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Design of an Efficient Indoor Lighting System based on PLC Control

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Abstract

According to the existing solar indoor lighting system survey on the market now, it is found that those problems - the ordinary solar light guide system cannot be "tracked" according to the angle change of the sun, the actual available lighting time is short in the use of a day, the efficiency is low, and so on. The solar lighting system controlled by single-chip microcomputer technology generally has problems such as weak anti-interference ability and poor scalability. In order to solve the above problems, using mature and stable PLC as a control module combined with dual-axis tracking technology for the sun "tracking", which not only greatly improves the efficiency of light chasing to ensure the fullness of indoor light, but also has the advantages of low failure rate, simple maintenance, good scalability, etc., equipped with an imaged human-computer interaction system, users can adjust the sensitivity and opening time according to their own needs, automatically turn on indoor lighting in the designated environment for fill lighting, so that users can use more worry-free, so that the home is more comfortable.

Keywords

PLC; Sun Tracking; Dual-axis Tracking; Optical Fibers.

1. Introduction

The Appropriate light can not only illuminate the things in front of us, but also bring us a pleasant enjoyment of the soul. In large stadiums, shopping mall basements, shopping mall underground garages, old residential buildings and other venues. There is a widespread need for long-term lighting, but the problem of solar rays is difficult to enter the room. The use of traditional electric lighting not only faces high lighting costs, but also causes a large amount of energy use, which is not in line with today's green development concept [1].

To solve these problems, an efficient indoor lighting system was born that introduces external light into the room through a fiber optic that guides light. The high-efficiency and stable PLC is used as the controller to adjust the position of the light acquisition module in real time according to the changes in the external environment, so as to achieve the best lighting effect.

2. Overall Design Scheme

The system is composed of six modules: PLC control module, photoelectric detection module, light acquisition module, human-computer interaction module, lighting module and power module [2].

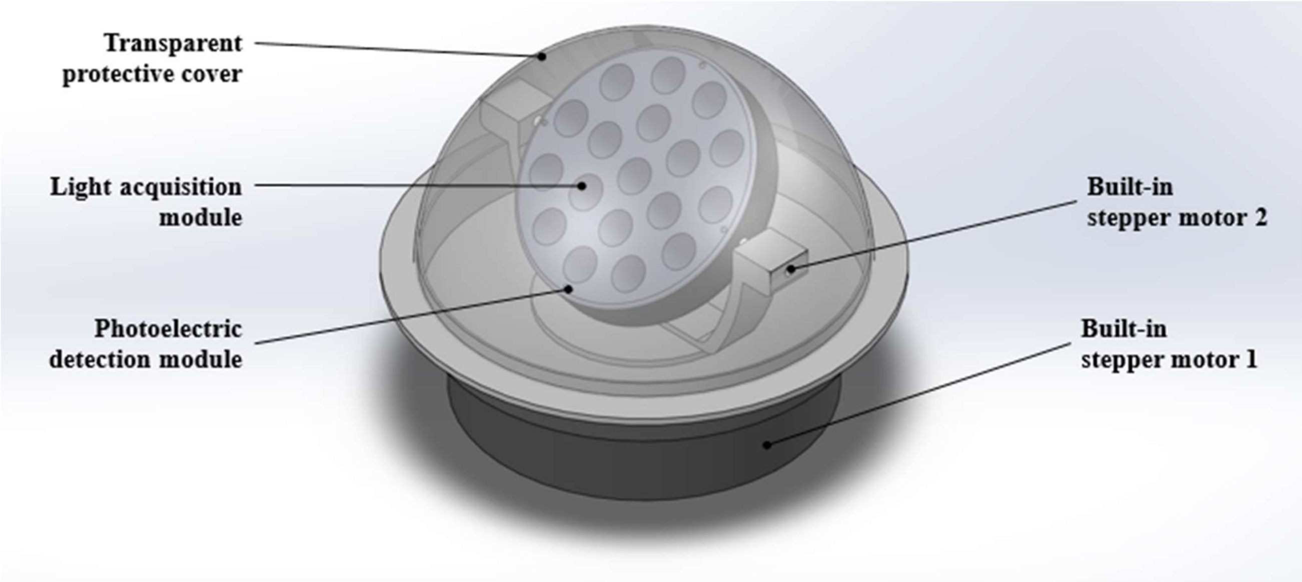

Figure 1. System operation flowchart

The photoelectric detection module is composed of 4 light sensors, detecting the light intensity, transmitting to the PLC control module, the PLC sends instructions to the servo motor after calculation, and adopts a dual-axis tracking system [3] to adjust the light acquisition module to reach the optimal angle and increase the amount of light. The light is gathered through the mirror to the receiving end, reached the designated location through the light guide fiber, and illuminated the room through a special light guide fiber lighting fixture.

