control measures can be implemented for the whole park. Intelligent lighting control systems can basically adapt to the lighting needs of all places, such as indoor and outdoor, and can use automatic dimming functions to meet the lighting needs of different places, especially in the park landscape design, without the need for close control to manage the lights and achieve intelligent management of park landscape lighting. Liu et al [10] proposed a design method for multi-dimensional urban landscapes based on nonlinear theory to address the issue of significant differences. Luo et al. [11] explored the principle of environmental tone coordination. The design of plant colors in the park should be coordinated with the surrounding environment, such as planting red or yellow series of colorful tree species such as purple leaf plum, tree species, maple, tea tree, and southern bamboo in front of light colored buildings. Or take the dark green coniferous trees as the background, and cluster the varieties of mosaic series, golden leaf series and green trees, which can play the role of icing on the cake. Tai [12] discretization the geometry into finite elements, and uses these elements to solve. In perspective projection modeling, geometry can be represented as a set of finite elements, and these elements can be used to approximate the shape and size of the entire geometry. These units can be geometric elements such as points, lines, and surfaces, as well as non-geometric elements such as curves and surfaces. Define the parameters of the element based on its shape and size, such as its length, width, height, etc. The finite element model is established by using the discretization element set to solve the position and shape of the geometry. Xu and Wang [13] believe that landscape design of CAD floor plans refers to the use of CAD software to deepen the design of floor plans. Including visual expression of landscape elements, grassroots and practice expression, dimension annotation, etc., in order to better express design intent and guide construction. In CAD construction drawing data, the floor plan is an important component, which is usually drawn during the conceptual and conceptual design stages. In the floor plan, designers can deepen the landscape design elements such as sketches and intention maps, and also need to annotate specific practices and dimensions for accurate on-site adjustments during subsequent construction. Therefore, the landscape design of CAD floor plans is an indispensable part of the entire design process, which can help designers better express their design intentions and guide construction teams to accurately carry out construction [14].

Different plants have different colors, and designers can design different plant combinations and landscape effects based on their colors. Kim et al. [15] can understand the growth status and health status of plants by observing their shapes, and can also design different plant combinations and landscape effects based on their shapes. Different plants have different shapes, and designers can design different plant combinations and landscape effects based on their shapes. Zhang and Deng [16] understand the growth status and health status of plants by observing their texture, and can also design different plant combinations and landscape effects based on their texture. Different plants have different textures, and designers can design different plant combinations and landscape effects based on the texture of the plants. Starting from the color extraction of landscape designers, this paper explores the emotional needs of color in street space design through the study of environmental emotional structure. The intelligent lighting control system has eight control methods, and different control methods have different features and functions, as shown in Figure 1. Therefore, in the process of park landscape design, it is very important to choose the control method.

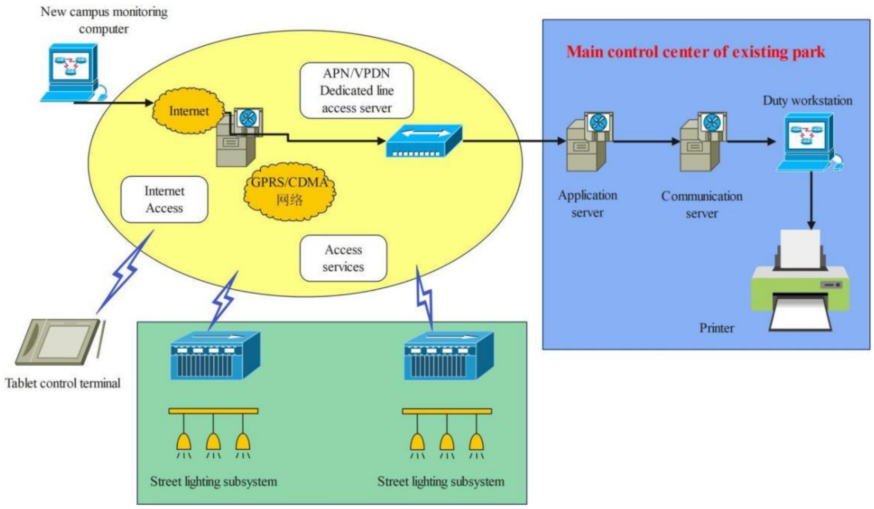


Figure 1: Control mode of intelligent lighting control system.

