Energy Saving Oriented Improvement of Public Lighting Circuit System in Wisdom Classroom

Lijin NIE, Hong He*
School of Mechanical, Electrical & Information Engineering, Shandong University, Weiahi, China

*Corresponding author e-mail: hehong@sdu.edu.cn

Abstract. According to the existing problems of the public lighting control circuit in classroom, we improve the lighting control circuit system by using the single chip microcomputer. On the premise of not changing the layout of classroom lamps, the existing lighting control circuit is updated from one row one control to one lamp one control. Depending on the actual light in the classroom, it is decided whether or not and in which position the lights need to be turned on. The intelligence of the public lighting facilities is an important part of the intelligent campus.

1. Introduction

China is a big country of education, with the expansion of university scale, the number of teachers and students and construction facilities are increasing. As public building facilities, colleges and universities are almost open management for classrooms and other office space. [1] Because of more curriculum arrangement, different class hours and lack of necessary supervision measures and project investment, there is a widespread waste of electricity in teaching. Especially there are large waste of electricity in public lighting in the classroom, such as long lights, fewer people and all lights on, the man is gone and the light is still on, etc. Without the wisdom of public lighting in the classroom, there would be no wisdom in the campus.

Aiming at the problems existing in the public lighting facilities of colleges and universities, this paper puts forward some improvement measures for the lighting circuit of the existing classroom. Through intelligent monitoring, image collection and analysis, cloud service lighting data analysis and cloud control, the intelligent control of lighting facilities in the classroom is realized effectively, and the energy saving effect is achieved. The lighting in university public facilities should not only meet the lighting requirements of indoor students, but also save energy and reduce emissions, to prolong the service life of lamps and reduce the school expenditure. To truly achieve the green and environmental protection of low-carbon campus construction. [2]

Since 1990's, intelligent control lighting system has been put forward. It has been studied and applied at home and abroad. The management and control of public lighting equipment are usually divided into three stages: manual control, timer light sensitivity control and computer control. [3, 4] The first two stages of lighting control are limited by their own technology that cannot satisfy people's demand. Intelligent lighting control based on computer and Internet technology come into our vision. [5, 6, 7] There are many successful cases of intelligent lighting. Such as the DALI Lighting Control system of Lutron, that adopting the complete distributed network structure and realizing the digital communication between the control module and the electronic rectifier. I-BUS Illumination Control System based on EIB bus proposed by ABB in Germany, HBS Illumination Control System jointly

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developed by Toshiba and Panasonic, with twisted-pair wire as communication medium, Australian Bunch has studied distributed Lighting Control system, Siemens instabus KNX/EIB Intelligent Building Control system for Heathrow International Airport. [8, 9, 10] Domestic intelligent lighting control information transmission technology mainly includes: power carrier, wireless network and integrated wiring technology. The intellectualization of control and the transmission of information are very important in the realization of intelligent control of lighting system. The integrated wiring technology connects the central controller, terminal and switch. The remote controller sends out the wireless signal of the central controller. The signal is transmitted to the terminal by wired mode. And the terminal completes the control instruction. Power line carrier uses both sides of the interconnected wire to communicate with each other and needs to be equipped with a wireless receiver. Wireless network technology through Zigbee, Bluetooth and other electronic devices to communicate with each other and the corresponding intelligent control. [11-14] By using the surveillance camera and the intelligent lighting control based on the video stream statistics technology, the regional division of the lamps and lanterns in the classroom is carried out. According to the actual number of people detected, the lamps and lanterns switch in the area block are controlled.

Researches on intelligent control of public lighting facilities has made some achievements and achieved energy-saving effect. However, it has not yet reached the control of a single luminaire, and we believe that for the existing university classroom lighting system intelligent renovation scheme is best not to affect the normal use of the classroom. The latter part mainly describes how to modify the lighting circuit of the existing classroom to realize one lamp and one control, so to obtain data and realize intelligent control. Overall improvement measures see figure.1, classroom lighting circuit transformation is the most basic part.

| Applications layer | Network client HTML |
|--------------------|---------------------|
| Data layer         | Data center (MySQL) | PUTTY          |
| Cloud services layer | Opens USE VMware | Azure Management Port |
| Infrastructure layer | Image acquisition of number and distribution in the classroom | Background maintenance |

**Figure 1.** Lighting circuit improvement and data acquisition in classroom

2. Improvement of Lighting Circuit in classroom

The circuit layout of lamps and lanterns in the existing classroom has been encapsulated. Its main control mode is one switch to control one row or a row of lamps and lanterns. According to the existing circuit layout, this paper puts forward the improvement measures, fixed lamps, only changes the circuit, in order to achieve the goal of intelligent control of individual lamps. Through testing on single-chip microcomputer control and circuit board, we try to prove the effect of improvement of the existing circuit. When we have only a few students in the classroom, we use manual control to compare the effect of the lights when they are fully or partially turned on according to demand. As shown in figure 2, where the (a) is fully turned on, the (b) can meet the lighting needs of the front and rear row students only when the front and rear lights are turned on. Both of them can meet the lighting requirements.
2.1. Circuit improvement mode
The wiring of the lighting facilities in the classroom has been fixed. In order to realize the switch of controlling each lamp separately, the wireless control method and the wired control method can be chosen to improve the performance of multiple lamps and lanterns that are controlled by the unified control on the original line.

