Research on Intelligent Indicator Lamp Control System and Its New Technology Based on Internet of Things Technology

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Abstract: in Recent Years, with the Wide Application of Modern Communication Technology, Computer Information Technology and Various Sensor Network Technologies, as an Application Example of Internet of Things Technology, Intelligent Lighting Control Has Achieved Rapid Development. the System Designed in This Paper Uses Stc 12c5 A60s2 Microcontroller as the Main Controller to Realize the Perception of Indoor Human Infrared Sensing, Illumination Detection and Other Environmental Parameters. the Esp 8266 Module is Used to Build a Wifi Wireless Local Area Network and Realize the Control Signal Conversion between Wifi Wireless Network and Uart Serial Port. Finally, an Intelligent Indicator Lamp Control System for Household Led Lamps is Realized through an an-Droid Mobile Phone Application Program. the Actual Test Shows That the Designed System is Stable, Safe, Simple and Flexible to Operate, Has the Function of Remote Control, and Has Certain Application Value.

1. Introduction

At Present, Due to People's Weak Awareness of Energy Conservation, Many Serious Waste Phenomena of Electric Lighting Are Often Seen in Families, Classrooms in Colleges and Universities and Various Public Lighting Occasions. in Today's Increasingly Tense Global Energy, Energy Conservation of Lighting is Naturally a Very Meaningful Thing [1]. Sensor Network Provides the Intelligent Lighting System with the Perception of the Environment, Which Makes the System More Humanized and Has Better Energy-Saving Effect. with the Progress of Technology and the Decrease of Cost, It is the General Trend That Led Lighting Gradually Replaces Incandescent Lighting [2]. the Internet of Things Refers to the Technical Characteristics of the Internet, Endows Common Articles with Programmable Intelligent Attributes, and Completes Data Exchange with Interconnection Skillfully According to Established Standards through Information Transmission Technologies Such as Radio Frequency Identification, Wireless Packet Switching, Power Line Carrier, Field Bus, Etc. Thus, Remote Data Communication is Carried out, and Finally the Functions of Intelligent Identification, Positioning, Tracking, Monitoring and Management Are Realized. in Today's World, System Intelligence is a Major Development Trend. Lighting Systems Are No Exception. in Many Foreign Buildings, Intelligent Lighting Systems Have Been Widely Used, and Their Power Consumption is Only 20%-30% of That of Ordinary Lighting Systems [3]. the Hotel Intelligent Lighting Control System Based on Internet of Things Technology Not Only Increases the Intelligence and Beauty of the Hotel, But Also Makes the Maintenance and Control of Hotel Lighting More Convenient and Reduces Energy Consumption to a Certain Extent.

2. System Scheme Design

This system adopts the basic structure of Internet of Things with sensing layer, control layer, network layer and application layer, and integrates sensor technology, automatic control technology and network technology to realize the hotel intelligent lighting system based on Internet of Things technology. The perception layer. The sensing part of the intelligent home lighting control system

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includes two aspects of data collection. The first part is the collection of environmental data, including indoor light intensity, indoor temperature and judging whether there is any object approaching. Transport layer. The transmission part of the lighting system mainly considers which communication technology is used for data transmission in the home. Application layer. Compared with the application of the whole smart home, the application of the lighting system is mainly focused on the control of lamps. In this paper, the light intensity, switching and color of lamps are mainly controlled [4]. The whole system includes the minimum system based on STC 12C5A602SCM, infrared and photosensitive parameter detection circuit, LED drive control circuit and interface circuit between ESP 8266 and SCM. This system supports RS232, RS485, CAN bus, TCP/IP, Wifi and other communication protocols. At the same time, integrating sensors supporting photo sensitivity, human body induction, infrared distance measurement, etc. makes the system more intelligent in detection and control, thus better realizing hotel environment detection and intelligent lamp state monitoring and control. The human body infrared sensor is used for detecting whether people are present, and the microprocessor controls the indicating lamp according to the detection signal; Where automatic dimming is required, it depends on the detection data of the light sensitive sensor. In order to meet the actual demand of indoor lighting power, the LED drive circuit uses a high-power drive module (Figure 1).