The traditional lighting control system basically meets the most basic needs of people for lighting. However, it also possesses great disadvantages, in the case of large-scale use, the wiring is more chaotic and each control switch has its own wiring, in addition.

3 RELATED TECHNOLOGIES

3.1 Common Lighting Control Algorithms

The system combines new technologies such as Internet + Internet of Things technology, new generation communication technology, big data analysis technology, AI artificial intelligence, and cloud data analysis to achieve intelligent, integrated, and refined management and control of landscape lighting fixtures and to build an efficient, safe, intelligent, innovative, and resource-sustainable city-level intelligent lighting management platform. The system architecture consists of four levels, which are: cloud (service application layer), pipe (transmission network layer), edge (edge gateway), and end (device sensing layer). The end is the control terminal and sensing device, including LED control terminal, LED lamps and lanterns and various sensors to complete the information collection and provide reliable data support for the lighting system decision. LED lamps and lanterns need to contain RDM information feedback chip, which can feedback the data of lamp operation (such as: current, voltage, temperature, etc.) to the control terminal. Sensors, on the other hand, collect environmental parameters such as illumination, human infrared, sound, temperature and humidity.

Free-illumination optics obeys the law of energy conservation. Free-form optics can change the distribution of the light beam, but not the total sum of light energy, and the total energy received on the irradiated target plane is equal to the total energy output from the light source. Considering the light source as a point source and located at the origin, the light intensity of the light source in the (θ,φ) direction is I, and dΩ denotes the unit stereo angle, the total energy of the light source is expressed as

$$\Phi_S = \int I(\theta, \varphi) d\Omega \tag{1}$$

Let the illumination distribution of the target surface be E(x,y) and dA denotes the unit area of the target surface. Then the total energy received is expressed as

$$\Phi_T = \int E(\mathrm{x}, \mathrm{y}) dA \tag{2}$$

According to the law of conservation of energy, it follows that

$$\Phi_S = \Phi_T \tag{3}$$

The energy mapping network is constructed based on the explicit light intensity distribution state and the target surface illuminance distribution based on the law of energy conservation. The illuminance uniformity is the ratio of the minimum illuminance to the average illuminance on the specified surface, which is generally used to reflect the distribution of illuminance size. The closer the illuminance uniformity is to 1, the more uniform the light distribution is, the more comfortable the visual sensation is, and vice versa, the smaller the illuminance uniformity is, the easier it is to cause visual fatigue. The formula is:

$$U = E_{\min} / E_{qv} \tag{4}$$

Where U - illuminance uniformity;

E - the minimum illuminance value of the plane.

Illuminance uniformity is a beautiful physical parameter of visual comfort, but also in the lighting design is second only to the illuminance standard of the main technical indicators. In the field of precision processing, illuminance uniformity has an important significance, the national lighting standards also have corresponding provisions. Natural light is one of the most important light sources for daily lighting, and it is a non-negligible part of the calculation of architectural lighting, but it is affected by more complex factors, for which researchers have done a lot of research to establish a sky brightness model for illuminance calculation. 2004, the International Commission on Illumination identified and published a standard general sky, including a full dark sky, a full cloudy sky and a standard model of the sky with 15 brightness in between, which is widely used by It is widely used in landscape lighting design in various countries. The sun is distant from the earth, so it can be considered that the sunlight shines parallel to the earth. To calculate the illumination of direct sunlight on the Earth, the orbital position of the Earth and the attenuation caused by the atmosphere should be taken into account, for the solar illumination outside the atmosphere, using the number of days in a year to correct the elliptical orbit is calculated as

$$E_{ext} = E_{sc}\left[1 + 0.034 \cdot \cos\left(2\pi \frac{N-3}{365}\right)\right] \tag{5}$$

Where Eext - solar illumination outside the atmosphere.

E - solar illuminance constant of 128×1031ux; N - the number of mouths in the year.

