Design of Classroom Lighting Control System Based on SCM

Jinghui Su

School of Electronics and Information Engineering, Changchun University of Science and Technology, Changchun 130000, China

sjh1216@sina.com

Abstract

The design for the serious waste phenomenon and the current situation of school classroom lighting control power, analyzes how to use the modern automatic control technology, so that we have an intelligent control and energy saving of the classroom lights, and achieve energy saving purposes. This design uses AT89S51 microcontroller as the core part of the control device, optical circuit of photosensitive triode to detect the intensity of illumination, the infrared detection technology to detect whether someone enters the classroom. According to the intensity of illumination and whether there are people in classroom etc, we have an intelligent classroom lighting control to avoid the serious classroom electric energy waste phenomenon. The system designed in this paper has the advantages of low cost, small energy consumption, and can be achieved on the classroom light reasonable control of real intelligence.

Keywords

Intelligent control, AT89S51, Energy saving.

1. Introduction

Energy shortage has become a great factor hindering the economic development of our country, but there are still severe wastes of electric energy in many colleges in China. For instance, lamps are still on when there is sufficient illumination in the daytime; lamps are still on in a classroom when there is nobody. It seems that lamps burning day and night in a classroom don't consume too much energy, but the energy consumption is not a small figure from the perspective of a whole school. Therefore, this is a huge waste. Apart from the weak energy-saving awareness, another significant cause for waste of electric energy is the laggard energy-saving hardware facilities.

At present, management over illumination electricity for teaching buildings in colleges generally falls into three modes: mode I: no person is specially assigned to control it and all lighting facilities need to be turned on and off independently by students; mode II: timing switches are used to turn on and off the lighting source of a whole teaching building based on the college's timetable; mode III: persons are specially assigned to take charge of the illumination; namely, the management personnel offer electricity to different floors of building according to the college's timetable and weather. [1] Although existing products and technologies of lighting control system is relatively mature, they are mostly designed for ordinary buildings such as the residential building and office building; therefore, it is difficult for them to meet the characteristics of a classroom in college such as high personnel mobility, long-time opening, no fixed timetable, no fixed seats and multiple purposes. Such a particularity of classroom in college added more difficulty in classroom energy saving in colleges. Thus, this paper profoundly researches the intelligent lighting control system of college's classroom.

2. Overall system design scheme

According to the analysis above, the key problems below shall be solved for the intelligent lighting control system of college's classroom.

The problem of inputting and collecting personnel parameters in a classroom;

Problems of inputting and collecting of ambient light parameters;

(3) Problem of light being automatically driven as needed. [2]

Therefore, the overall thought of system design is as follows: SCM (single chip microcomputer) is used as the control core and infrared detection technique is used to detect the existence of human body; a light sensor is used to detect the ambient light intensity; when there is sufficient light ambient light intensity, no light will be turned on with or without anybody. When there is only weak ambient light and people stay here for a period of time, the controller will automatically turn on the lamps; lamps will be turned off when people leave for a period of time. When it exceeds 12:00 at night and people stay here, close the automatic controller and manual operation shall be adopted. The structural diagram of overall system control scheme is shown in Fig. 1.