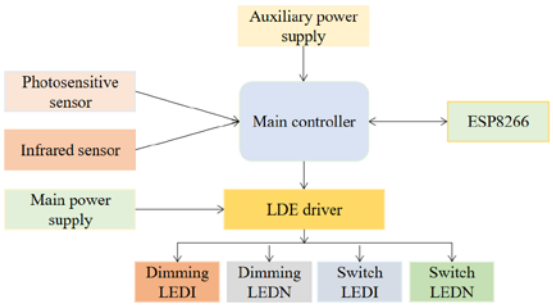

Fig.1 General Scheme of Household Intelligent Indicating Lamp Control System

3. Hardware Design of the System

The control system of household intelligent indicator lamp is designed according to the common residence with three rooms and two halls. The whole system is equipped with two dimming lights and several switching lights. Dimming lighting is used for room lighting in the master bedroom and the sub-bedroom; Lighting of other rooms, corridors, balconies and other places shall be switched on and off. In this design, the core intelligent controller is AT89C52, an 8-bit single chip computer produced by ATMEL Company of the United States. Its data acquisition and processing capabilities are relatively strong, making the system achieve stable effects in realizing remote control, liquid crystal display and intelligent control. In the process of chip selection, memory, operation speed, GPIO, interface, power consumption and development difficulty are mainly taken as comparison items, among which, it is better to have multiple UART in the interface, which can directly use the chip to complete the information interaction with each communication device, thus saving the trouble of building peripheral circuits. Switching lighting control is divided into two types: one is completely controlled by mobile phone APP, which is suitable for indoor lighting control; The other way is the light delay switch-off control realized by the control signal of the mobile phone APP and the human body infrared detection signal, which is more suitable for corridor lighting occasions.

3.1 Design of Main Control Circuit of Single Chip Microcomputer

Based on the above control requirements, the household intelligent indicator lamp control system uses STC 12C5A602SCM as the main controller. The SCM is an enhanced 8051 SCM with 2 PWM outputs and 8 high-speed 10-bit A/D conversion. There is no alternating current, because the capacitor has the characteristic of isolating direct current and alternating current, the photocoupler will not conduct the singlechip to detect that the P3.3 pin is at a high level, thus meeting the needs

of light modulation output using PWM technology and processing the analog input signal of the photosensitive sensor. The intelligent gateway controller designed by this system includes three modules: serial communication, control and protocol conversion, which can realize the conversion between multiple protocols. The on-site intelligent controller can complete the information collection of the sensing layer in the system and upload the data [5]. It has many addressing methods and very concise kernel instructions. As well as a large number of analog instructions, sufficient registers and on-chip data storage can all participate in the operation, and it also has very efficient look-up table processing instructions, which ensures that developers can design highly efficient source programs. Ringing signals are sent in 5 seconds, i.e. 1 second and off in 4 seconds. that is, pin P3.3 of the single chip microcomputer can detect a square wave signal, which can be directly output to the port of the single chip microcomputer, thus realizing ringing detection. the specific ringing detection circuit diagram is shown in Figure 2.

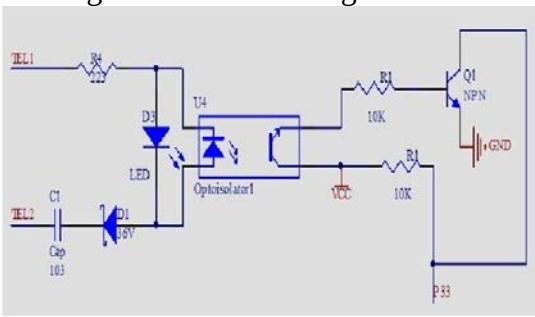

Fig.2 Ring Detection Circuit

3.2 The Design of Wifi Module Circuit

ESP 8266 is a UART-WiFi chip with ultra-low power consumption designed for mobile devices and Internet of Things applications. The module provides users with a highly integrated WiFi SOC solution, which can be carried as a slave on other host MCU to run [6]. In theory, the external crystal oscillator circuit is not necessary, but the internal oscillator circuit is unstable in some occasions with high clock requirements, such as timing and serial communication. In this paper, serial communication will be the communication bridge between different modules of the whole project, so the external crystal oscillator circuit is used. This module provides a way for Wi-Fi wireless network to embed into other systems. Under the development environment (SDK) of ESP 8266, a small wireless local area network can be established through corresponding configuration. The intelligent lamps and curtains are controlled through preset control schemes or commands from the server. The sensing layer adopts digital sensors such as photosensitive sensors and human body infrared sensors, which mainly realize the collection of surrounding environment information. The essence is to connect a resistor of about 300 Ω at both ends of the telephone line while picking up the microphone. according to this characteristic, when the number of telephone rings meets the set conditions, the automatic off-hook can be realized by controlling the relay to be closed and the triode to be used as a switch through a singlechip. the specific circuit design is shown in Figure 3.

