

Design of Multi-mode Lighting Control System of Classroom

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Abstract: To decrease the waste of electric energy phenomenon caused by personnel distribution, long-time opening, and no fixed schedule, etc, the intelligence classroom lighting control system is designed based on human body signals and environment light intensities. According to the system, the environment light intensity and the number of people (personnel distribution) signals are collected by the ambient light monitoring module and the human body signal monitoring module. Experiments results showed that the lighting control system can control and regulate the conditions and illuminance of lighting devices effectively by the way of human detector, light sensor, and manual control, etc. Also, it provides reference for the design of power-saving optimization in the modification of public lighting system.

Keywords: Lighting system, Regional separation, Environmental light monitoring, Human body monitoring, Energy saving

Introduction

At present, most of the domestic university classrooms waste lots of power for the absence of good management. The waste of electric energy phenomenon is very normal, the lights of the classroom of teaching buildings work all the day. the lights always been turned on when no one in the classroom. Universities in energy conservation action are not only the needs of the country's energy, but also to train college students' talents and improve their comprehensive quality. Colleges and universities as an important role in national energy-saving square, must be in the first of knowing and action in energy conservation[1]. Lighting energy-saving work in the university campus is very necessary. In order to cut the unnecessary power consumption, an intelligent lighting control system is designed here.

According to the relevant provisions of Standard for lighting design of buildings of the People's Republic of China, the light intensity of the desk surface at least reach 300 lx, the light intensity of classroom blackboard surface at least reach 500 lx[2], regional multi-mode control system both can obtain the best lighting environment for the students and achieve the purpose of saving energy.

Structure design of the system

The intelligent lighting control system need have the characteristics of simple and reliable structure, low cost, strong practicality. Which can realize multi-mode control to the lighting according to the personnel distribution and lighting intensity. Control system can make more precise control of lighting environment within the classroom, can control lights on or off according to the number of students in the classroom and the precise position, so the students learning in the classroom can get the best lighting environment. At the same time, according to different uses, such as self-study, theory, multimedia class, the system has presented different work patterns. Users use the appropriate operation mode according to different needs, such as self-study mode, teaching mode, multimedia mode. We set a switch in the system, can force the switch to any set of lights, make the system more humane[3].

The system chooses the Single Chip Microcomputer as the micro processor of the whole system. Together with other elements as the photosensitive resistances, AD conversion chip, the infrared sensing signal processor and the electric relay, the system can monitor the existence of the human body and the illumination strength, and issue the corresponding orders. According to the rational conditions of switching light on or off, the embedded classroom lighting system is orderly and intelligently controlled to avoid a large amount of waste of electricity in classroom based on

identifying the signal of the existence of human body and the signal of the environmental light. The system structure design is shown in Fig.1.

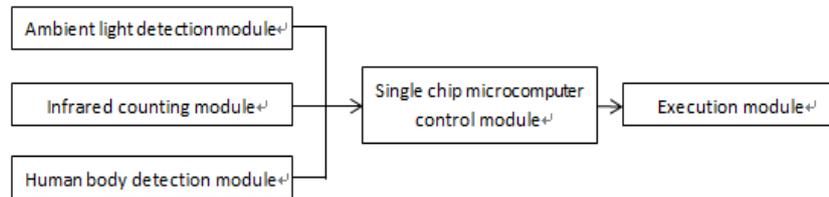


Fig.1.the system structure design

Hardware design of the system

Overall installation layout of the system

Sometimes there is only one or a few people in the classroom, but all lights in the classroom are open. Natural light intensity meet the requirements in the classroom, but the lighting also still open. The location of the students are different from the windows. the sunlight is not the same, the light intensity is also different. In order to achieve better energy saving effect, we can classify the lighting control in the classroom, and divide a large classroom into several smaller lighting control areas[4]. In this way, we can solve the problems above.

As shown in Figure 2, the entire classroom is divided into five regions: A, B, C, D and the podium area. We need to install the illumination sensor and the body sensor in the center of each region, The system separately carries on the real-time monitoring management to each region, can control the lighting according to the region of illumination and personnel activities.

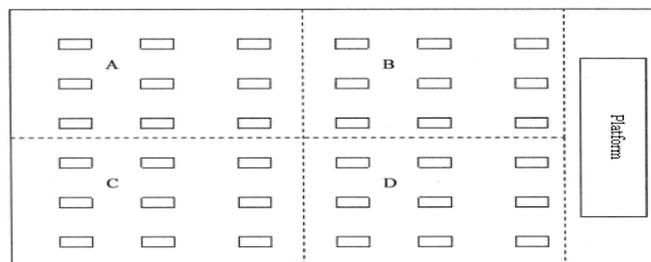


Fig.2 division diagram of the classroom

Single Chip Microcomputer control module

The main control module of the system uses AT89C51 microcontroller as the core component, AT89C51 microcontroller is also the core of the whole hardware, all other circuit module should be connected with it, AT89C51 microcontroller is used to process the data in the system, which can connect each module and realize the coordination between the modules.