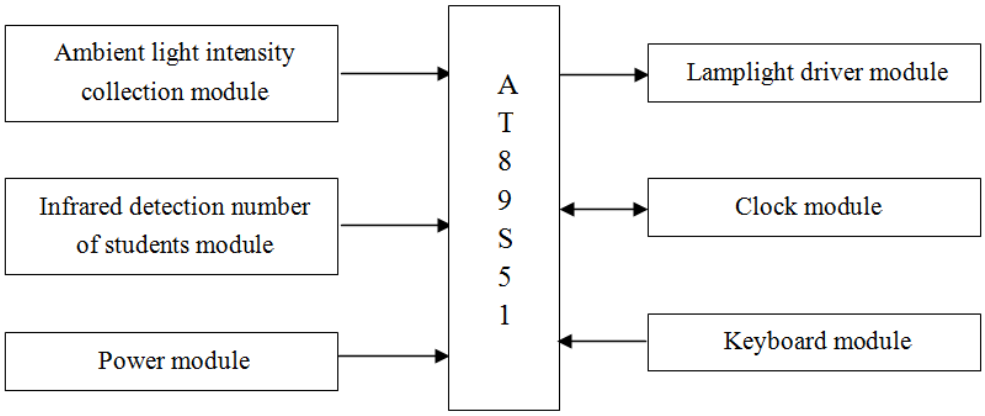

Fig.1 Structural diagram of overall system control scheme

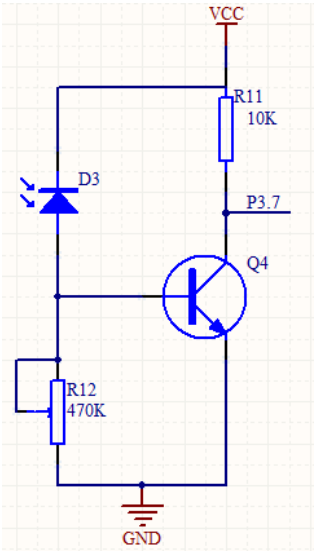

Fig. 2 Ambient light intensity collection circuit

3. Main module design of system hardware

3.1 Ambient light intensity collection module.

The ambient light intensity collection circuit is shown in Fig. 2. When the ambient light intensity is higher than a certain degree, phototriode D3 will be in a low-impedance state, the base voltage of triode Q4 will rise to reach saturation conduction of Q4, and the collector will output low level. When the ambient light intensity is lower than a certain degree, D3 will be in a high-impedance state to cut off Q4 and collector will output high level. Regulating R12 resistance value can achieve the break over of Q4 with proper luminance under the influence of ambient light.

3.2 Infrared detection number of students' module.

We use the infrared detector to detect whether anyone enters a classroom and how many persons in the classroom. The schematic diagram of infrared detection circuit is shown in Fig. 3. The infrared light emitting diode (LED) is used in the infrared emitter in the circuit; phototransistor is used in the receiver. When nobody passes through the detector, the 1 end of U1:A will output low level; when people pass through it, the 1 end of U1:A will output high level.