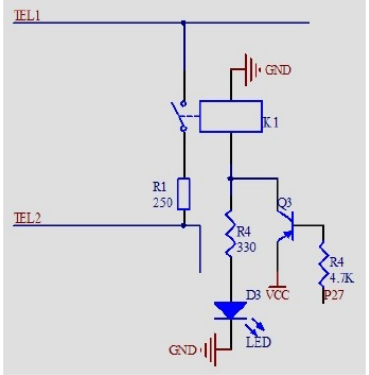

Fig.3 Automatic Off-Hook Circuit

3.3 Design of Power Supply Circuit

The power supply of the system mainly includes DC 24V, 5V and 3.3V which supply power to various chips. The 24V DC power supply is the input power of the LED driver chip XL4005 and is realized by the AC/DC module of MAY 50-220S24N. The module inputs 220V AC, outputs 24V DC, and outputs 48W rated power. Monitoring terminals need to communicate with necessary or handheld devices in remote monitoring. All data are sent to data transparent transmission module (GPRS module, power line module, etc.) through serial port. However, single UART port uses TTL level, which is not universal with RS232 level of standard equipment. Therefore, level conversion circuit needs to be designed to complete normal and stable data exchange [7]. As the input power for STC12C5A60S2 single chip microcomputer and lm358 op amp. 3.3V DC power supply is the input power of ESP 8266 module, which is obtained by using low noise LDO voltage stabilizing chip SPX 3819 M5. In order to ensure that the system can recognize human body, a password protection function is specially set up, which can be modified remotely by mobile phone or telephone or directly in close range by keys on hardware. thus, the flexibility of the system is ensured. the interface of the keys is connected to P1 port of the singlechip, and the specific circuit is shown in Figure 4.

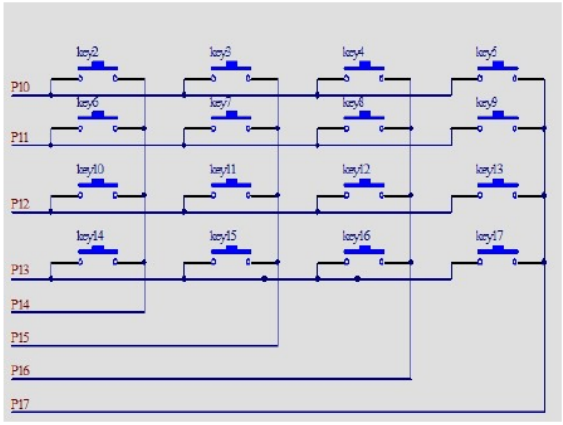

Fig.4 Keyboard Control Circuit

4. Software Design

4.1 Main Program Design of Single Chip Microcomputer

After the microcontroller is powered on, the system initializes and then calls the serial interrupt service function to wait for the trigger interrupt. Serial port interrupt is issued by ESP 8266 module, and MCU extracts control information after the interrupt is triggered. The single chip microcomputer will continuously detect whether there is a ringing signal. When the ringing times are equal to the set times, the system will hang up automatically. Voice prompts the user to enter the password. If the password error reaches three times, the system will hang up automatically. The data acquisition module mainly refers to ADC analog-to-digital conversion of STM8L and subsequent data processing, such as software correction of collected data, fault determination, power calculation, etc. Sending some information will be important data observed by the monitoring terminal and must be accurate and real-time. Modular programming is adopted in the code writing and design process of the software, which is convenient for code writing, debugging and improvement. After the dimming LED lamp is turned on, dimming is carried out according to the detection signal of the indoor photosensitive resistor, and the photosensitive signal is collected in a timing interruption mode and the average value of the collected signal is processed, thus effectively preventing the LED lamp from flickering on and off due to large changes in ambient light and shade.

4.2 Design of Wifi Module Communication Configuration Program

As shown in Figure 5, the esp 8266 module program receives the callback control program flow

chart. the esp 8266 receives the callback function and receives the real-time control information through the control instruction sent by the application program at the mobile phone terminal through the timing scanning. when receiving the data, the esp 8266 sends the corresponding switch instruction to the singlechip through the serial port interruption to realize the led lamp control.