After atmospheric attenuation, the direct solar illuminance is.

$$E_{dn} = E_{ext} e^{-cm} \tag{6}$$

3.2 Productibility Conditions

The free-form surface is fitted through a series of discrete faceted data points, which can be obtained mathematically or geometrically, or the corresponding normal vectors, and the actual normal vector distribution of each point needs to be consistent with the computed ideal normal vector distribution to form a smooth and continuous free-form surface during the fit, which mathematically requires that the integral of the normal vector distribution of these data points along any closed loop is 0, i.e:

$$\oint_C \vec{N} \cdot dl = 0 \tag{7}$$

The landscape type is determined by identifying the Chinese characters representing the urban park landscape in the map as well as the elevation figures. The connected pixels with aspect ratio greater than 1.8 are considered as elevation symbols, the pixels with similar connected domains near the elevation symbols are considered as numbers, and the remaining connected pixels are Chinese characters. In this paper, 100 commonly used Chinese characters in four fonts (Song, Black, Yahei and Young Round) representing urban park landscape types are selected and normalized to 64×64 size as training samples, and a feature training classifier is used to recognize Chinese characters. Chinese characters can be considered as a special kind of texture image, and the Gabor filter is similar to the human eye cells often used as a feature extraction means to recognize texture images. Gabor filter function expression is

$$g(x, y, f, \theta, f, \gamma) = \frac{1}{2\pi\sigma_x \sigma_y} \exp\left(-0.5 \times \left(\frac{x_1^2}{\sigma_x^2} + \frac{y_1^2}{\sigma_y^2}\right)\right) \exp\left(\mathrm{i}2\pi x_1 f_{\mathrm{u}}\right) \tag{8}$$

where: θ=kπ/8, where k is the total number of directions; fu=fmax/2n/2, n expresses the number of scales of the Gabor filter; σx=σy=2/fu indicates the standard deviation of the Gaussian factor of the Gabor function, and the four directions of 0°, 45°, 90° and 135° are selected according to the stroke direction after experiment, and then five scales are extracted to form 20 Gabor filter to meet the requirements of Chinese character recognition. Let the image be I(x, y), and convolve the image with the real part of the filter according to equation (9) to get the filtered image.

$$G(x, y, f, \theta) = I(x, y) * (g(x, y, f, \theta, \gamma)) \tag{9}$$

The filtered images are equally divided into m×m blocks, and the mean and variance of pixels are calculated as feature vectors for each block of size 64/m, where the mean μij and variance σij are

$$\mu_{ij} = \left(\sum_{x=0}^{64/m-1} \sum_{y=0}^{64/m-1} G(x, y)\right) / (64/m-1)^2 \tag{10}$$

$$\sigma_{ij} = \sqrt{\left(\sum_{x=0}^{64/m-1} \sum_{y=0}^{64/m-1} \left[G(x, y) - \mu_{ij}\right]^2\right) / (64/m-1)^2} \tag{11}$$

In this paper, the 20 filters with k=4 directions and n=5 scales are used for filtering to obtain the k×n×m×m×2-dimensional feature vector fe=[μ111, σ111, ..., μm2kn, σm2kn] formed by μij and σij.

3.3 Acquisition of Urban Park Landscape Dimensional Information

The automatic acquisition of urban park landscape dimensional information is the basis for realizing the lighting design automation system, i.e., extracting the drawing wall pixel coordinates into actual two-dimensional real coordinates. The picture after Hough correction is a binary picture consisting of

