ISSN: 2710-0588 DOI: 10.29556/FSE.202104_1(1).0005

Design of Control System for Energy-saving Street Lamp

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Abstract

Nowadays, with the rapid development of science and technology, great changes have taken place in the lighting field. It is necessary to study the urban intelligent energy-saving street lamp control system, which can save energy and reduce the consumption of manpower and material resources. This paper designs and builds an energy-saving street lamp control system through single chip computer and related hardware facilities. The energy-saving street lamp closes during the day, and some people or vehicles come at night, and the street lamp automatically lights up. When vehicles or pedestrians pass by, the street lights are automatically turned off for one minute. Even if pedestrians pass by during the day, the system will not be bright, this can save lots of energy. This set of intelligent energy street lamp control system is simple and practical in design, and has a high cost-effective ratio. It is very suitable for road construction in major cities.

Keywords

Energy Saving and Environmental Protection; Intelligent Street Lamp; Simple and Practical.

1. Introduction

According to relevant data, China's current lighting power consumption accounts for about 20% of the total power generation, while urban road lighting accounts for about 30% of all lighting power. According to relevant survey data, most urban street lamps in China are traditional street lamps. These street lamps do not have intelligent energy-saving system management, resulting in huge power waste and unstable communication. At present, many urban street lamps in China cannot make full use of energy and require huge amounts of energy. Maintenance and management costs. The second is that the current street lighting system installs timing equipment in the distribution box to automatically turn on or off the street lights according to the scheduled time. Therefore, the street lights are always on for people and no one, and the time to turn on or off the street lights cannot be automatically adjusted according to the season. It needs to be set artificially, which causes a huge labor cost and time cost consumption, and it is not possible to monitor the running status of the street lamp in real time and collect the running data of the street lamp.

2. Overall design

The intelligent energy-saving street lamp control system is composed of the smallest single-chip microcomputer system, plus some related sensor modules that can intelligently identify daytime and pedestrians, such as infrared sensor modules, photo resistor modules, etc. In order to be able to realize this design, this article also designed a power supply module, signal acquisition module and so on. The working mode of the intelligent energy-saving street lamp control system designed in this paper is that the street lamp is turned off during the day, and the street lamp is continuously illuminated at night when there are people. After the passerby leaves, the street lamp is turned off with a delay. This system works in a simple way but is intelligent and energy-saving, which can achieve the design theory Requirements [2]. The overall design block diagram is shown in Figure 1:

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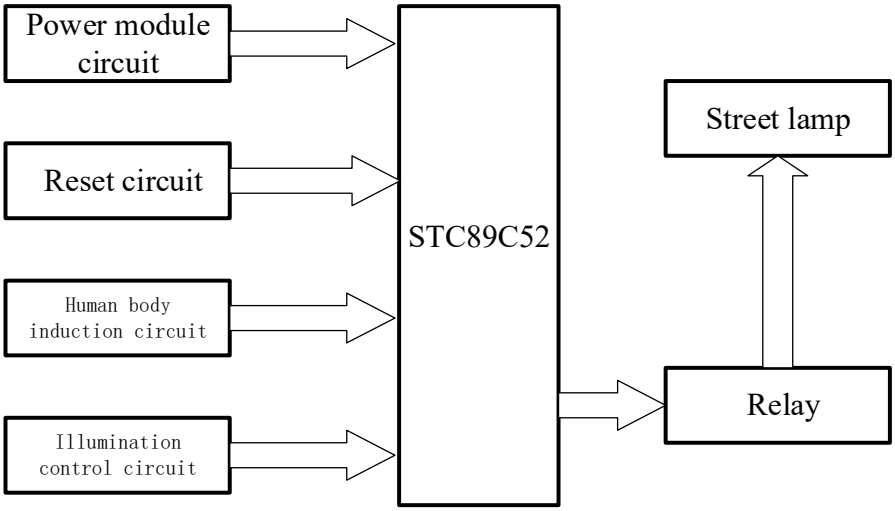

Figure 1. Overall design

3. Hardware circuit design

3.1. STC89C52 MCU

STC89C52 is a single-chip microcomputer produced by STC, which has low power consumption and a high-performance CMOS 8-bit microcontroller. The programmable flash memory has 8K. STC89C52 uses the classic MCS-51 core, but many improvements have been made to make the chip have features that the traditional method 51MCU does not have. STC89C52 integrates an intelligent 8-bit CPU and programmable flash memory on a single chip, providing highly flexible and ultra-efficient solutions for many embedded control applications.

