

# Design and Research of Lighting System for High-end Office Environment Based on Big Data Analysis

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**Abstract:** For office lighting, in order to achieve good lighting quality, it is necessary to consider the overall arrangement of lamps to make the illuminance and brightness distribution of the space meet certain uniformity requirements. In addition, people may have different perceptions of the comfort of the lighting environment when engaging in different activities. Intelligent lighting system can effectively control the dimming and switching of the whole lighting circuit, and has flexible controllability; When switching lighting scenes, the system can ensure fade-in or fade-out, and has strong scene control ability. This topic mainly aims at how to improve and improve the intelligent level of high-end office environment lighting, and designs a high-end office environment lighting system based on big data analysis. The system mainly includes three parts: intelligent human body detection and regional positioning module, lighting control module and intelligent monitoring software module of upper computer. Mask R-CNN based on deep learning is adopted as the model of human detection. The purpose of using deep learning to classify areas instead of strictly dividing image areas is to deal with the problem that the installation positions and azimuth angles of image acquisition equipment in each office are not exactly the same, so that the system can achieve more intelligent control. The whole system has the advantages of intelligence, high efficiency and so on, which better meets the requirements of high-grade office environment for lighting quality.

**Keywords:** Lighting System; High-end Office Environment.

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## 1. Introduction

With the increasingly high requirements of lighting system design, while meeting people's work, study and life, it is beneficial to save energy to design in the direction of energy saving, and to study the design of high-end office environment lighting system based on big data analysis [1]. So as to create an efficient, comfortable, safe, economical and beneficial environment and implement green lighting. Using intelligent lighting system can reduce electricity consumption and improve electricity efficiency, and at the same time, it can intelligently adjust the current lighting brightness according to people's different scenes, fields and behaviors, which brings great convenience to people's lives [2]. Lighting design needs to meet certain quality requirements, and excellent lighting environment is conducive to people's comfort and pleasure. In the office environment, high-quality lighting conditions can provide workers with the light they need for their work, and also help to improve their enthusiasm and work efficiency.

Intelligent lighting system can effectively control the dimming and switching of the whole lighting circuit, and has flexible controllability; When switching lighting scenes, the system can ensure fade-in or fade-out, and has strong scene control ability [3]. Traditionally, the design of office lighting should consider some important factors, such as illuminance, brightness, environmental color and color rendering performance of light source, which are mostly quantitative indicators of lighting. Nowadays, after decades of research progress in office lighting, it is no longer a difficult problem to meet the lighting requirements based on simple quantitative standards. The research focus has shifted to how to meet people's psychological deep-seated needs for working environment lighting through appropriate indoor brightness distribution, glare restriction, light color application and automatic dimming, that is, office environment lighting is

more comfortable and flexible, in line with people's physiological rhythm changes, rather than simply increasing the illumination without limit [4]. In recent years, artificial intelligence has developed rapidly, and the corresponding applications have increased year by year. The lighting system has become more and more personalized and intelligent, and intelligent lighting has gradually become one of the signs of social advancement and intelligent life. At the same time, the word big data has been hotly debated all over the world, and the development of big data has gradually occupied all aspects of social people's adaptation to society.

For office lighting, in order to achieve good lighting quality, it is necessary to consider the overall arrangement of lamps to make the illuminance and brightness distribution of the space meet certain uniformity requirements. In addition, people may have different perceptions of the comfort of the lighting environment when engaging in different activities. As a densely populated area, high-grade office buildings are large consumers of energy, especially electric energy, among which lighting electricity accounts for a large proportion. This topic mainly aims at how to improve and improve the intelligent level of high-end office environment lighting, and designs a high-end office environment lighting system based on big data analysis to solve the problems of high-end office building lighting power waste, high manual maintenance operation cost and difficult management.

## 2. The Research Method

### 2.1. Overall system design

People are users of lighting, and the lighting environment affects people's physiological state. Good lighting quality makes people feel happy and mentally satisfied, while poor lighting quality makes people feel unhappy and even reduces work efficiency. As an important factor affecting visual comfort, uncomfortable glare is a key research object in the

field of lighting. At present, it is believed that uncomfortable glare is caused by scattered light entering the eye, which leads to visual discomfort. Background illumination can improve the adaptive level of human eyes. The higher the background brightness, the smaller the perceived glare. The luminous area of the light source and the distance between the light source and the eyes determine the size of the solid angle it occupies in the field of vision. The larger the luminous area of the light source or the smaller the distance from the eyes, the larger the body angle the light source establishes in the field of vision and the more obvious the glare is. Finally, the closer the light source is to the observer's line of sight, the more glaring it is.