0 and 1. The base condition of load-bearing wall extraction uses the average integral projection function to determine the location of most of the walls and the width of the load-bearing walls. The wall is the area where most of the pixels exist, and when the accumulation of pixels in a row area or column full area in horizontal or vertical direction exceeds a certain threshold value directly reflects the location and width of the wall. The average integral projection function is as follows:

$$Z(x) = \frac{1}{y_2 - y_1} \int_{y_1}^{y_2} I(x, y)\mathrm{d}y \tag{12}$$

$$H(y) = \frac{1}{x_2 - x_1} \int_{x_1}^{x_2} I(x, y)\mathrm{d}x \tag{13}$$

Where: I(x, y) denotes the pixel value at point (x, y); Z(x) denotes the pixel integration value of the image in the vertical direction between columns y1 and y2; H(y) denotes the pixel integration value of the image in the horizontal direction between rows x1 and x2. Figure 2 represents the horizontal average integral projection result after normalization, where the horizontal coordinate represents the length of the image and the vertical coordinate represents the horizontal integral projection value. The horizontal coordinate with the projection value over 0.2 is the location of the wall, and the widest continuous horizontal coordinate (ab area shown in Figure 2) is taken as the load-bearing wall width w.

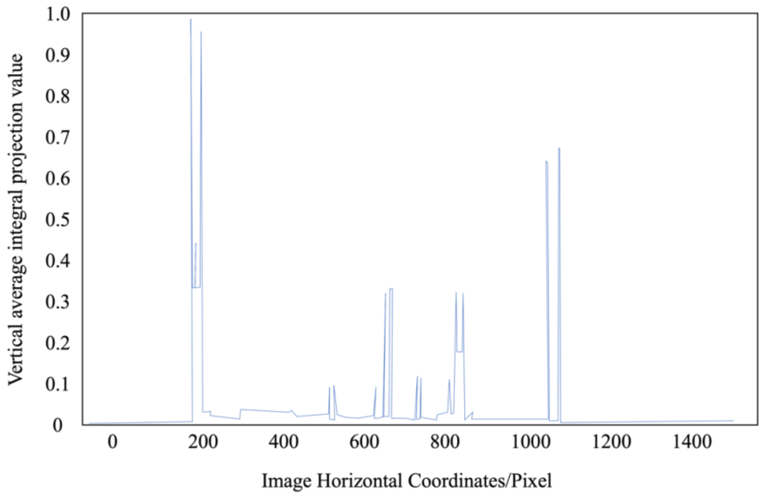


Figure 2: Average integral projection function diagram.

After extracting the wall width w, the solid load-bearing wall in the horizontal direction can be extracted by using the structural element se of 1.2w to perform the open operation in the horizontal direction first and then using the structural element se of 0.9w to perform the open operation in the vertical direction.

The windows commonly used in architecture are straight windows and folded windows, both of which have a total of 4 parallel lines that are parallel to each other and equally spaced. According to the two conditions that the parallel lines are equal in length and parallel and equally spaced within 0.3w, the horizontal and vertical opening operations of the drawing extract the location where the windows are located in the architectural plan drawing. After finishing extracting the load-bearing walls and windows in horizontal and vertical directions, a traversing band is established from the four sides of the load-bearing walls, short distance parallel to each side, if the traversing band traverses an even number of black pixels, the load-bearing walls are considered to be connected to ordinary walls, and a random white pixel between the front and back black pixels is extracted in order as the initial seed point as described later, and the coordinates of the seed point are stored in the stack set together with the direction of the vertical wall edge. windows are searched only whether there is a common wall attached at the short edge.

Nonlinear regression analysis is the theoretical basis of generalized regression neural networks. The regression analysis of the non-independent variable Y relative to the independent variable x is to calculate y under the maximum probability value. f(x, y) is the joint probability density function of the random variables x and y. If the input value of x is X, then the regression of y relative to X is also the predicted output Y zan for the conditional mean.

$$\hat{Y} = E(y/X) = \left(\int_{-\infty}^{+\infty} yf(\boldsymbol{X}, y)\mathrm{dy}\right) / \int_{-\infty}^{+\infty} f(\boldsymbol{X}, y)\mathrm{dy} \tag{14}$$

4 EXPERIMENTAL RESULTS AND ANALYSIS

4.1 Training Results

To verify the effectiveness of the method in this paper, the type and size information of the urban park landscape was extracted according to the algorithm described above using matlab for programming, and the type number of the urban park landscape, the length, width and height of the urban park landscape, and seven indicators such as the standard value of illuminance, power density value and illuminance uniformity specified by the functional urban park landscape specification were used as the input of the network in the experiment, and the 2 indicators such as the number of luminaires arranged per row and per column as the predicted output of the network. Due to the reason of data collection difficulties, this paper uses one kind of luminaire, and a total of 150 sets of input data of 3 types of rectangular city park landscapes, such as classroom, conference room and office, and selects the first 120 sets of data to train the generalized regression neural network GRNN, and the last 30 sets of data as prediction data to calculate the correct recognition rate, and compares the correct rate between the 3 types of city park landscapes BP network and the method used in this paper are compared, as shown in Figure 3.