3.2. The smallest system of MCU

The smallest system of MCU consists of a clock circuit and a reset circuit, as shown in Figure 2. This design uses the STC89C52 series of single-chip microcomputers. Compared with other single-chip microcomputers, this type of single-chip microcomputer has rich resources and outstanding advantages, which is very suitable for the design of this intelligent energy-saving street lamp control system.

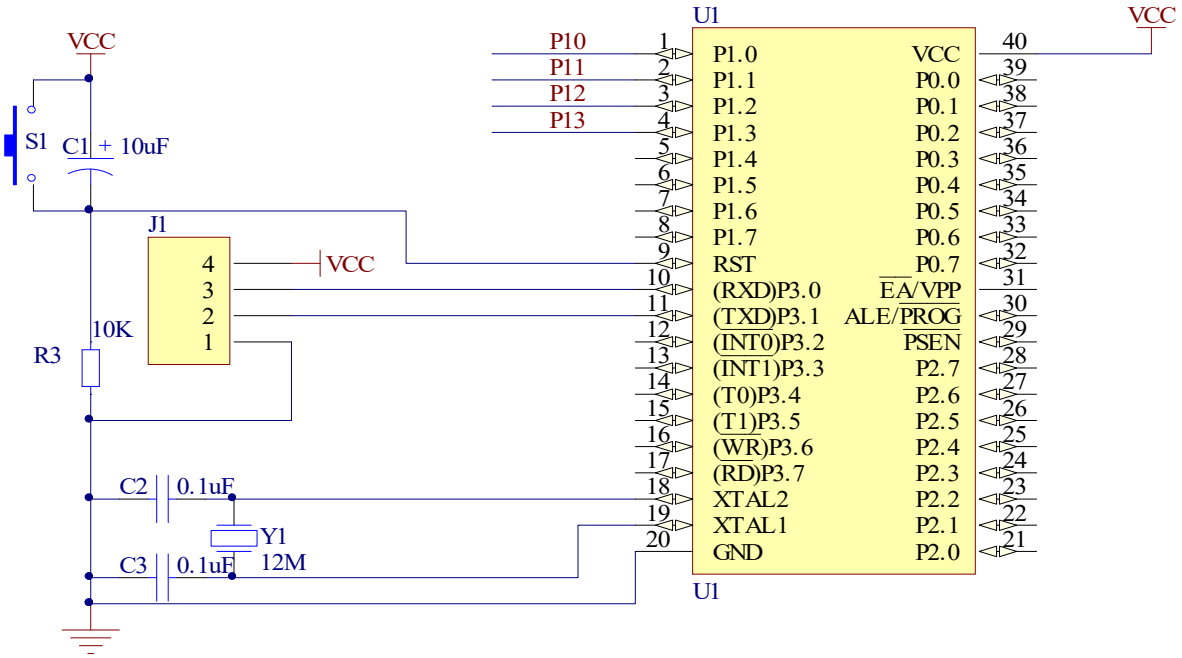

Figure 2. The smallest system of MCU

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The power supply of the single-chip microcomputer control part in the intelligent energy-saving street light control system designed this time is provided by external dry batteries. The number of dry batteries is determined according to the operating voltage of the single-chip microcomputer. Usually three dry batteries are required to drive the operation of the single-chip microcomputer. The reset circuit of this intelligent energy-saving street system has a huge effect. It is used to complete the startup process of the single-chip microcomputer. At the same time, when the program runs away, it is used to reset the program and let the program continue to execute from the beginning, which makes a huge contribution to the operation of the intelligent energy-saving street light control system. In order to make the reset circuit better serve the intelligent energy-saving street lamp control system, we designed an external manual button reset circuit.