The AT89C51 provides the following standard features: 4Kbytes of Flash, 128 bytes of RAM, 32 I/O lines, two 16-bit timer/counters, a five vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator and clock circuitry. In addition, the AT89C51 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port and interrupt system to continue functioning.

A single chip microcomputer minimum system consists of single chip microcomputer and its necessary components, such as power circuit, clocking circuit and reset circuit. Which allows the microcontroller to remain in normal operation and can make the microcontroller has been in a state of normal operation. Using it, the microcontroller can complete more complex functions. The minimum system is shown as Fig 3.

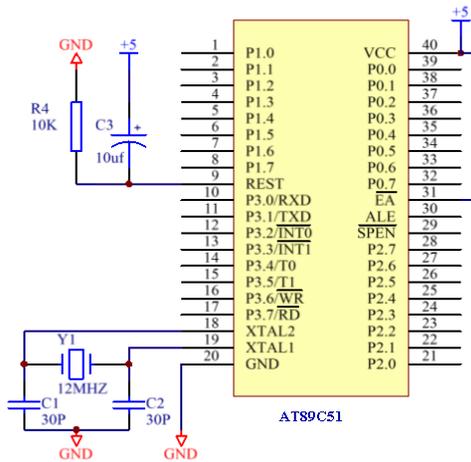


Fig.3 Principle of the minimum system

Ambient light detection module

To achieve energy-saving, the most fundamental thing is to make full use of natural light, thus reducing the consumption of electricity. In the design, we want to quantify the intensity of light or the measurement of the illumination, and do not use photodiode to measure the intensity of the light, because the result error is bigger. so the choice of the chip is very important. If we can find a chip, there is a certain relationship between output and light intensity, this problem is solved. The optical frequency converter TSL230 produced by American TI company is just in line with our requirements.

The TSL230 programmable light-to-frequency converters combine a configurable silicon photodiode and a current-to-frequency converter on single monolithic CMOS integrated circuits. The output can be either a pulse train or a square wave (50% duty cycle) with frequency directly proportional to light intensity. The sensitivity of the devices is selectable in three ranges, providing two decades of adjustment. The functional block diagram is shown as Fig4.

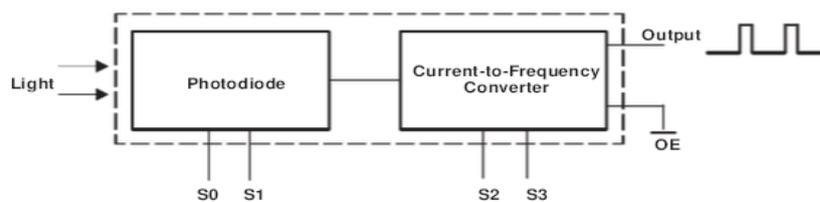


Fig.4 Functional block diagram

The interface circuit of the TSL230 and the AT89C51 is shown in Figure 5. TSL230 chip converts light intensity to the corresponding voltage signal pulse, but the voltage signal amplitude changes too small, then the sensor output signal is fed into the 74HC14 chip, which can change the input slow change signal into a clear, jitter free output signal. Then 74HC14 chip plastic the input signal, improve the steepness of the edge of the signal, reduce the frequency count error of the signal. The connection diagram of TSL230 with 74HC14 is shown as Fig5.

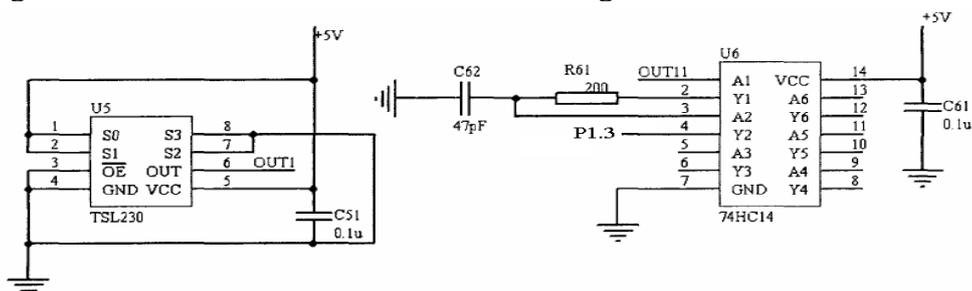


Fig.5 Connection diagram of TSL230 with 74HC14

Infrared counting module

We install two NE555 infrared reflection counter at the door of the classroom. The infrared emitting tube of the E555 is emitting infrared rays, and the infrared receiving tube receives the infrared light. When someone or something blocks the infrared light and the receiving tube do not receive the infrared signal, the amplifier will output high level, when the body pass the two infrared reflective counter in turn, the counter starts counting[5]. We provide the direction of access, according to the direction, we can record the number of people entering a certain area, the data will be transmitted to the microcontroller. In this way, we can access the number of classroom in real time.

Human body detection module

The human body monitoring module can detect whether there are student activities in the area. pyroelectric infrared sensor is the core element of the detection module. Pyroelectric infrared sensor can detect the human body moving at a certain wavelength of infrared light, the probe received infrared rays through the Fresnel lens filter, Pyroelectric infrared sensor and a certain amount of external components can constitute the most basic infrared pyroelectric sensor module.