The time required to run the system is compared between the optimized GRNN network, the GRNN network and the normal BP neural network, as shown in Figure 3. Collectively, it can be seen that the optimized GRNN network is the best choice in considering the running time and accuracy.

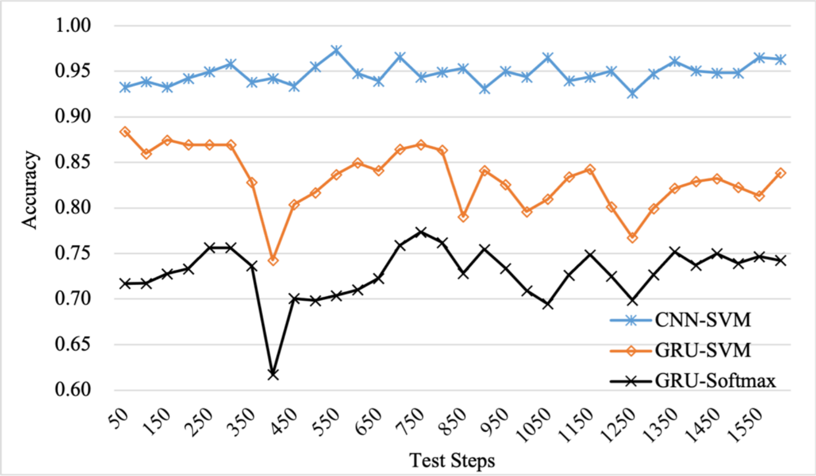


Figure 3: Accuracy of running time of three network systems.

4.2 System Simulation and Analysis

According to the lighting design automation system shown in Figure 4, the architectural plan of the school building shown in Figure 4 is used as the experimental object, and the information of the city park landscape is input into the trained GRNN neural network after the architectural plan recognition, and after the simulation, each city park landscape luminaire arrangement scheme is obtained experimentally as shown in the figure. In order to verify whether the layout scheme obtained by using GRNN neural network training meets the requirements, this paper uses dialux lighting design simulation software to carry out an example simulation according to the luminaire layout scheme, with the average illuminance of the working surface (standard for office and classroom (300±10%), standard for conference room (500±10%), power density (standard for office and classroom ≤9, standard for conference room (≤15) and illuminance uniformity (>0.6 for office, classroom standard and conference room standard) to determine whether the specification criteria are satisfied, the results are shown in Figure 4, and it can be seen from the training results that GRNN can generate the luminaire arrangement model more accurately.

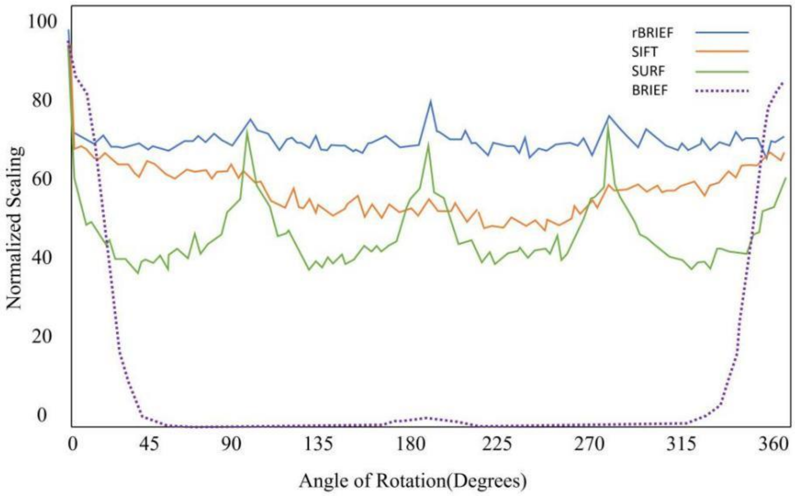


Figure 4: Results of each urban park landscape dialux test.