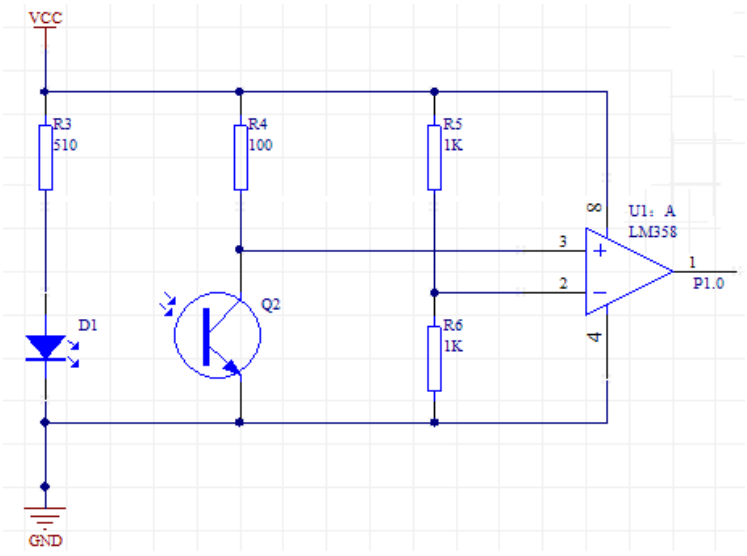

Fig. 3 Schematic diagram of infrared detection circuit

The whole system is in the combined use of two active infrared detectors. The 1 end of amplifier U1:A in an infrared detector is connected to the P1.0 lead of AT89S51 SCM; The 1 end of another amplifier is connected to the P1.1 lead of AT89S51 SCM. Combined use of two detectors aims at judging whether people passing by go into or come out from a classroom and recording the number of persons in the SCM. Detector 1 and detector 2 are installed indoor and outdoor respectively. That people pass through detector 1 first and then detector 2 indicates that people go out and the internal counting procedures of SCM will automatically subtract 1; that people pass through detector 2 first and then detector 1 indicates that people come in, and the internal counting procedure of SCM will automatically add 1. When the figure in the counter is 0, it means there is no one in the classroom and the SCM won't open the lighting circuit; when the figure in the counter is more than 1, it means there are people indoor and the SCM will open the lighting circuit. To open the lighting circuit, there is another precondition, namely, control of ambient light intensity module. With a strong ambient light, it is not necessary to open the lighting circuit even if there is someone indoor.

3.3 Lamplight driver module.

Lamplight driver interface circuit is shown in Fig. 4. The relay is driven by S9012. When it is power-on, P3.5 after initialization of SCM is a high level and the triode is cut off. Therefore, after startup, the relay is always in the release condition. If P3.5 is a low level, the base electrode of triode

will be decreased to generate sufficient base current for break over of triode; then, the relay will pull in after being powered on to drive load to turn on corresponding lamps. The relay's output end in parallel connection with 100Ω of resistance and 6800PF of capacitance aims at avoiding sparks during the relay pull-in and release period. [3]

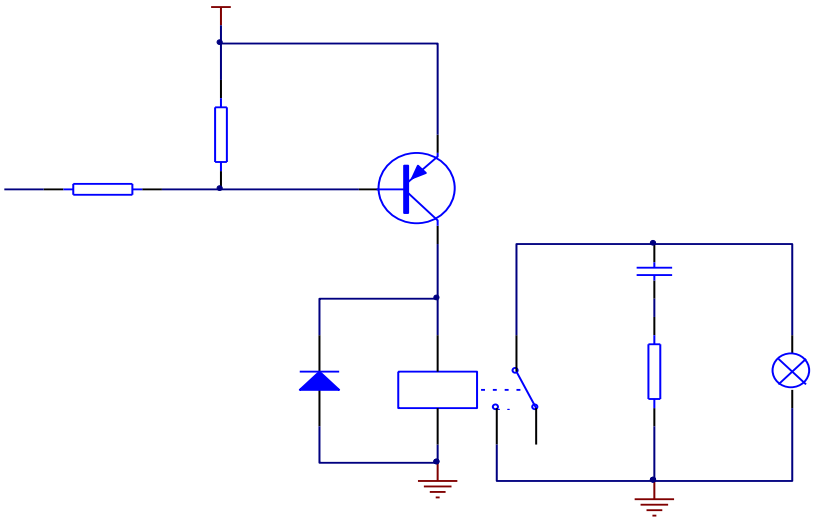

Fig. 4 Lamplight driver interface circuit

4. Main module design of system software

The system software design adopts the top-down structural procedure design idea, mainly including major system monitoring program module, ambient light intensity collection module, human body existence signal collection module, lamplight driver module etc.

4.1 Major system monitoring program module.

The main monitoring program is the core of the whole control system; generally, other peripheral modules need to pass through the monitoring module to realize their functions in the control system.[4] The main monitoring program, which receives and analyzes orders from keyboard and then transfers control to corresponding entrances for handling subprograms, has a leading function. The system's main monitoring program flowchart is shown in Fig. 5.