3.3. Power module

The power module of the intelligent energy-saving street lamp control system is relatively simple. According to the selected single-chip microcomputer chip model, the power supply of the single-chip microcomputer is provided by three dry batteries in series. Through multiple tests, it is tested that the single-chip microcomputer can operate stably, and the dry battery is used as the power supply. Affordable and convenient. The circuit design of this power module uses a circuit diagram as shown in Figure 3. This power circuit is designed with a light-emitting indicator to show whether the power is on or not, and it is also convenient for later maintenance and repair.

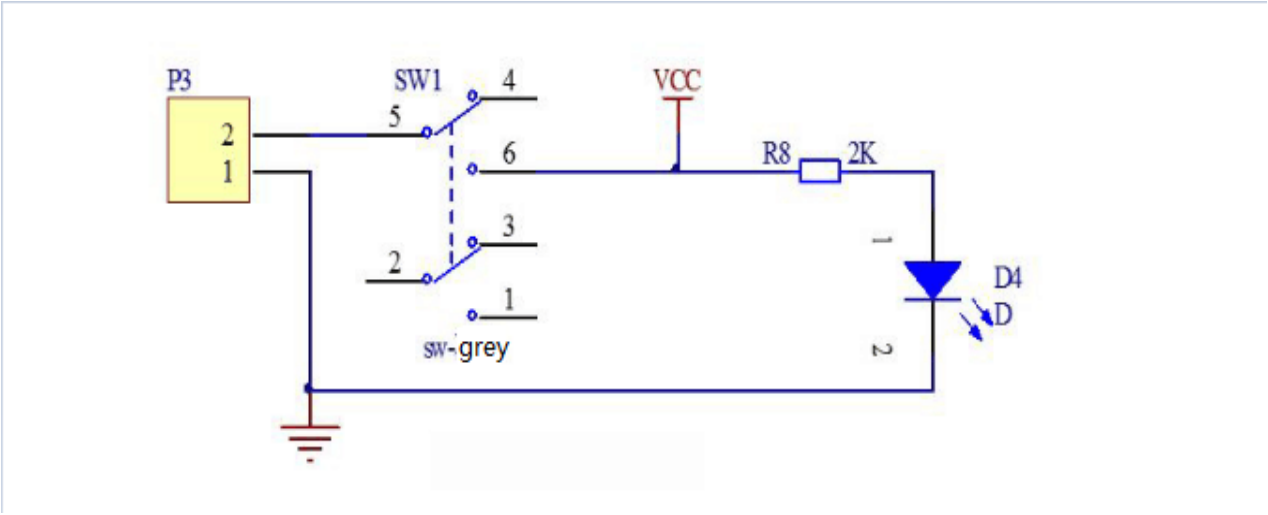

Figure 3. Power module

3.4. Street lamp drive circuit

The street lamp drive circuit is the circuit of the output module of the intelligent energy-saving street lamp control system designed this time. The operation of this module is to convert the sensed information into electrical signals through the previously designed infrared pyroelectric module and photoresistor module and transmit it to the single-chip microcomputer. The single-chip microcomputer outputs a level signal through calculation, and the output level signal is used to drive the S8550 transistor, and then control the relay to close or open. In order to better display the pull-in status of the relay, it is necessary to design an indicator light. When the relay is closed, the indicator light will glow, which also means that the street light is always on at this time. If the light bulb is connected at this time, the light bulb will glow. The light bulb needs to be equipped with an additional power supply, that is, the relay here is equivalent to the intelligent switch of the intelligent energy-saving street light control system. The circuit diagram is shown as in Fig. 4.