Office building is a type of building with the largest number and scale besides residential building, which plays an important role in the development of the city. According to the nature of use, construction scale and standards of office buildings, various types of rooms are determined. Common office buildings are composed of office buildings, public buildings, service buildings and other ancillary facilities. Office space is closely related to our daily work and life, and the design of office space directly affects the comfort and efficiency of our work. The design of office space is often directly or indirectly influenced by many factors such as social politics, economy, technology and culture, and its construction and operation process is also full of coordination and integration among various interests, so it is a continuous, complex and dynamic decision-making and action process.

In the traditional lighting control system, the system mainly uses high-voltage circuit switch to execute various commands, and adopts single lamp or local area automation control mode as the main execution mode. The defects of the traditional lighting control system are particularly obvious, such as the difficulty in supervision, the difficulty in improving the lighting brightness of LED lamps, and a lot of time is wasted. The unscientific equipment selection is also reflected in the specific construction electrical design. Most of the electrical designs are not standardized, and many control loops are designed irrationally, which seriously affects the control effect of the loops.

The framework and workflow of the high-end office environment lighting system designed in this paper are shown in Figure 1. The framework mainly includes three parts: intelligent human body detection and regional positioning module, lighting control module and intelligent monitoring software module of upper computer.

The human body detection and regional positioning module collects office image information through the camera in the office, and detects the human body and the lighting area where the human body is located by combining deep learning and image processing. The upper computer sends the information of people in the office to the control module and the upper computer software monitoring module respectively. Intelligent lighting system is mainly realized by using camera to collect image data and deep learning software algorithm, and provides a visual platform for real-time monitoring of office lighting in the upper computer. The upper computer and office control module adopt Zigbee wireless communication, and the system uses a small number of infrared sensors and illumination detection sensing.

Intelligent perception captures all kinds of information in the area covered by lighting lines in real time through all kinds of intelligent sensors. All kinds of sensors with convenient integration are applied in the project to collect all kinds of information on the lighting site as fully as possible, so that the

big data processing center of the application layer can deduce refined and personalized lighting strategies for each lighting line or even a certain lighting route. The gateway node connects through the 4G/5G network and transmits the collected equipment and environmental parameters to the application layer for processing. The application layer can send control and various configuration commands through the transport layer to control the state of lighting settings.

The application layer of big data processing is the core of intelligent lighting system, and the operation of intelligent lighting control system can reflect the overall operation of the system. Scientifically use all data information collected by the system, including environmental parameter information, to conduct big data analysis, and accurately feed back the results to the control terminals of LED lamps in all branches of the system, so as to ensure that the LED lamps can realize automatic adjustment and truly achieve the goal of energy saving. The big data processing center includes five modules: data source, data acquisition, data storage, data processing and data display.

The big data processing center can accurately reflect the running status of the entire intelligent lighting system. Its main function is to receive all lighting information data and equipment operation information data collected and transmitted by other subsystems, analyze and process them through the big data processing center, draw conclusions and give feedback, so as to monitor and efficiently control each terminal equipment, so as to find faults and problems in the operation of intelligent lighting system in time, realize the purpose of adaptive adjustment and energy saving, and ensure the normal operation of the whole system.

## 2.2. Key technology realization

Due to the infiltration of the idea of office landscape, the authoritative system of information has replaced the authority of class and become the core of planning, and artificial intelligence is used to analyze complex business. In addition to flexible and effective organization and management, another advantage of office beautification is its economy. The area of the workplace accounts for a large proportion of the building area. The change of office form also reflects the change of society. Employees don't have to sit in front of the manager's office, but they can walk around freely, no longer constrained by space and hierarchical management. At the same time, a lot of heat generated by computers and other electronic equipment must be discharged, and the problems of refrigeration, ventilation and lighting in office buildings are becoming more and more important. Data optical cables and equipment pipelines must be laid in office places on lower floors. This development trend requires the office layout to have a stronger sense of space, higher floors and more modern building service facilities to meet the new demand.