3. Analysis of Working Principle

3.1 Light Acquisition Module

The light acquisition module consists of a plurality of light gathering devices, which are responsible for concentrating sunlight onto the light guide fiber and transmitting it through the light guide fiber [4].

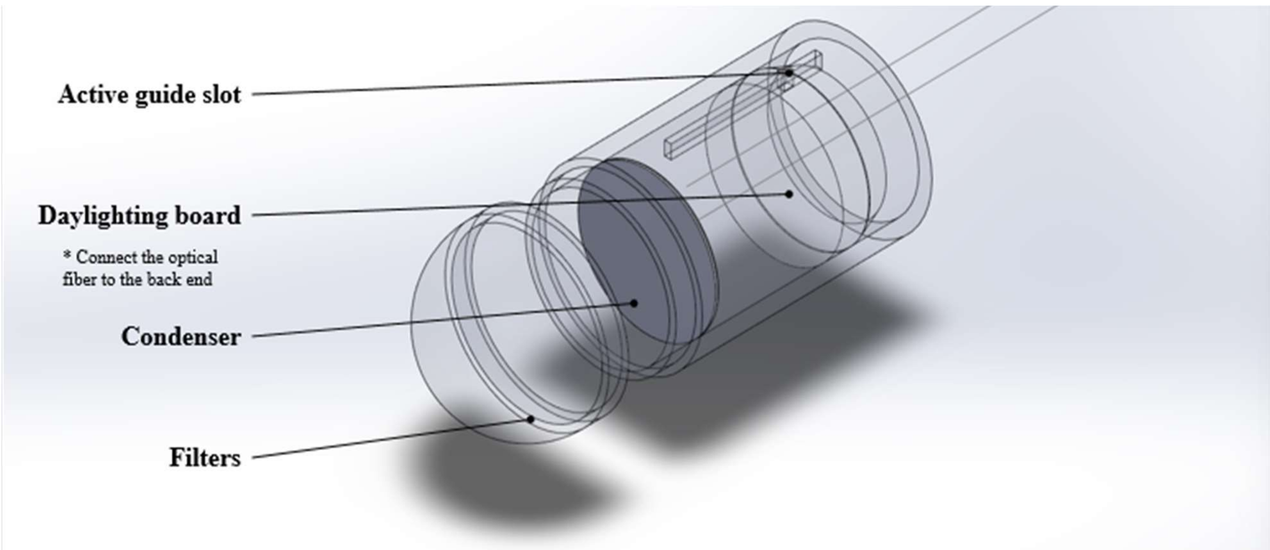

Figure 2. Light gathering device

3.2 Photoelectric Detection Module

The metering device measures the intensity of light in each direction and converts it into a photoelectric signal and sends it to the PLC control module.