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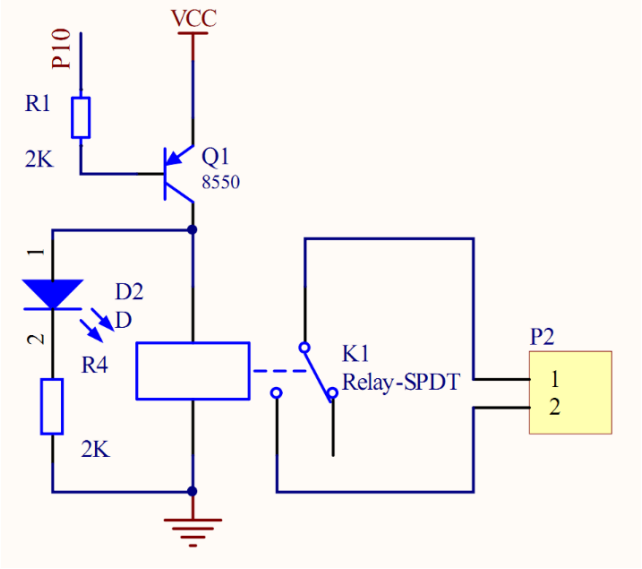

Figure 4. Street lamp drive circuit

3.5. Photosensitive circuit design

In order to be able to recognize day and night more intelligently, the intelligent energy-saving street lamp control system also needs to design a detection circuit for light intensity. This control system can only be turned on when there are people at night to illuminate the road. However, this light intensity detection circuit needs to be improved, because the weather is not immediately dawn or immediately dark, and there is a change process, which requires further processing and the photosensitive circuit. The detailed design schematic diagram of the photosensitive circuit is shown as in Fig. 5.

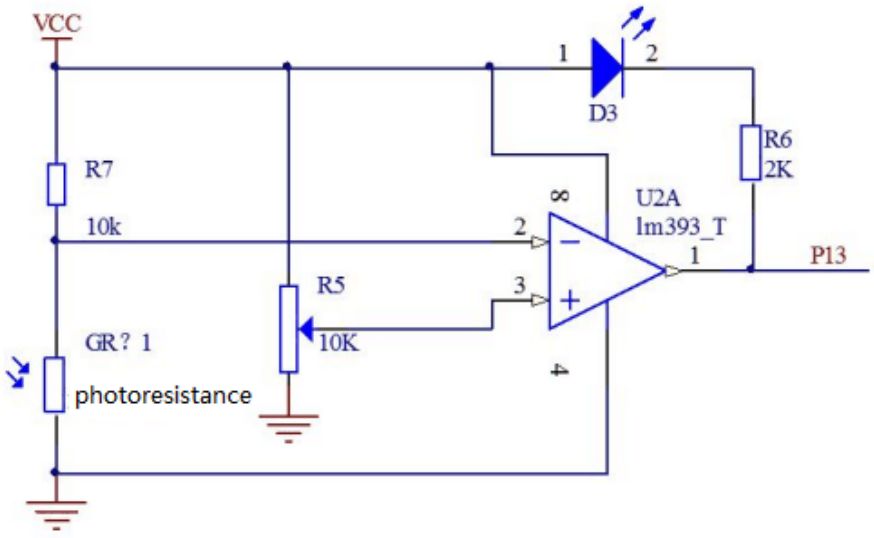

Figure 5. Photosensitive circuit diagram

By understanding the above photosensitive circuit diagram, the circuit schematic diagram is relatively simple and easy to understand. The working method of this circuit can be simply summarized as: compare the voltage of the two input terminals 2 and 3 through a comparator, and output a high-level signal or low-level signal. The level signal is sent to the single-chip microcomputer through P13, and the street lamp lighting condition is controlled through the judgment of the single-chip microcomputer. As a result, intelligent control of street lights to identify day and night can be completed.

