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Design and Implementation of Intelligent Colored Lantern Control System based on Internet of Things

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Abstract

In view of the shortcomings of traditional lanterns, which can only be controlled manually on site, and can only independent control, and the color is fixed and single, a smart lights control system based on the Internet of Things is designed. The controller based on STM32F1 is used to obtain the status of the lanterns, and then the coordinator will forward the information to the cloud server through the 4G router. Then the user can log in to the client webpage through the browser and realize the monitoring and change of the running status of each light node. Experiments show that the system is stable and reliable, which is composed of lanterns, servers, network coordinators and lantern controllers.The system not only realizes the remote multi-platform control of the lantern, but also realizes the coordinated control of the multi-lantern network.

Keywords

Internet of Things (IoT); Lantern Controller; Micno Control Unit (MCU); Web Server.

1. Introduction

Lantern is originated in China, a traditional folk handicraft of the Han nationality, the Lantern Festival is from the Tang Dynasty has been continued to today, lanterns have been fully integrated into people's life. Today's lantern is a product of the traditional lamp making process and the close combination of modern science and technology, the electronic, construction, machinery, remote control, acoustics, optical fiber and other new technology, new technology used in the design and production of lantern, the shape, color, light, sound, motion combined[1]. But at present for the control of the lights most of the full hardware circuit or single chip microcomputer to achieve a single function, can only be controlled in the field, only in accordance with the fixed mode of shining, not according to different needs to adjust the brightness of the lights, dynamic effect, lack of user operability. In literatures [2], [3] and [4], AT89C51 single-chip microcomputer is used to control LED lights, and the lighting effect is switched by pressing keys, and each lighting effect is fixed. Literature [5] adopts 555 timer, shift register, JK flip-flop, inverter and other related hardware circuits to realize 8-channel color light control, which has complex circuit and single lighting effect.

The development of Internet of Things(IoT) [6] technology has provided a new direction for the development of colored lantern. In Internet and communication technology, the cloud server, using sensors, embedded systems, establishing a wisdom lights control system, through a Web browser, users can real-time monitoring the various lights node status information, to achieve a single or multiple independent control lights lights node cooperative control, according to different requirements, seting up personalized lighting mode.

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2. Intelligent Lantern control system architecture

Intelligent lights control system is mainly composed of lights controller, coordinator, 4G router, cloud server and various terminal devices equipped with Web browser, etc. The overall structure is shown in Figure 1. The components of the system are described in detail as follows:

(1) Lantern controller: The lantern controller is responsible for collecting the state information of each light node, such as the switching state of the light, the brightness size, the current size and so on, and passing these information to the coordinator. When a fault occurs in a colored light node, the controller can report the warning information in real time, deal with the fault in time and avoid the accident. In addition, the controller can complete the control of the colored light nodes according to the instructions received from the coordinator.

(2) Coordinator: The coordinator is responsible for networking and managing each color light controller, and uploads the status information of color light nodes to the cloud server through the 4G router network. The tree structure is adopted among the lights node, lights controller and coordinators, and the coordinators assign IDs to each lights node. The network control is realized through the coordinators.

(3) Cloud server: The cloud servers mainly include application servers, Web servers and database servers. The application server is responsible for timing communication with each coordinator, obtaining the data of each colored light node, and saving it to the database server, and publishing the data to the Internet through the Web server, for users to view the relevant information remotely through the browser. When the user needs to remotely control a colored light node, the control command is written to the database server through the Web server, and then the application server sends it to the corresponding coordinator after taking it out from the database.

(4) Remote control terminal: The remote control terminal includes various computer devices such as desktop computers, portable computers and smart phones. Through the Web browser, users can not only remote control each node of the lights, but also according to their own needs to develop different dynamic changes of the lights.