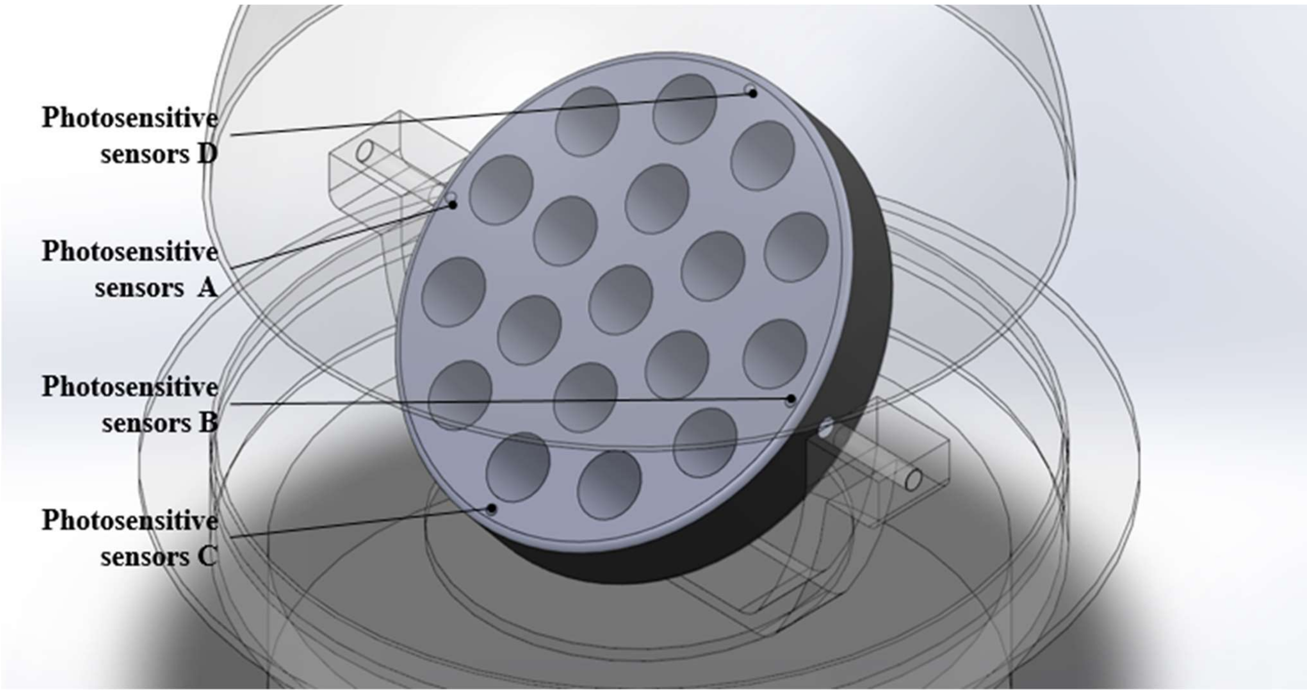

Figure 3. Light sensor distribution

The light metering device, composed of 4 light sensors, is distributed on the four sides of the light acquisition module, and is symmetrical to each other, the light sensors A and B are symmetrically distributed left and right, and the light sensors C and D are symmetrically distributed up and down The light intensity is measured in real time, and converted into an analog signal to be transmitted to the PLC control module.

3.3 PLC Control Module & Human-Computer Interaction Module

The PLC control module is composed of Mitsubishi PLC and stepper motor drive module, through the input of the care intensity data to the PLC, PLC output pulse frequency control the speed of the stepper motor rotation, the use of stepper motor to drive the movement of the dual-axis motion platform, so as to drive the light acquisition module to the optimal position.

In the operation mode, the PLC control module receives the analog input signal of the lighting module, compares the analog signal returned by the A and B photosensitive sensors, when the signal difference range of signal A and B reaches a certain value SU, the stepper motor begins to rotate, controlling the horizontal direction of motion, when the A and B signals stop rotating within the difference range, the finite switch is installed on both sides, and the limit switch is touched to return to the origin to re-move. Compared with the analog signal returned by the C and D photosensitive sensors, when the signal difference range of signal C and D reaches a certain value SU, the stepper motor 2 begins to rotate, controlling the vertical movement, when the C and D signals stop rotating within the difference range, the finite switch is installed on both sides, and the limit switch is touched to return to the origin to re-move.

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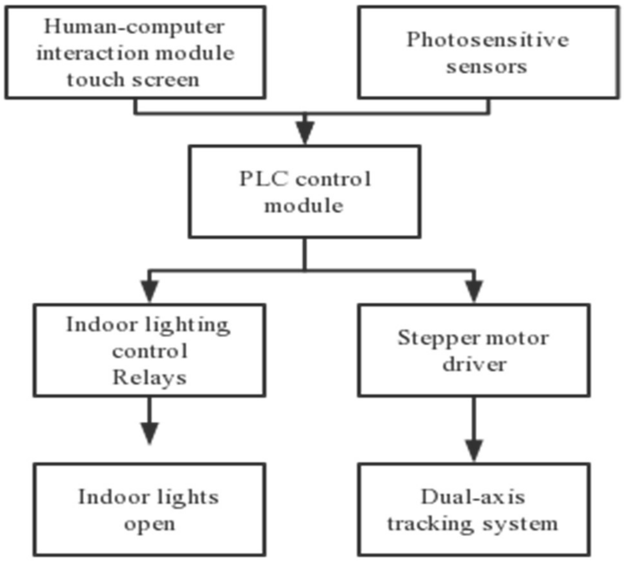