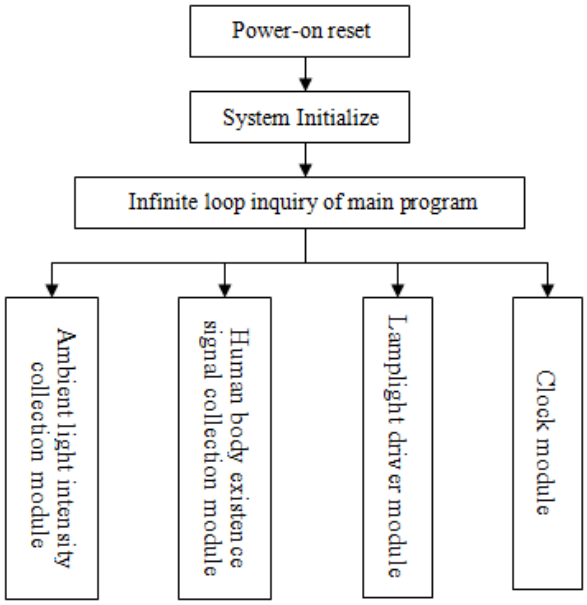

Fig. 5 System's main monitoring program flowchart

The ambient light intensity collection module and data information gathered by the human body existence signal collection module in this control system jointly determine whether to turn on a lamp. The table of logical relationship among the three is shown in Table 1.

Table 1. Logical relationship among ambient light, human body existence and lamp

Ambient light zone bit (0 for strong light)	Number zone bit (0 for no person)	Light-up zone bit (0 for light off)
0	0	0
0	1	0
1	0	0
1	1	1

4.2 Ambient light intensity collection module.

Intelligent control is carried out over the classroom lamplight according the classroom light intensity and the existence of personnel in a classroom. In case the classroom's ambient light intensity reaches a certain value, no lamp will be turned on regardless of the existence of persons in a classroom; in case the classroom's indoor light intensity is less than a certain value and there are people in the classroom, the lamps shall be turned on. [5] The ambient light enhancement service program flowchart and ambient light decrease service program flowchart are shown respectively in Fig. 6 and Fig. 7.

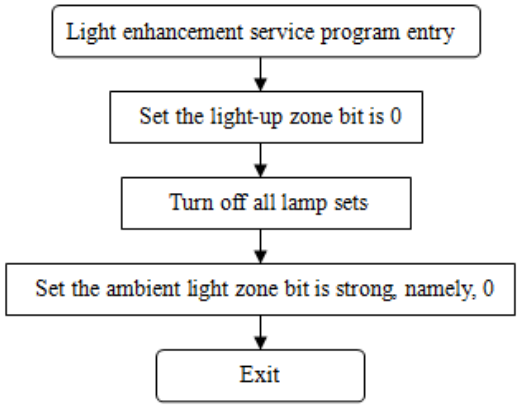

Fig. 6 Ambient light enhancement service program flowchart

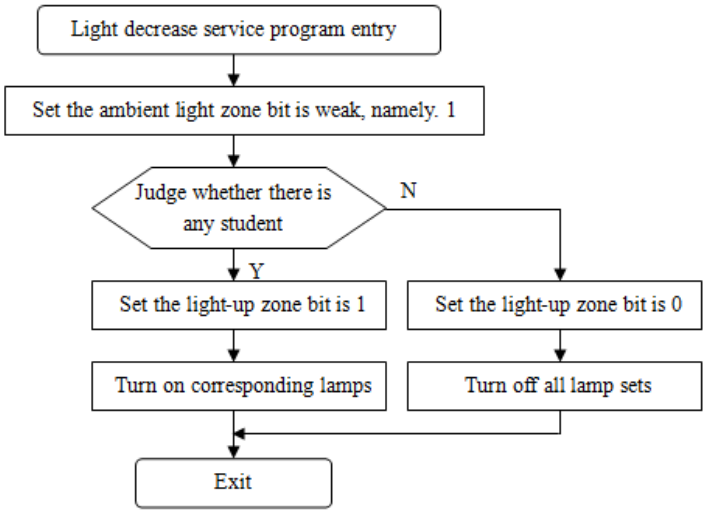

Fig. 7 Ambient light decrease service program flowchart

Human body existence signal collection module.