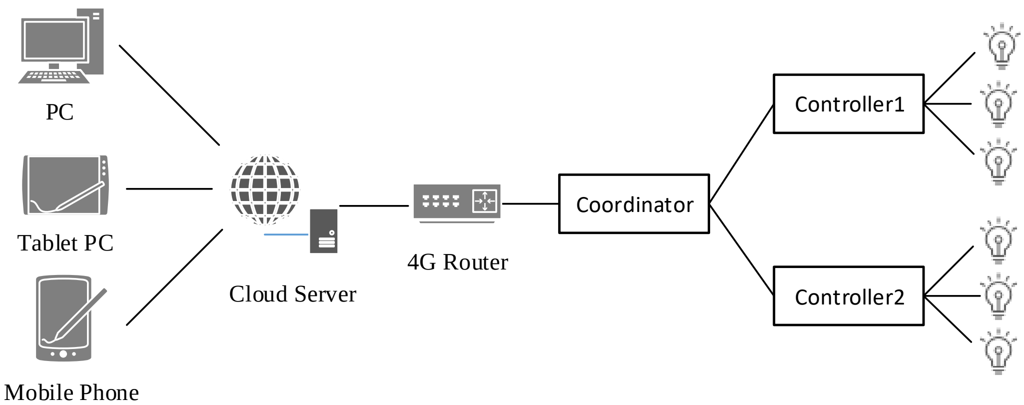

Figure 1. The overall structure of the intelligent lantern control system

3. System Hardware Design

The hardware design of the intelligent lantern control system mainly includes two parts: one is the color light controller that directly controls the color light switch and brightness; the other is the coordinator responsible for data forwarding and networking control. The hardware structure of the system is shown in Figure 2. The controller uses STM32F103RBT6 chip based on Cortex-M3 architecture as MCU.The controller adopts dual power circuit design, one way is

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12V DC input, power supply to the chip, the other way is 220V AC input, power supply to the external lights, so designed to be able to drive high-power lights equipment. Through the relay to control the switch of the lights, through the current sensor real-time monitoring of the current information of the lights, when a fault can be timely up to the computer to issue early warning information.

In addition to transferring data, the coordinator also needs to dynamically generate the control instructions of each color light node according to the user-defined light transformation, so it requires good computing power and larger storage space. Therefore, the AM3358 chip based on ARM-Cortexa8 architecture is used as the MCU. The coordinator is equipped with 512MB DDR3, 512MB Flash, 32KB EEPROM, and a network PHY chip. The Linux operating system is transplanted to MCU, and the kernel of Linux-4.1.8 is adopted. The communication between the upper computer and the controller and the networking control of multiple colored light nodes are realized by the way of multi-task management. The data transmission between the coordinator and the lights controller adopts RS485 serial communication. In order to ensure the stability of the communication and the accuracy of the message, the Modbus communication protocol is adopted and the RTU mode is adopted. The coordinator is the host and the lights controller is the slave, which is managed by the coordinator uniformly.

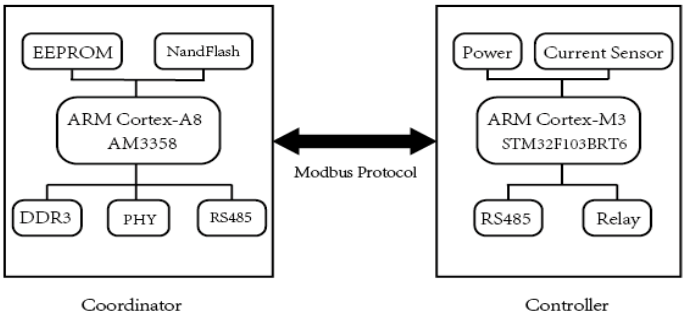

Figure 2. Hardware structure of the system

4. System Software Design

4.1. Lantern controller

Lantern controller as the end effector of the system, its role is to control the lights switch and brightness adjustment, brightness value change range of 0~100, a light controller can be connected to multiple lights, each way can be set independently. In order to distinguish the connected lights, the controller will assign an ID to each road of the connected lights, which is convenient for management.In addition, since there is more than one color light controller in the system, in order to distinguish controllers, each controller will be set a unique ID corresponding to the address in the Modbus message frame, which will be uniformly managed by the connected coordinator. The software flow of the colored light controller is shown in Figure 3. After the system initialization is completed, when the instruction from the coordinator is received through the RS-485 bus, the controller executes the corresponding instruction and sends the status of the colored light switch and the current information obtained through the current sensor back to the coordinator.

4.2. Coordinators

Ccoordinators are mainly responsible for the transmission and processing of the information in the intelligent lantern system. It needs to process the received information to make it conform to the communication protocol of the server and the lantern controller respectively, rather than just forwarding the message out. As shown in Figure 4, the software

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implementation of the coordinator adopts the mode of multitasking management. Two processes are created, the parent process is responsible for communicating with the cloud server, the child process is responsible for communicating with the controller, and the channels are used to communicate between the processes. The communication between coordinators and the cloud server adopts the C/S model. The cloud server is used as the server side, and coordinators are used as the client side. Coordinators are connected to

