Design of intelligent control system of classroom electricity based on Microcontroller Control Unit

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Abstract

This design builds an intelligent control system of classroom electricity based on STM32F103 MCU and ZigBee communication network. This system determines the usage patterns according to the prefabricated schedule, and automatically judge and set up the work condition of lighting and teaching equipment on the basis of the number and position of people, light intensity in the classroom and other information. The practical tests show that the designed system works steadily and achieves the purpose of intelligent energy-saving control, reducing the power consumption of the classroom and improving the service life of the teaching equipment.

Keywords

ZigBee; STM32F103; Intelligent control of electricity.

1. Introduction

With the rapid development of China's economy and the progress of the society, the contradiction between power supply and demand is more and more prominent. However, there are serious waste phenomenon in university, especially the classroom lighting and teaching equipment. Sometimes in situation such as there is no class and few or even no one in the classroom, lighting and teaching equipment are still all open, causing waste electricity and equipment spoilage. Conservatively estimate that the electricity consumption of invalid lighting in colleges and universities is at least 0.07 KWh/(d.p), and wasted electricity each year nearly reach 300 million KWh.[1-2] The waste of energy will not only bring the school heavy burden in power spending, also contribute to the domestic energy crisis.

For all the above reasons, this paper design a classroom electricity intelligent control system, system divides the classroom into class mode, self-study mode and sleep mode. In the class mode, system supply power for all teaching and lighting equipment in the classroom, teachers and students have the freedom to control their work status; In the self-study mode, cut off all teaching equipment power supply, according to the intensity of the light, position sensor detection, selective opening lamp; In the dormancy mode, only open the infrared alarm. The electricity intelligent control system, not only can save energy, improve the utilization efficiency of the classroom/ energy consumption proportion, and prolong the service life of teaching equipment.

2. The overall design of system

Classroom electricity intelligent control system consists of the control unit, counting node, sensor node and the execution nodes. The communication protocol between them is the wireless Zigbee protocol, and system structure diagram is shown in figure 1. The main execution node is the relay group, and we can control the switch of teaching equipment through them; Sensor node position

sensor including light intensity sensor and the human body location sensor are used to gather light intensity and human body location information in the classroom , and determine the headlamp switch of current node ; Counting nodes use infrared method, and also summarize the number of people in and out of the classroom; The control unit receives information from counting node and sensor node, and judge the execution node action according to the information of prefabricated schedule.

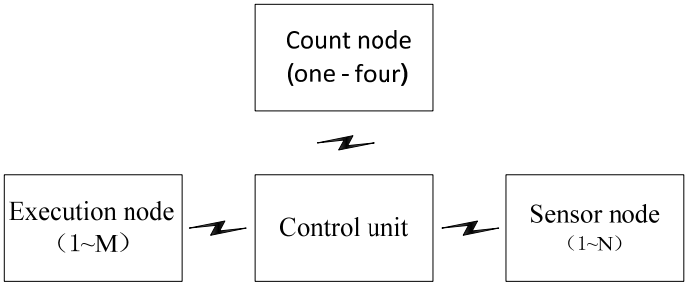

Figure 1 system structure diagram

3. The hardware design of system

3.1 The control unit design

Control unit using STM32F103RB Microcontroller Control Unit as core control device, it will be on schedule information stored in the SD card in advance, and through the ZigBee module receives the intensity of light in the classroom, body position and quantity information from sensor nodes comprehensive judgment. Then, through the ZigBee module to send the result of information processing to the execution node, control the action of the execution node. In addition, the control unit also has a simple keyboard input and display function. The structure diagram of the control unit is shown in figure 2.