In the infrared signal processing, the system selects the high performance infrared signal processor BISS0001, which has minimal static current, independent operation of the high impedance input operational amplifier is arranged inside the lock and the delay time of the timer, at the same time there is a bidirectional amplitude discriminator, can play a good role in suppressing interference. BISS0001 chip consists of a voltage comparator, a state controller, an operational amplifier, a delay timer and blocking time timer special consisting of mixed-signal integrated circuits. Infrared pyroelectric sensor toad map shown as Fig 6.

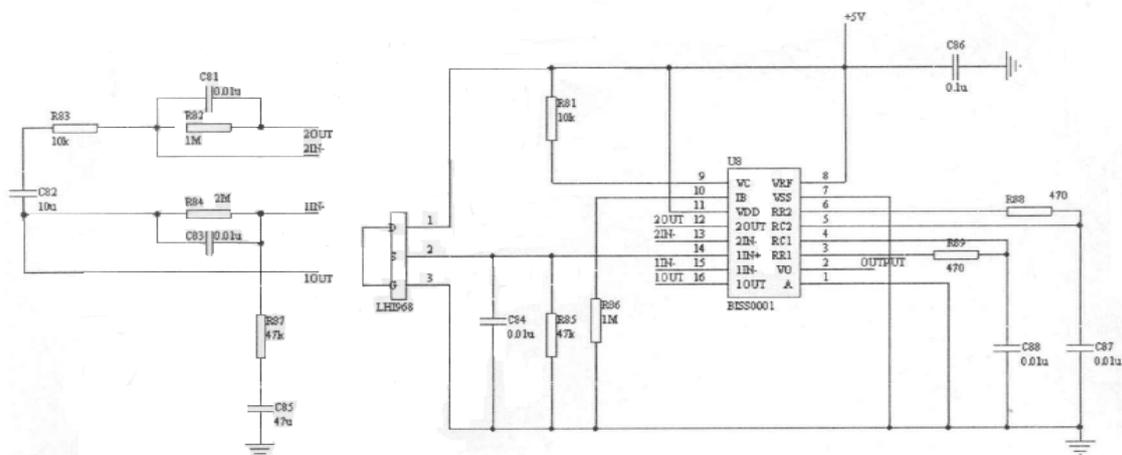


Fig.6 Infrared piezoelectric sensor toad map

Software design of the system

The system control process is as follows: first of all, the Single Chip Microcomputer checks the presence of the human body in the corresponding part of the classroom. If there is no presence, it continues to detect; if anyone presents, it enters into the interrupt process, and detect the illumination strength in the corresponding part of the classroom and through the AD conversion, converts the light strength into digital information, and then transmit it to the Chip. The Single Chip Microcomputer changes the working state according to the pre-programmed program, and have Communication among the control unit, execution unit and detection unit. After carries on the comprehensive analysis, the control information is sent to the execution unit, then execution unit carries on the precise control to the ligh[6], Finally the machine accomplishes the relevant actions. The general flow chart of the system is shown as Fig7.

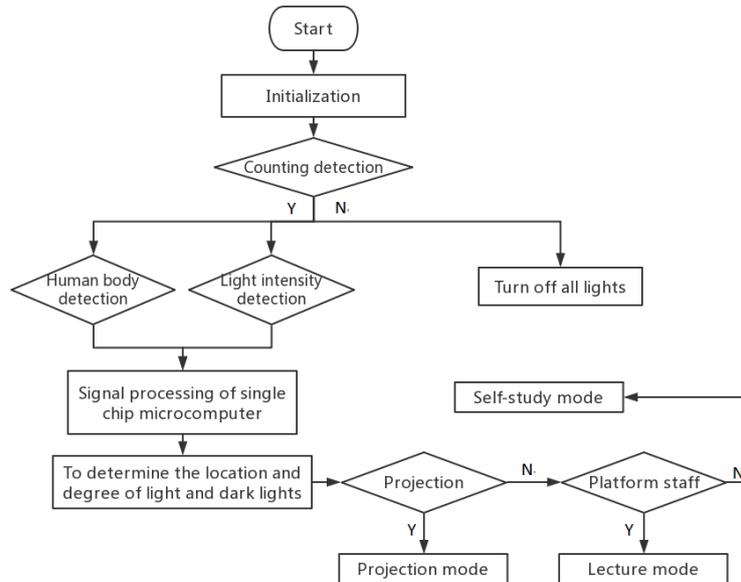


Fig.7 General flow chart of the system

Summary

In order to realize the intelligent and electric energy utilization of classroom lighting control system, to achieve the goal of energy saving, The intelligent lighting system is designed. AT89C51 is the core of the control system. Classroom was divided into several regions. By scanning the signal of human body with infrared device periodically, the lights in the unmanned regions can be turned off automatically. And if students are too scattered, lights in some regions will also be turned off automatically to assemble the people. This system solved the problem of the much waste of university classroom lighting system and increased energy usage ratio significantly.

Acknowledgments

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