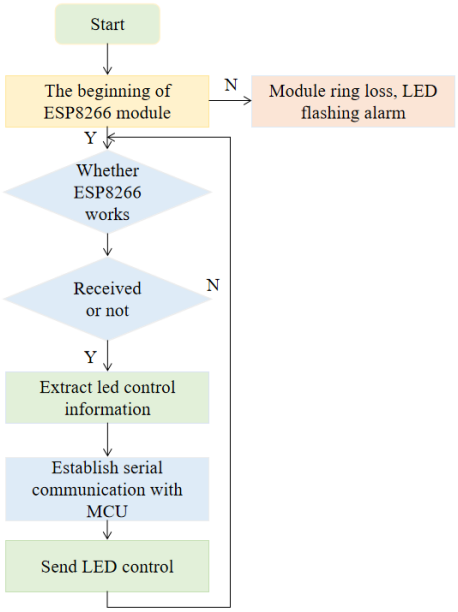

Fig.5 Esp 8266 Module Receives Callback Control Program Flow Chart

The ESP 8266 module has a built-in 32-bit MCU, so the Wi-Fi module is initialized when it is powered on. The initialization mainly includes the steps of setting the working mode of the ESP 8266 module, establishing Wi-Fi hotspot and configuring UDP communication mode [8]. In the process of data communication, PLC and GPRS will also use corresponding communication protocols to complete data transmission. For example, TCP/IP protocol is used to exchange data with the Internet when GPRS modules communicate in network. As a guarantee of correct data transmission, such communication protocol is a universal protocol and has nothing to do with the communication application scenario. The communication configuration program of ESP 8266 is written in a special open environment (SDK), and the written program is downloaded to the module through the module's own serial port. This feedback signal has a different frame structure from the command signal, and other DALI ballasts on the same loop will not respond to it. The DALI main controller of the monitoring stage receives the signal, converts the DALI signal into an RS-485 bus signal and feeds it back to the RS-485 loop. Therefore, the specific content of the communication protocol is not fixed in length, and the specific instruction type and the total control or data information length contained in a certain protocol must be effectively marked. W designs the function type and data length information bits in the communication protocol.

4.3 Program Design for Mobile Terminal of Mobile Phone

Android mobile phone client software is developed based on E4A platform. Android mobile phone client mainly has login management function, room light group lighting control function and global lighting control function. In order to verify the feasibility of the design, the designed control system was tested in practice. In the test, remote control of household lighting equipment and control of lighting in close-range classrooms were used as examples respectively, and good results were achieved. The login management function can set the user account number and password to ensure that only users with permission have the control permission of the lighting control system, avoid being maliciously controlled, and ensure the safety of the system. The global lighting control management can realize the on-off control of all lights when users enter and leave the house. In order to increase human-computer interaction and improve user experience, users can log into APP through smart terminals such as mobile phones and tablets to automatically set the lighting intensity and color in the room and switch scenes.

5. Conclusions

In this paper, aiming at the problems of single control of traditional lighting, difficulty in troubleshooting, complex circuit and single scene tone, sensors such as illumination and human body infrared are used as sensing layers. The intelligent control module is used as the control layer. Mobile phones, tablets, etc. are used as network application layers. Compared with traditional lighting control, the residential intelligent lighting system based on WiFi Internet of Things technology adopts embedded technology and Internet of Things technology, which has the advantages of simple wiring and convenient use. As an intelligent control device, the control system has the advantages of system stability, safety, simple and flexible operation, remote control function and the like, and can be applied to lighting control in various occasions. Using multi-level control scheme, intelligent light control in rooms, corridors, halls and other areas can be well realized, which can increase the experience of residents to a certain extent and reduce energy consumption.

References

[1] Jiang Huali, Lin Jieben, Lin Suwei, et al. (2019). Research on LED Intelligent Lighting Based on Cloud Control Technology of Internet of Things. Science and Technology Communication, no. 11, pp. 110-111.

[2] Kayley Chung. (2017). Design of Intelligent Street Lamp Maintenance System Based on Internet of Things Technology. Digital World, no. 8, pp. 10-12.

[3] Zhang Zhuoyun. (2017). Research on City-level Internet of Things Technology in LED Public Lighting Monitoring System. Heilongjiang Science and Technology Information, no. 10, pp. 16-16.

[4] Bai Yanfeng. (2017). Design of Lighting Control System Based on PLC Internet of Things. Modern Manufacturing Technology and Equipment, no. 2, pp. 55-55.

[5] Zhu Yuhui. (2019). Research on the smart lighting scheme of medical building networking. Lamps and Lighting, no. 2, pp. 48-51.

[6] Zhang Ye, Wang Xiang, Li Chenhong, et al. (2018). Energy-saving control system for classroom lighting based on Internet of Things. Electronic World, no. 1, pp. 95-96.

[7] Xu Xinyin. (2019). Design of dynamic regulator for intelligent lighting system. Internet of Things Technology, no. 8, pp. 80-81.

[8] Guan Beibei, Tian Liguo, Meng Li, et al. (2017). Design of LED Intelligent Indicator Lamp Control System Based on IOT. Science and Technology Innovation and Application, no. 17, pp. 35-36.