Wireless communication that sends wireless signals from one transmitter to one or more receivers and does not require cumbersome wiring. A transmitter corresponds to wireless communications for multiple receivers. As the carrier of communication electromagnetic wave wireless spectrum has different frequencies and wavelengths. The wireless spectrum ranges from 9khz to 300,000Ghz. The successful transmission of wireless signals requires the transmitter at the transmitter and the receiver at the receiver, and the transmitter must be adjusted to the same frequency in order to realize the effective transmission of the signal. For the same signal transmitter, if it communicates with multiple receivers at the same time, it needs many different signal frequencies; otherwise, each receiver cannot receive the wireless signal accurately.

2.1.1. The circuit improvement method based on wireless communication mode.
In order to control multiple lamps on a single line of the original circuit and improve the control of each lamp, it is necessary to add a separate switch to each lamp. The switch here is a control switch made up of a wireless signal receiver. The signal transmitter transmits a plurality of non-repetition frequency signals to multiple receivers to control each switch separately. Since each lamp is equipped with a receiver, it is necessary to assign different frequency channels to each receiver. In view of the excessive number of classroom lamps and different frequency channels in many classrooms, the frequency channels are occupied too much, which is difficult to realize, and the cost of transformation is too high.

2.1.2. Wired communication mode
Based on the original circuit, the wired communication mode adds the control circuit to the layout and adds the relay control switch corresponding to each lamp. The light control signal sent by the master control system controls the work of the relay to achieve the goal of individual control of each lamp.

We chose wired mode to improve the lighting circuit in the classroom.

2.2. Reform of lighting equipment Circuit

2.2.1. Single chip computers and control switches
We use STC89C52 MCU controller in the improved circuit and use it as the output control of the signal. The STC89C52 development control board is shown in figure 3.
STC89C52 is a high-performance, low-power CMOS 8-bit microcontroller produced by STC. Its system programmable Flash memory has 8K. [15] STC89X52 can reduce to 0Hz static logic operation, and can support two kinds of software choice power saving mode. In idle mode, the CPU stops working, allowing interruptions of RAM, serial ports, timers / counters to continue to work. In the state of power-off protection, the oscillator will be frozen and the RAM content will be saved, and all work of the single chip will be stopped until the next hardware reset or interrupt arrives.

2.2.2. Circuit improvement principles

In the actual university public lighting facilities, the condition of lamp switch control is that one switch controls one or more lights on one row or one row simultaneously, and the realization principle of the circuit is shown in figure 4.

![Existing actual switch control circuit](image)

**Figure 4.** Existing actual switch control circuit

In the circuit diagram of zero end of fire line, 220 V ~ and (GND) are used respectively. Switch S1 simultaneously controlling the brightness and extinguishment of D1, D2 and D3. D1, D2 and D3 is connected to a high voltage line (220V ~), and the other end of the three lamps is connected to the same ground wire. When the switch S1 switched on, there is a voltage difference of 220V between the two ends of the lamp D1, D2 and D3 at the same time. In this way, three lamps are turned on at the same time. The control principle for S2 S3 is the same.

In order to realize the realization of intelligent control of single lamp, we select STC89C52 as the controller, add relay control switch to each lamp based on the original circuit of the circuit. The STC89C52 controls the output signals that directly controls the work of the relay. Then the switch
control of each lamp can be realized according to the switch on state of relay to achieve the purpose of intelligent control of lighting facilities.

The improved circuit principle is shown in figure 5. The left side is the chip STC control, and the right side is the improved circuit. Compared with the actual lighting circuit diagram in figure 4, the schematic in figure 5 improves the switch at the same high voltage end with the same ground line end and three lights that were previously controlled by the same switch. The connection ends of the three lamps are drawn out respectively, the wiring diagram of D1, D4 and D7 in figure 5 (the leftmost column in the diagram) is corresponding to the relay control switch. The STC89C52P1 port of the controller is the input, the signal sent through the P0 port is sent to each control relay, and the switch of the relay is controlled to realize the intelligent control of each lamp. In the same way, the control of D2, D5, D8 and D3, D6, D9 was realized.

![Figure 5. Improved circuit schematic](image)

3. Realization of the improved lighting circuit

We have carried on the actual circuit improvement on the single chip computer and the circuit board, as shown in figure 6.

![Figure 6. Improvement and realization of illumination control circuit](image)
The STC89C52 chip control board that outputs the control signal is on the right side. The circuit board is on the left on which the white for nine three-row lights are imitating the classroom three-row switch-controlled three-row lamps. The square blue block next to the white indicator is the added relay control. 8-bit port P0 is as the output of control signal that controls the work of each relay and realizes the individual intelligent control of each lamp. The program debugging is shown in figure 7.

During debugging, the keyboard input signal is used to input the P1 port and output from the P0 port. The small windows in the test interface Parallel Port0 and Parallel Port1 show normal input and output signals. Pins shows that the port high and low level value, and pins at P0 port corresponds to the control level of relay.

After the control program was burned and tested successfully, we verified the control effect of the improved circuit. Electrical initialization of the circuit, as shown in figure 8, each light detects whether it is working properly, and nine indicators are lit to indicate that it is normal. The effect of normal work is shown in figure 9.

4. Conclusion
In this paper, aiming at the goal of saving energy in intelligent classroom, we put forward the improved circuit principle, simple realization on the controller STC89X52 and circuit board, and successfully debug. Each lamp can be controlled separately according to the control signal. The advantage of the measure is that there is no need to change the distribution of existing classroom lamps. This part of the work is the basis of the intelligent control of the whole lighting system.

The camera of the standardized classroom is used to collect the image, and the face recognition algorithm is adopted to process the image. We can analyze the information of number and location of
students in the classroom. According to the lighting numbers in database of classroom, intelligent control lighting is realized. By using the data information obtained from image analysis, the students can be provided with the services of querying the self-study classroom and so on.

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