Corridor Intelligent Lighting System Design

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Abstract. Although there are many sources of electric energy, there are various waste phenomena in various occasions, especially the waste of electric energy in building corridors is often ignored. This paper introduces a corridor intelligent light system, which includes several sensors, the gateway, core controller and cloud platform. The system can effectively save energy and has intelligent lighting control such as automatic induction of people, automatic switching of corresponding upper and lower floor lights, etc.

Keywords: Intelligent lighting; The Internet of Things; Arduino Nano; Remote control.

1. Introduction
Nowadays electric energy is widely used, but energy waste in China reaches hundreds of billions of degrees every year[1]. In daily life, the most easily neglected waste of electric energy is that the lighting of building corridors can not be effectively turned off. Therefore, it is very necessary to design an intelligent lighting system based on the goal of energy saving and humanization of the lighting system.

The Control application of the Internet of Things in building lighting is also more and more with the rapid development of the Internet of Things technology. By the corridor of the basis of the Internet of things in the corridor lighting system, intelligent lighting system can be designed according to the environmental change automatic control. That is to say, it can not only provide good lighting, at the same time, it can save energy resources, reduce the labor costs management of lighting system, and can be in a certain range of building lighting for unified management.

2. Intelligent Lighting
From the "Smart building" in the 1990s, to "Smart home", and then to the “Green lighting improvement plan”, intelligent lighting comes out at the right moment, integrating four energy-saving effects: intelligent pressure stabilization (power saving), improve power factor (energy saving), eliminate surge harmonics, and extend the life of lamps[2].This fully embodies the purpose of intelligent lighting: save electricity and improve the quality of work and life.

The intelligent lighting system, especially gold halogen lamps, high pressure sodium lamps such as high-voltage HID lamps[3], and the dimming of the emerging LED lamps[4]. The application of intelligent lighting control technology will play an important role. From the aspects of energy saving, environmental protection, operation and maintenance and easy to use, the modern intelligent lighting control mode will surely become the mainstream of lighting control. With the increasing maturity of the Internet of Things, the low cost and easy deployment of the Internet of Things makes the intelligent lighting system applied in ordinary communities and ordinary buildings possible, which makes ordinary people experience the comfort and convenience brought by technology. Therefore, the design of the intelligent lighting system in the corridor based on the Internet of Things technology is very meaningful.
3. Corridor Intelligent Lighting System Design Scheme

The Internet of Things is divided into network layer, application layer and perception layer. The system follows the basic architecture of the Internet of Things, as shown in Figure 1. From the perspective of the Internet of Things, it can be roughly divided into the following points: The network layer is composed of WIFI, through which LAN devices connect to the Internet for uploading data and issuing control instructions; The application layer adopts the web framework of Alibaba Cloud and the control interface of receiving data delivery. When Alibaba Cloud receives data, it synchronously displays it on the web page. When the device is controlled on the web page, Alibaba Cloud issues control instructions through MQTT. Perception layer adopts three kinds of sensors, respectively is photosensitive sensor, sound sensor and human body infrared sensor (pyroelectric sensor), photosensitive sensor used to detect the ambient light intensity, sound sensors used to detect whether anyone in the corridor, the human body infrared sensor to detect whether there is the human body infrared signal in the corridor, the corresponding application logic can see it that way, Photosensitive and (human infrared or sound). At the same time, the code also includes emergency mode, when activated emergency mode, regardless of whether there is someone in the corridor will turn on the lights of each floor.

![Figure 1. General block diagram of the system](image)

This system uses Arduino Nano chip, sensor and Alibaba Cloud to realize the information interaction and control the operation of the system. And take the Arduino Nano single-chip computer as the core control unit, other functional modules to assist in the construction of the overall framework, and access the cloud platform in the way of mobile network hot spots or WIFI.

4. Hardware Design of Intelligent Corridor Lighting System

The intelligent corridor lighting system uses Arduino Nano microcontroller as the core control unit, other sensor modules for data collection, and Raspberry PI as the gateway for data exchange with Alibaba Cloud. The sensors include sound sensor, human infrared sensor module, photosensitive resistance sensor module.

When choosing the hardware, consider whether the power supply is 5V or 3.3V. At the same time, when connecting the hardware, try to connect the grounding of all hardware together to ensure that the direct level voltage of different devices is the same.

The hardware connection diagram of Arduino Nano development board is shown in Figure 1, and the hardware connection diagram of Raspberry PI is shown in Figure 2.
5. Corridor intelligent lighting system programming design

The program design and development of this system are mainly based on raspberry PI and Arduino Nano microcontroller. As for Alibaba Cloud, it mostly adopts visual and convenient development, and does not need to write additional codes by itself. Devices can be roughly classified from the three aspects of the Internet of Things. Raspberry PI belongs to the network layer, Alibaba Cloud belongs to the application layer, and Arduino Nano and sensor belong to the perception layer.

5.1. Raspberry Pi-related Procedures

Raspberry pie programming logic is as follows, the first need is through an MQTT connection Alibaba Cloud, so in the code you need to construct an MQTT request header, enter the relevant equipment interfaces, and the corresponding Alibaba Cloud data interface, triples in Alibaba Cloud equipment can be found, the console will triple information and Alibaba Cloud data interface as variables stored in the program, Once Raspberry PI is connected to the Internet and the application is launched, the application authenticates triples to Alibaba Cloud. Once the triplet authentication is successful, MQTT is officially established. The raspberry PI then needed to send a heartbeat packet at regular intervals to keep the MQTT connected.