Human detection has always been a research hotspot in the field of computer vision, and it is widely used in the field of image processing, including public safety, video surveillance, behavior analysis, intelligent robots, etc. In this paper, Mask R-CNN based on deep learning is used as the model of human detection. The office intelligent lighting system controls lighting according to the distribution of people. Human detection plays an important role in the intelligent lighting system, and the accuracy of human detection directly affects whether the system can be accurately controlled.

Mask R-CNN network is one of the R-CNN series networks. R-CNN is the first CNN to use deep learning for

object detection, which is of great significance to deep learning object detection. Compared with R-CNN, the operation speed of Fast R-CNN has been greatly improved, reaching quasi-real time.

According to the trained human body detection model of Mask R-CNN, the human body in the office can be identified, and the human body boundary box can be regressed, thus the human body image coordinates can be obtained. In this paper, some images are extracted and classified to locate the region.

The rectangular bounding box of people in the office is obtained by Faster R-CNN human detection model, and the center point of the rectangular bounding box is taken as the human image coordinates. At the image acquisition point, the image with a specific pixel width is taken as the feature input of the classification model. Images with different pixel widths are classified by classification neural networks, and three groups of probability tensors of the coordinate points belonging to each region are obtained. After adding the probabilities, the region with the highest probability is output as the illumination region where the human body is located.

In this paper, deep learning is used to classify regions instead of strictly dividing image regions. The purpose is to deal with the problem that the installation positions and azimuth angles of image acquisition equipment in various offices are not exactly the same, so that the system can achieve more intelligent control.

### 2.3. System test

According to the designed system structure and hardware circuit, the software program corresponding to the circuit function is written. In the intelligent lighting system, each lamp (network node) has a microprocessor, which collects the data of illuminance sensor and pyroelectric infrared sensor in real time, and controls the output of constant current source according to the collected data, so that the output can meet the required driving current to control the brightness of LED lamps, and lighting adjustment can be realized according to the personnel situation. And complete the network communication function between each lighting unit in the intelligent lighting system. In the experiment, a test system of intelligent lighting system based on CAN bus communication is built by designing multiple node circuits, and the communication between nodes is realized through software programming.

From the measurement results, it can be seen that the current accuracy is within 5%, and it can completely meet the dimming of lighting brightness from 0 to 100%. The efficiency can reach 83.27% when working at 1A current.

In the experiment, the video file is directly read by the upper computer to simulate the real-time acquisition of image data by the camera. After the software algorithm, the data is transmitted to the office terminal by Zigbee to realize the simulation control of the single-room office, thus completing the comprehensive test of human body detection, regional positioning and hardware module. After recognition, the human body detection in the image is accurate, the regression frame size is appropriate, and the mapping from the image coordinates to the lighting area can be completed, and the office terminal can also realize intelligent control according to the data signal transmitted by Zigbee.

Excellent indoor lighting quality needs to meet the

requirements of appropriate illumination level, comfortable brightness distribution and no glare interference. In addition, the comfort of lighting environment is different when people engage in different activities. Using advanced big data technology can not only improve the illumination management of intelligent lighting system, so that it can achieve the effect of high efficiency and energy saving, but also solve the problems and failures in the process of system operation in time through accurate analysis and processing of data, and greatly improve the safety of the whole intelligent lighting system. The whole system has the advantages of intelligence, high efficiency and so on, which better meets the requirements of high-grade office environment for lighting quality.

### 3. Conclusion

This topic mainly aims at how to improve and improve the intelligent level of high-end office environment lighting, and designs a high-end office environment lighting system based on big data analysis to solve the problems of high-end office building lighting power waste, high manual maintenance operation cost and difficult management. Using advanced big data technology can not only improve the illumination management of intelligent lighting system, so that it can achieve the effect of high efficiency and energy saving, but also solve the problems and failures in the process of system operation in time through accurate analysis and processing of data, and greatly improve the safety of the whole intelligent lighting system. The whole system has the advantages of intelligence, high efficiency and so on, which better meets the requirements of high-grade office environment for lighting quality. Based on the intelligent lighting system of big data technology, the system functions will be richer and more intelligent.

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