According to the infrared detection number collection module designed in the hardware, we can gather the number of people coming in and going out of the classroom. When someone enters into the classroom and there is no adequate light, we will turn on the lamps; when someone enters into the classroom and there is adequate light, no lamp will be turned on; when someone goes out of the classroom, check whether the number zone bit set in the SCM is 0; if it is 0, turn off the lamps; otherwise, turn on or off lamps according to the conditions. The human body existence signal processing program flowchart is shown in Fig. 8.

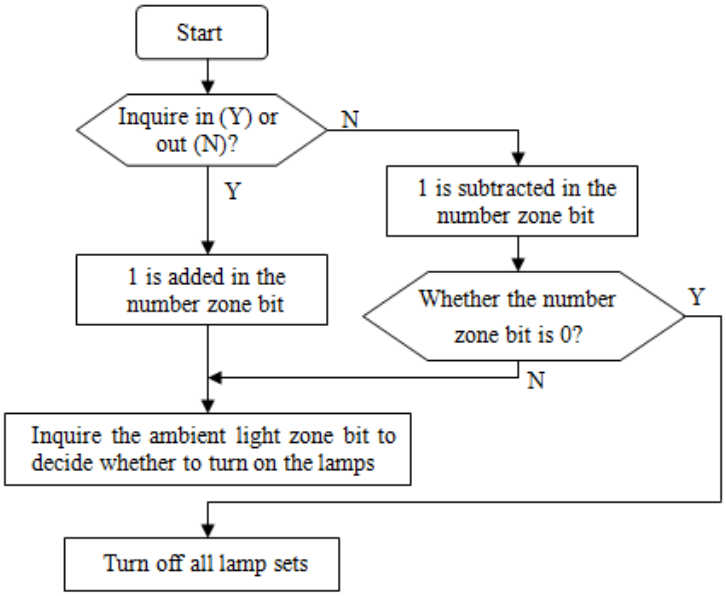

Fig. 8 Human body existence signal processing program flowchart

Lamplight driver module.

The module conducts operations according to the light intensity, number of people, time and other comprehensive conditions in a classroom. After initialization of SCM, the relay in the module will be in a release state and lamps will be turned off. When requirements of lighting up are met, through the intelligent control of SCM, the relay will be closed to actuate load and lamps will be turned on; when the requirements of lighting up are not met, the SCM will issue an order to release the relay and lamps are turned off. The lamplight driver module flowchart is shown in Fig. 9.

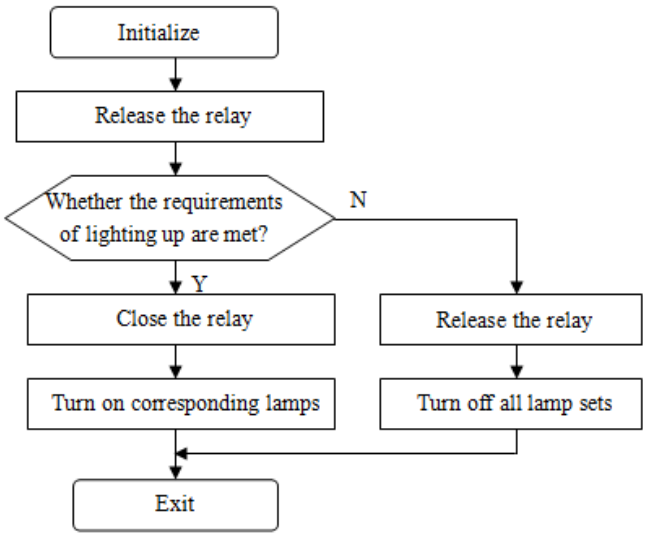

Fig. 9 Lamplight driver module flowchart

5. Conclusion

This system, where SCM is used as the control core, is applicable to the classroom lamplight intelligent control system. Owing to the system's simple structure, easy control and strong practicality, when it is used together with the existing classroom lamplights, intelligent control over classroom lamplight can be realized without largely altering the existing equipment circuit. This largely reduces the use cost. Meanwhile, as for software design, the system uses the multitask form to collect and process signals to reach the final goal of lamplight control.

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