Figure 4. Module communication flowchart

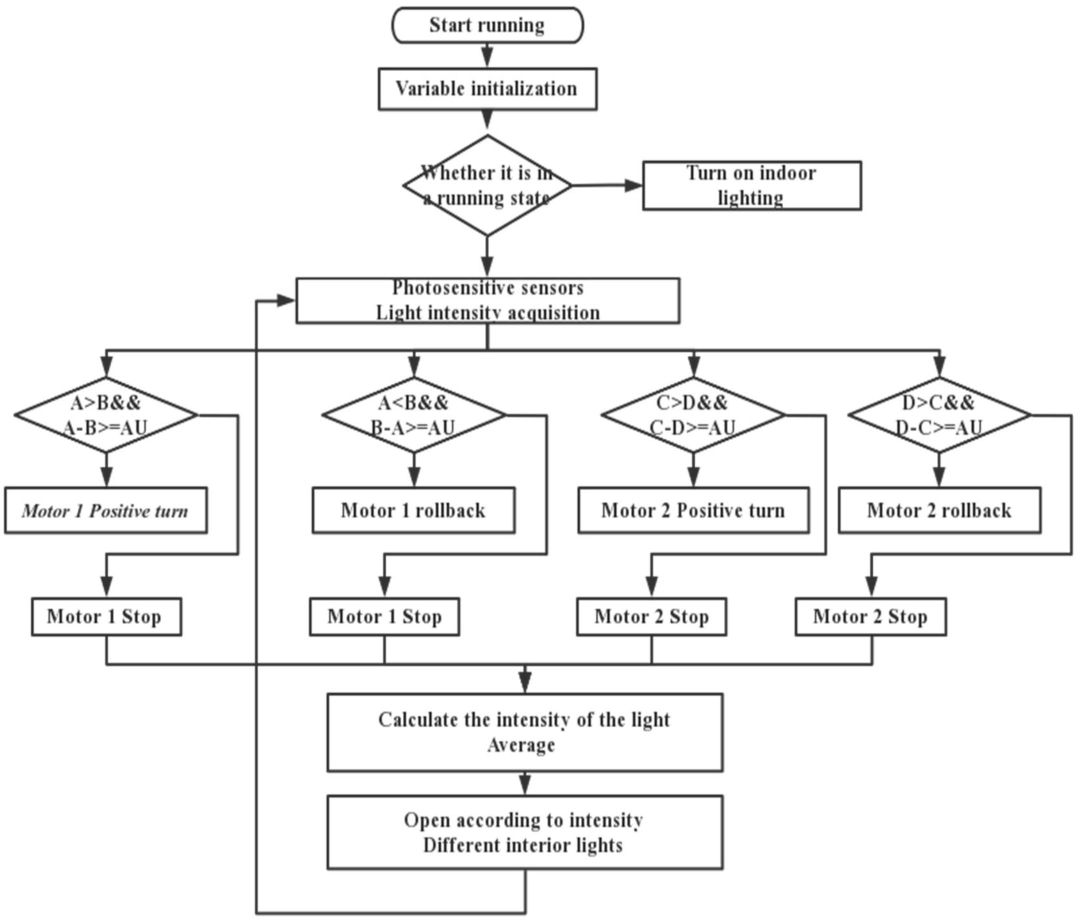

Figure 5. PLC software design flowchart

PLC left 4 indoor lighting control interface, for connecting AC contactor, PLC calculation calculates the average value of the sensor, when the light intensity is less than a specific value or reaches the specified time, automatically turn on the indoor light for filling, according to the different intensity of care, indoor lighting can be divided into 4 different intensity levels, turn on the corresponding intensity of indoor lighting.

The human-computer interaction module consists of a Kunlun dynamic touch screen that is affordable and has high stability. Communicate with the PLC through an efficient network cable interface to facilitate indoor wiring. It can also be connected to the original network system, reducing the installed cost of the post-installation.

Through the touch screen, the user can easily adjust the rotation speed and difference range (i.e. sensitivity SU) of the stepper motor, the smaller the difference range, the more sensitive the light tracking system, in the actual application case, reduce in rainy or cloudy weather, because the sensitivity is too high, in a chaotic operating state. Users can set a timed shutdown to stop running at night, reducing energy consumption at night and making energy saving and environmental protection more. Users by setting different light intensity automatically open part of the indoor lighting lighting for filling, 4 different intensity level settings, to solve the problem of weak sunshine intensity in rainy weather, the problem of insufficient indoor light, but also greatly save the consumption of electrical energy, so that users can use more convenient and worry-free.

4. Conclusion

Through the actual installation of the experimental machine, an efficient indoor lighting system based on PLC and optical fiber guide fiber was tested. During the installation, the structure of the device is simple, the installation difficulty is low, the indoor wiring is simple, the wall opening is less, and the damage to the original building is small. The original lighting control line can be connected, and the original indoor lighting can be linked to the system through simple relay line transformation. During the use, the device operates stably and has a high accuracy of sunlight tracking. Based on the human-computer interaction interface designed by the touch screen, the operation is simple and easy to understand, and the user only needs to move his finger to control the system, reducing the user's learning cost. In terms of later maintenance, the system structure is streamlined, the modular design is adopted, the failure rate is low. When the failure occurs, the repair can be completed by replacing the corresponding module.

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