MSE (Mean square error) metrics are used to evaluate the results of model training. MSE represents the mean squared error, so the smaller the better, but there is no uniform standard for this, and since the neural network is an iterative convergence approximation of the analytic formula, it is impossible to reach 0. The MSE metrics of the constructed BP neural network are shown in Figure 5, and the following three solid lines indicate the performance of the BP neural network in the training process, validation process, and testing process in each generation, The MSE of the validation process and the testing process in each generation, and the Best dashed line indicates that this network has the most optimal training result when it is trained to the second generation.

The constructed BP neural network linear regression plots are shown in Figure 6, and the four plots indicate the training process, the validation process, the testing process, and the overall situation, where the closer the R value is to 1, the better the model fit is. It can be seen that the overall model fit value is R=0.97524, which is a good fit.

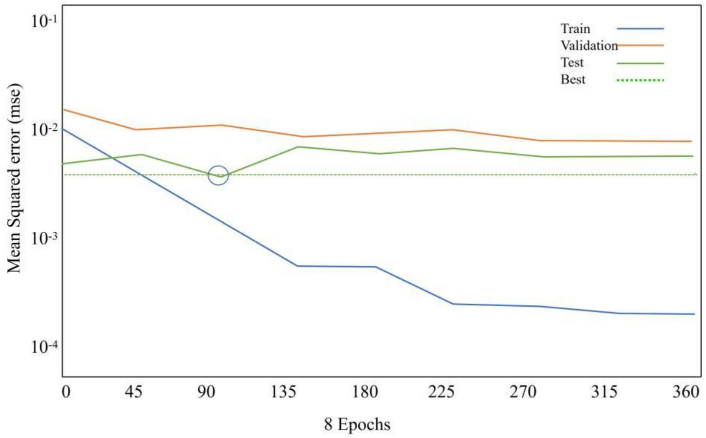


Figure 5: MSE index of the constructed BP neural network.

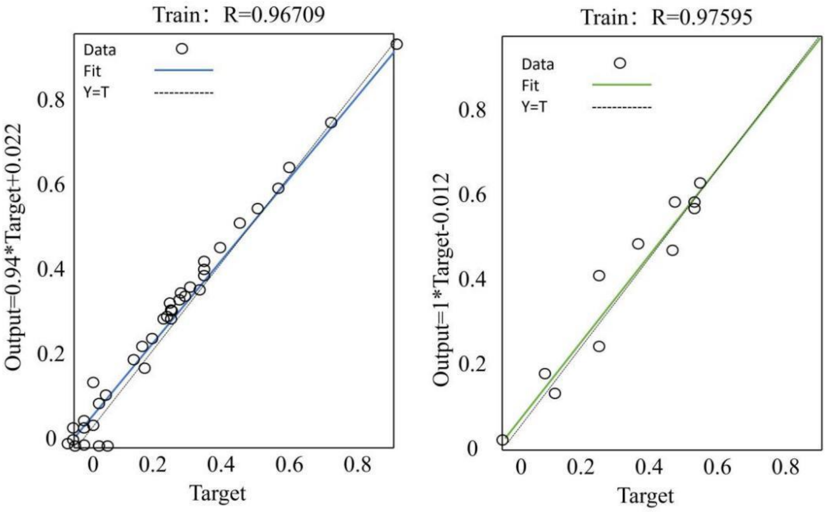
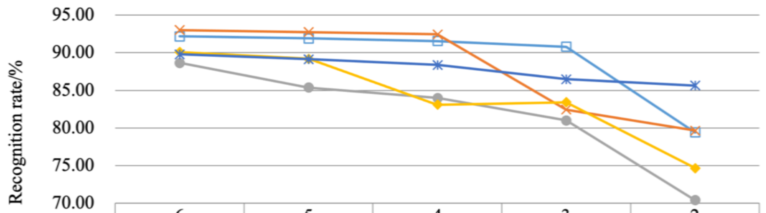


Figure 6: constructed BP neural network linear regression diagram.