After the MQTT data transmission part is written, it is the turn of local data transmission with sensors and Arduino Nano on each floor. Data transmission to Alibaba Cloud can be determined as a scheduled task, which detects the value of the local sensor at intervals and then sends it to Alibaba Cloud; The receiving of Alibaba Cloud data can be operated as follows: set up a monitoring function. Once there is data incoming, this function will be triggered. In this function, data processing and instructions that need to be operated locally will be parsed and delivered, so as to achieve the purpose of controlling the local device.

5.2. Arduino Nano-related Procedures

The Arduino Nano program is designed as follows: in a loop, the infrared sensor, sound sensor and photosensitive sensor of the human body are continuously delayed. When the photosensitive sensor detects that the environment is dark, if someone passes through the corridor, the light will be on; On the contrary, when the photosensitive sensor detects that the environment is bright, the other two sensors are not detected. Write these logical decisions into each loop and add a delay at the end.

The Arduino Nano on each floor is connected to three sensor modules and a lighting device (lamp). When D2 is high voltage, it indicates that the environment is in dark; when D2 is low voltage, it indicates that the environment is in bright environment. When D3 input is high voltage, it indicates that there is human infrared signal; when D3 input is low voltage, it indicates that there is no human infrared signal. When D4 input is at low voltage, there is sound signal. When D4 input is at high
voltage, there is no sound signal. When A3 output is high, the light is on; when A3 output is low, the light is off.

The data transmission logic of each Arduino Nano on each floor is as follows: If there is someone on a floor, the Arduino Nano on the floor will send the message that there is someone on the floor to the adjacent floor. When the adjacent floor receives the signal of someone on the floor, it will execute the corresponding special function to turn on the light. Lights on all floors will automatically turn off in the 20s if no one continues to pass by or otherwise. The above program logic is the automatic control mode.

In addition to the automatic control mode, there is an emergency control mode, namely the aforementioned if Alibaba Cloud issued an emergency signal will trigger mode, when the system of raspberries pie, Alibaba Cloud over emergency reception emergency mode will be forwarded to the first floor of the Arduino Nano development board, at the same time on the first floor will deal with the emergency mode, implement emergency lights. Only when the safety signal is received, the lights will stop turning on and the emergency signal will be sent to the Arduino Nano on the upper floor. Similarly, the emergency signal will be continuously forwarded to the upper floor. The same is true when a safety signal is received.

5.3. Relevant Configuration of the Cloud Platform

There are many cloud platforms on the market, and the larger cloud platforms are Alibaba Cloud, Tencent Cloud, and Baidu Cloud. The functions of each platform are similar with minor differences, and all of them can realize the design requirements of this system. Therefore, We choose Alibaba Cloud as the cloud platform. Alibaba Cloud platform provides a complete set of supporting solutions, which can directly realize the process from product creation to application.

Firstly, enter the console of Alibaba Cloud Internet of Things platform, click New product, enter the product name, select user-defined category, gateway device, Internet mode, wi-fi, data format, and click OK to complete the creation of the product. Next, go to the product details page and add the function definition, that is, add the name of the property of the data to be transferred and the data type of the property. Click Edit draft, add custom functions, select properties, enter function name, enter identifier, select data type, fill in the corresponding value or value range, select read and write type, click OK to complete creation, and click Publish online. Then switch to the Devices TAB, click Add Device, select the product you just created, type DeviceName, this is very important, for the raspberry PI's type one secret dynamic device registration, and click Ok to add device. After the device is added, you can view the device details. You can find the corresponding triples (ProductKey, DeviceName, and DeviceSecret) in the upper part of the page, which can be used for manual registration. After creating a device, visualize the device information on a web page for easy control and monitoring. At the same time, in order to make the system has better fault tolerance, when ali cloud failure or network disconnection, ali cloud platform detects the device offline, will be in the form of a notice to the total system maintenance personnel, maintenance personnel can contact system at this time in area of offline, head of the equipment for testing and processing.

6. Summary

Corridor are analyzed in this paper the development status quo of intelligent lighting system, combined with their own learned the basic knowledge of software and hardware knowledge and Internet of things, to find and make up for the deficiency of the previous corridor intelligent lighting system, and combining the knowledge of the Internet of things, through the WIFI network, designed a high automation and intelligent application of a corridor intelligent lighting system, The test results show that the implementation effect is good and the user experience is good. Compared with the ordinary corridor lighting system, it can save about 50% of the power consumption and reduce about 60% of the maintenance cost.

But as the first generation of design, you can see that the system still has a lot of shortcomings, first of all, each floor needs a power supply battery. If there is the use of 220V voltage, it is bound to need a transformer. Secondly, we can replace raspberry PI by a wifi module or network cable as the gateway. Thirdly, dupont line as a serial communication has great limitation. The biggest problem is that it is
easy to cause data loss. Therefore, it is hoped that these shortcomings can be improved and perfected in the future design to make it more perfect.

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