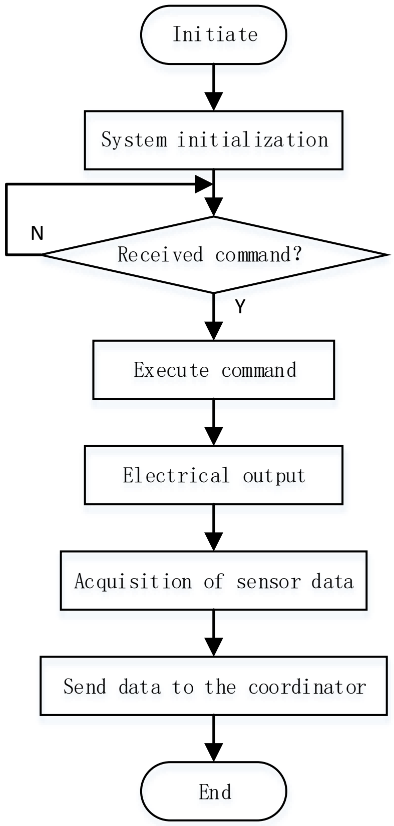

Figure 3. Color lamp controller software flow

the cloud server through 4G router. When coordinators receive the data from the cloud server, it sends the data to the FIFO 1 created by the child process. After receiving the data from the FIFO 1, the child process will judge the command to be executed, generate the corresponding data and then send it to the controller through the RS485 bus. The child process will periodically query the status of the lights to the controller, and send the obtained information to FIFO 2. When the parent process receives the data from FIFO 2, it will be processed and sent to the cloud server.

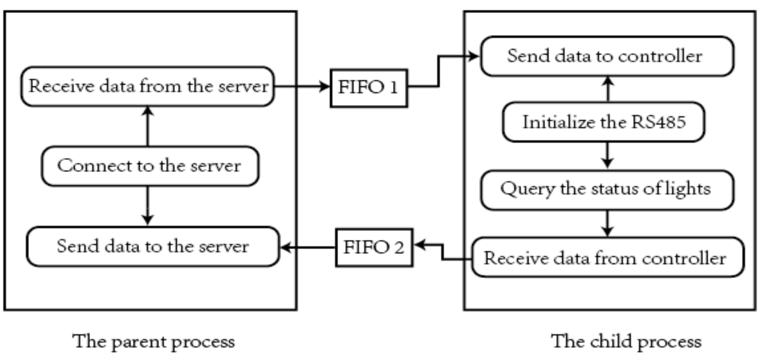

Figure 4. Coordinators software design

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4.3. The Web server

The Web side adopts the cooperative use of the three protocols to realize the real-time update and response effect of the device state [7]. Go language is used to build a communication structure based on HTTP protocol and WebSocket protocol, and then TCP/IP protocol is used to achieve two-way data interaction with hardware devices, so as to achieve the function of remote monitoring of physical devices. At the same time, the user action data collected by the Web page is transmitted to the TCP server at the back end. After the data is parsed and escaped by the TCP server, the corresponding communication protocol command is sent to the device to realize the remote control of the device. The specific data frames of communication between the Web server and the coordinator are shown in Table 1.

To this end, with Goland as the development tool, Google Chrome and Net Assist as the testing tools, the Web framework of Go language Beego is used to build the HTTP server, and the TCP communication framework Zinx is used to build the TCP server[8].An Internet of Things control platform is developed based on WebSocket protocol, which is deployed in Ali Cloud server to realize the whole network use of the platform. The website has realized the monitoring and control of the switching state of the equipment, the monitoring of the current size of the equipment and the coordination and linkage control among the equipment. After the administrator passes the login verification, he can carry on the remote monitoring operation to the connected hardware in the webpage end.

Table 1. Custom data frame structurecoordinator

Sequence Number	Name (Word Length)	Content
1	Data Type(2B)	
2	Data Length(2B)	
3	ID of Lantern (1B)	
4	Data(NB)	
5	Checksum (1B)	The sum of all bytes other than this byte

5. System Test

The upper computer of the intelligent lights control system mainly includes three parts: terminal management, log management and configuration management.Intelligent lights management system through the operation interface to achieve real-time monitoring of the status of lights, as well as lights remote control and fault warning and other functions. At the same time, in order to facilitate operation tracking and other purposes, the log management function is added to realize the inquiry and setting of the operation log.The main interface of the intelligent color lantern control system is shown in the figure 5.There are four control modes of colored lights, which are manual mode, running light mode, running light mode and breathing light mode. In manual mode, the switch and brightness state of each color light can be set independently.Water light mode can set the speed and direction of water;Under the running light mode, the starting position, speed and direction of the LED lights can be set. The RGB lights can be customized to set 10 colors for alternating transformation, and the interval time can be set.Breathing light mode can set the frequency of breathing, RGB color lights can also set the color of breathing.