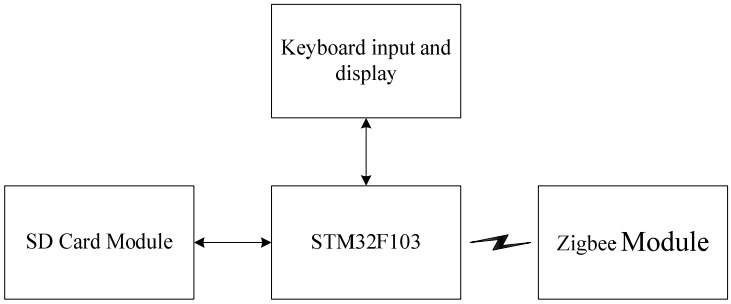

Figure 2 The control unit structure diagram

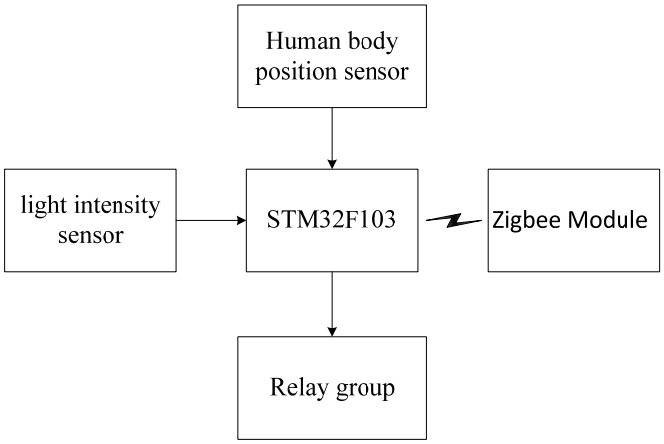

Figure 3 composition block diagram of sensor nodes

3.2 Zigbee node design

(1) Sensor node design

Sensor nodes including light intensity sensor and human body position sensor, with STM32F103C8 Microcontroller Control Unit control sensor data collection, and data were sent

through the ZigBee module to the control unit. When the classroom light intensity is lower than the set threshold value and the human body position sensor testing detection area have someone, relay work, open the corresponding position of the lamp. The sensor node composition block diagram is shown in figure 3.

The principle of light intensity sensor is a kind of photoelectric conversion circuit, its principle diagram as shown in figure 4. By integrating op-amp LM324 and the feedback resistance Rf, the silicon photocell (the equivalent of an optically controlled constant current source) of the output current change into a voltage signal output. By adjusting the size of the Rf value, can change the size of the output voltage, which can adapt to the latter control circuit of the input signal voltage requirements. In practical application, the light intensity affect the magnitude of Is, thus cause the change of Vout, so as to realize the transformation of light intensity signal to voltage signal. Microcontroller Control Unit through A/D sampling make light intensity digitization. In figure 4[3] , Vout connection PC0 of STM32F103 microcontroller.

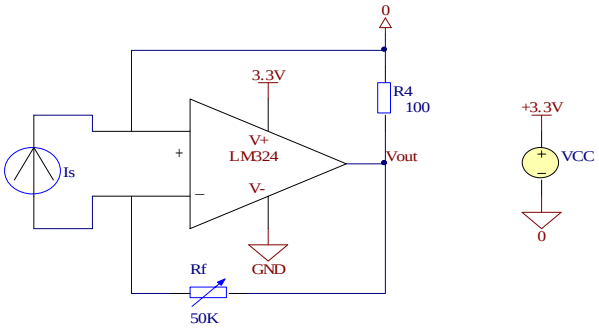

Figure 4 light intensity sensor circuit diagram

Human body position sensor using pyroelectric infrared sensor detection module, circuit as shown in figure 5, [3]include pyroelectric infrared sensor (PIR), infrared sensor signal processing of integration circuit IC (CSI9508), resistor R1~ R4, capacitor C1 ~ C6 and variable resistance RP1