As shown in Figure 5 and Figure 6, for general lighting design, its design process roughly includes two processes: scheme design and illuminance calculation. Generally, first, according to the city park landscape use and design experience to select light sources, determine the type of lighting fixtures, and then according to the distance to height ratio layout lamps; then use the coefficient method and other calculation of illuminance value on the work surface. Check whether the lighting design program meets the lighting requirements. In order to make the lighting quality meet the national standards, it is often necessary to repeatedly adjust the design scheme and repeat the calculation. Resulting in a waste of human resources, which complicates the design process. These methods for small areas, lighting requirements are not high places can still solve the problem, but there is also about 10% of the error. When the required lighting place area is larger, the use of traditional illuminance calculation method is large, cumbersome steps, does not have self-learning function, can not accumulate their own design experience, has certain limitations.

4.3 Experimental Verification

In order to verify the performance of the model, three different images as shown in Figure 7 were used for the experiments. The target images were fed to the constructed network model, and when the training process was completed, the output of U-Net was obtained as the surface data points of the free-form surface.



	6	5	4	3	2
NN	92.18	91.90	91.55	90.79	79.41
DBN	93.02	92.74	92.45	82.45	79.65
CNN	88.65	85.36	84.00	81.02	70.42
SAE	90.08	89.20	83.10	83.41	74.68
FCNN	89.78	89.14	88.37	86.47	85.65

Number of training samples/10000

Figure 7: Comparison of recognition accuracy of training methods.

The free-form surface shape data output by CNN network is reconstructed by Sneer transport layer, and the reconstruction result is visualized and output, as shown in Figure 7. The recognized illuminated image has good clarity, retains the contour features of the original image, and is restored in some details, but there are many black noise spots in the bright areas of the original image, and the overall quality has a large gap with the target image of the input model. Then the output free-form surface shape data was subjected to optical simulation, as shown in Figure 7. The simulated image has significantly more noise and less clarity, the white lines of the soccer ball, the hair of the cartoon girl and other detailed features are lost, and the overall quality is very poor and far from the reconstructed image. The data in the lower left corner represents the illumination uniformity, which refers to the ratio of the minimum illumination to the average illumination on the specified surface, reflecting the uniformity of light distribution. After analysis, the custom-built Snells transmission layer is an approximate simplification of the actual physical process of light passing through the free-form surface to the target plane, so the reconstruction process is a relatively coarse calculation, while the simulation process is a very accurate simulation of the actual physical process by the optical software, which is like instructing with a low standard, but testing with a high standard, obviously the test result is impossible to meet the expectation, so caused this discrepancy.

In summary, the free-illumination optical design method based on this paper has achieved certain results and is able to design free-form surface data points for generating target images, but the weak capability of the network model and the lack of precision in the calculation of the reconstruction process leads to less-than-ideal final results and there is a lot of room for optimization.

5 CONCLUSION

With the development of the economy and the improvement of people's living standards, people's requirements for the comfort of the environment they live in are getting higher and higher. In this paper, we studied the function, composition and data transmission method and control method of intelligent lighting control system, and studied the application of three typical park landscape lighting control systems in park landscape lighting design, and studied the lighting design automation system based on graphic recognition and GRNN neural network, firstly, we used the mean integral projection function, morphological operation and the improved seed filling algorithm to extract all walls in the architectural drawings and obtain the dimensions of each room. A Bayesian classifier cascaded with a two-level Chinese character classifier is then used to confirm the landscape type, and finally a generalized regression neural network is used to train the correct lighting samples and optimize the smooth factor using a 4-fold cross-validation method. Experiments show that based on the average projection integral function and improved seed filling algorithm can effectively take out all walls, and the optimized GRNN network reduces the influence of human tuning, and has higher accuracy and speed in generating lighting schemes compared with GRNN network and ordinary BP network. This study provides an effective reference for engineers in designing park lighting systems. It has important research implications in designing intelligent control systems for real-time monitoring and tracking of park landscape lighting equipment.

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