After the system design is completed, in order to test the functions and stability of the system device, field tests are adopted.The smart lantern system is set up with 3 groups of lantern nodes. The first group is 12 independent LED lanterns, the second group is an RGB lantern, and the third group is a three-way LED lanterns.Each group can set different modes independently, such as the first group for manual mode, the second group for breathing light mode, the third group for water. light mode. In the actual test process, the system runs stably, and the control

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effect of each group of colored lights can reach the expected setting. Through the simulation of abnormal scene, the abnormal treatment can be effectively realized.

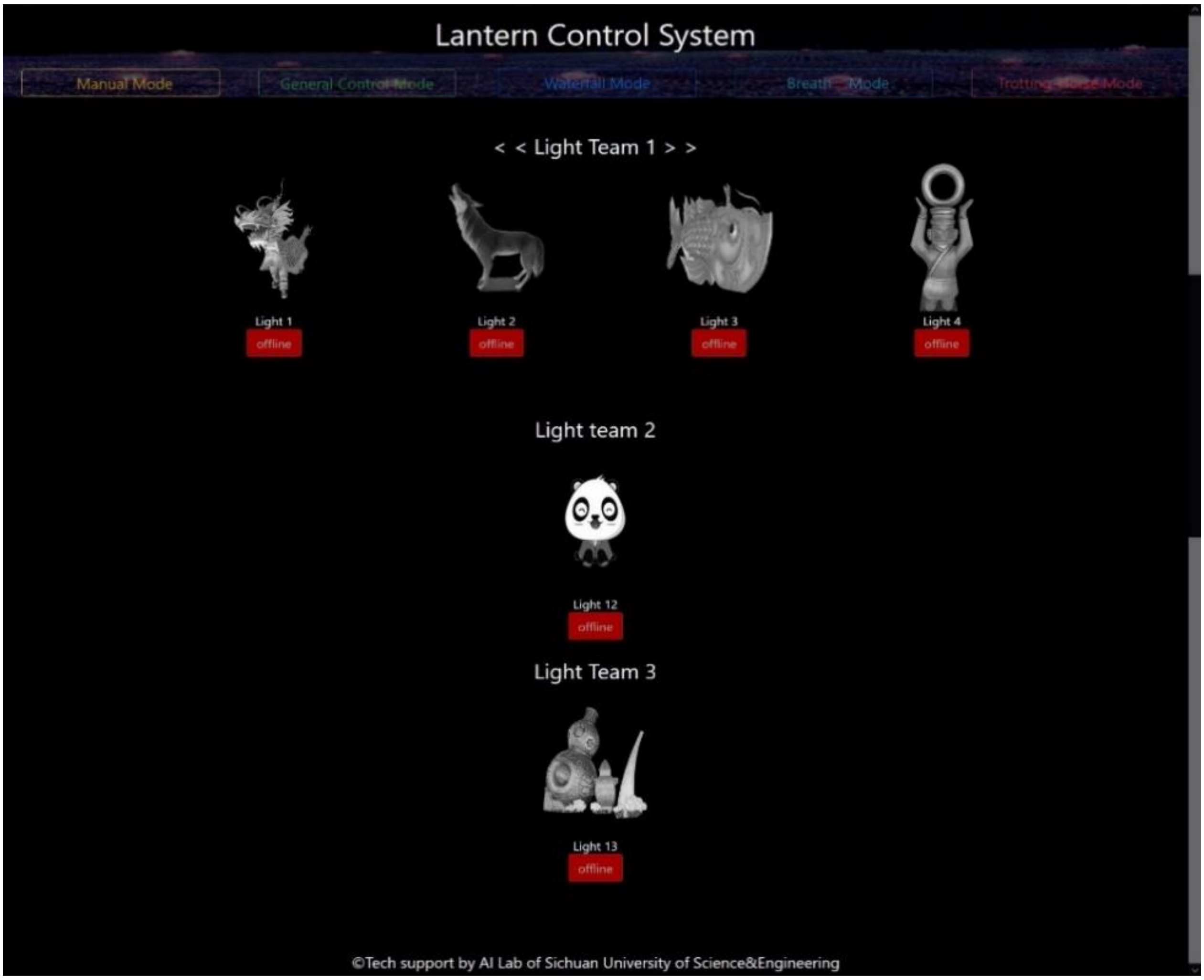

Figure 5. Main interface of intelligent color light control system

6. Conclusion

In this paper, the intelligent lights control system based on AM3358 microprocessor, STM32 microprocessor and cloud server is designed, and the hardware framework design and system software implementation process are described. The experimental results show that the system is easy to operate, real-time and stable. Different from the traditional lantern control system, this system can not only realize remote control and network control, but also make different lighting plans according to the actual needs.

Acknowledgments

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