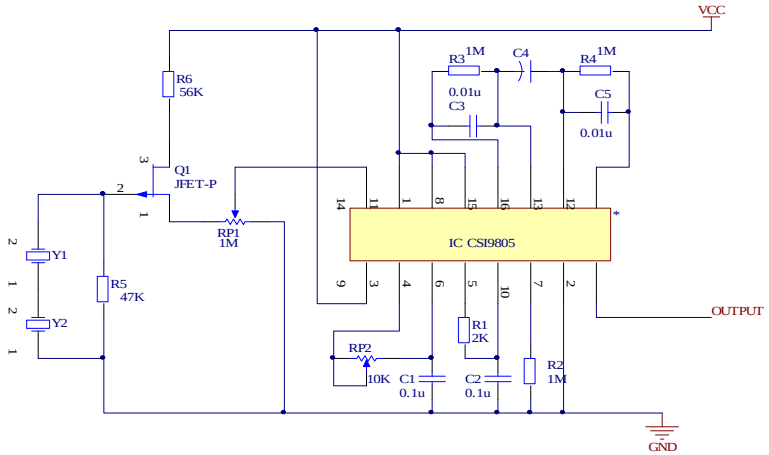

Figure 5 Pyroelectric infrared sensor circuit diagram

and RP2. After power on, when people enter the PIR detection area, PIR will transform the human body infrared signal into electrical signal, the electrical signal amplitude is limited by RP1 and the circuit inside of IC completion of the electrical signal amplification and plastic, so that the second pin of IC output a high level control signal. After the people left, internal delay procedures of IC keep second pin high level for a short period, and then turn into a low level. Microcontroller Control Unit can detect second pin high or low level, to judge the body position. Adjust the resistance value of RP1, can change the sensitivity of PIR . In figure 5 the OUTPUT connect PC1 of STM32F103 microcontroller.

(2) Count node design

Choose the infrared method to calculate the number of people in the classroom .The method is based on infrared emission diode (TSAL6200) and infrared receiver (TSOP1838). In the figure 6, [4]infrared emission circuit use NE555 chip as the pulse signal generator, infrared light emitting diode TSAL6200 driven by transistor Q9. Through changing the rheostat RV3 values, produce the frequency of the system need to 38 KHZ infrared light. Infrared receiver TSOP1838 connection adjust circuit, output signal through the not gate SN74LVC2G14 input microcontroller IO port. SCM by detecting the corresponding IO port level, judge people enter or go out. Each classroom door installed two road detection circuit, output respectively connected microcontroller PC2 and PC3.When someone comes in and out of the classroom, microcontroller through the Zigbee module send number of remaining people information to the control unit

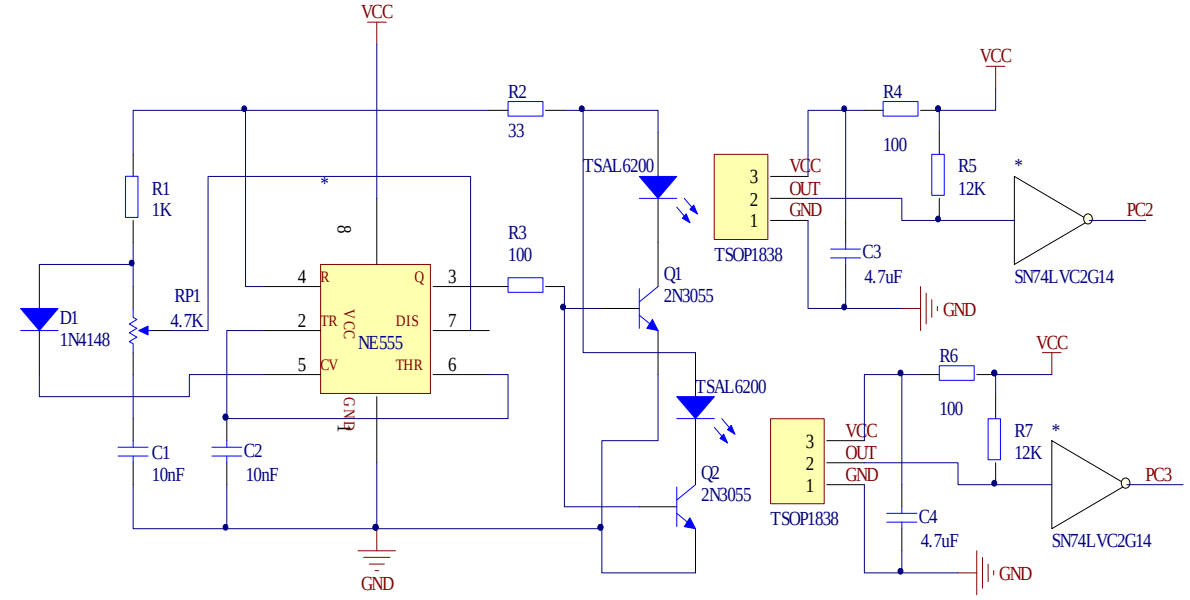

Figure 6 infrared counting module circuit diagram

(3) The execution node design

Execution nodes consist of STM32F103C8 microcontroller, ZigBee module and relay group. ZigBee module receives the command from the control unit, Microcontroller Control Unit control relay group work according to the command .To change the projector, computers and other teaching equipment working condition. The execution node composition block diagram as shown in figure 7.

Figure 7 execution node composition block diagram

4. The software design of control unit

Control unit can change the working mode of the classroom by realtimely inquiring clock signal and the schedule information stored in the SD card. For example, the setting time of the use of the classroom one day is 6 PM to 10 AM, in which period if there is a lesson in the classroom, the classroom will be converted into a class model, providing with electricity all the teaching equipment and lights in the classroom. The teachers and

students are going to have the freedom to control them. When there is no class, the classroom will be able to be turned into self-study mode, it will disconnect all the power supply of the teaching equipment, according to the light intensity and the detection of the position sensor, it can selectively turn on the lamp. Except the using time of it, the classroom will be turned into sleep mode in order to

reduce the power consumption with only the infrared alarm open. The software flow chart of the control unit is shown in figure 8.

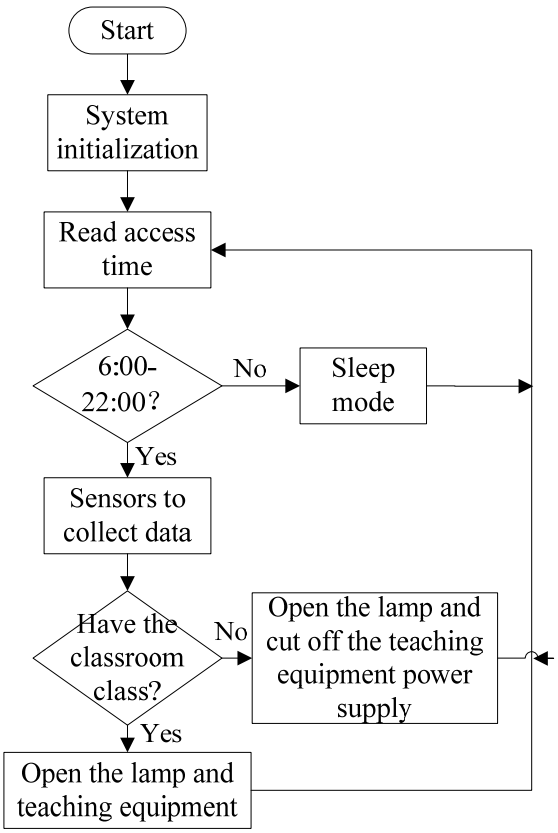

Figure 8 the procedure flow charts of the control unit

5. Conclusion

This paper sketches the design method, main structure, practical function and key technology of intelligent energy-saving control system for teaching buildings based on STM32F103, which can be applied to the energy-saving management of teaching buildings, with high use value. Applying ZigBee communication technology overcomes the defect of complex routing in traditional control system, realizing the wireless and adaptive control of electrical equipment in the classroom. As the country is increasing concentration on energy conservation, the application prospect of this system is very wide.

References

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