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4. Program design of intelligent energy-saving street lamp control system

The intelligent energy-saving street light control system designed this time can complete the intelligent energy-saving control of street lights with only one main program. Compared with other energy-saving street light control systems, it is much simpler. The program code designed this time is simple and easy to understand, which can ensure intelligent energy saving. The efficient and stable operation of the street lamp control system reduces the failure rate and reduces the trouble caused by daily maintenance. However, other intelligent street lamp control system programs are complex, which can easily cause frequent bugs, affect the working conditions of street lamps, and invisibly increase the cost of daily maintenance and repair. The program block diagram of the intelligent energy-saving street lamp control system designed this time is shown in Figure 6.

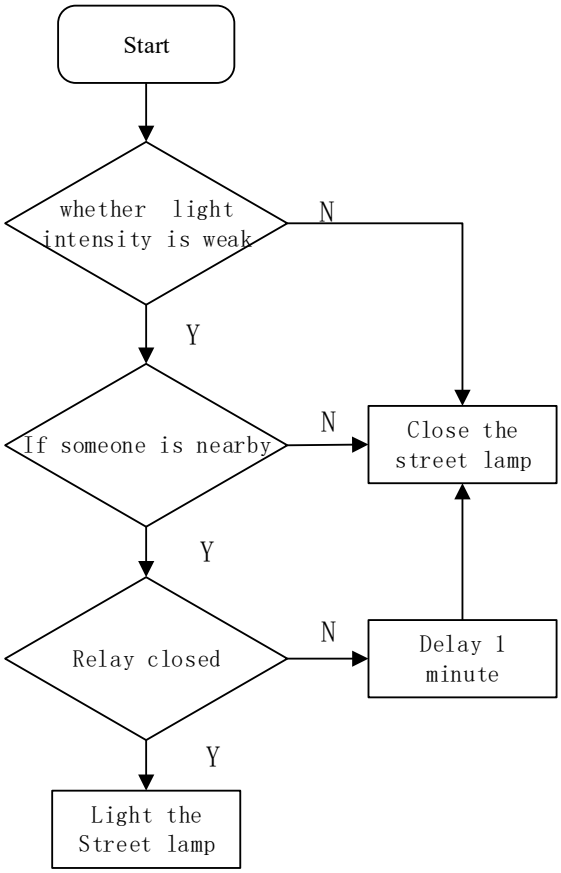

Figure 6. System main program flow chart

When designing the main program of this system, several states need to be judged. First, judge the intensity of light, then judge whether pedestrians or vehicles pass by, and finally judge the state of continuous lighting of street lights and one-minute delay of lighting. When someone passes by the intelligent street light controlled by this system at night, the street light will be turned on and the street light will be turned off automatically with a one-minute delay. If a pedestrian resets after the delay time within one minute, the street light will be turned off again with a one-minute delay.

5. System debugging

5.1. System software simulation debugging

The software used in the circuit simulation diagram design is Proteus, which is the EDA tool software released by the British Laboratory Electronics Center. Its simulation ability is very

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powerful, can simulate many costly circuits, and has made a great contribution to industrial design. Although domestic use has just begun, it is favored by many electrical engineers. The simulation results show that the power indicator is always on when the system is working normally, the identification indicator of the infrared pyroelectric sensor is always on at night when there are people, the indicator of the photoresistor is always on, and the lighting system of the street lamp is turned on. The intelligent energy-saving street light control system is a system simulation diagram for various situations. In addition, when the pedestrian leaves, the intelligent energy-saving street light control system will control the street light to delay turning off for one minute.

5.2. System hardware debugging

The first is the debugging of the smallest system circuit of MCU. This part of the circuit can be debugged together with the power circuit module. After the debugging is completed, there is no problem and you can continue to debug the circuit of the photoresistor part. When there is no light, the indicator light of the photosensitive circuit part will light up, if the indicator light is always on, then it proves that there is no problem with the photoresistor part of the circuit. Next, debug the infrared pyroelectric module circuit and place the sensor near the pedestrian. If the indicator light of the infrared pyroelectric module circuit is on, it proves that the module is ok. Finally, we can do a general debugging of the intelligent energy-saving street lamp control system together with the street lamp drive circuit to see if the system can operate stably and correctly according to the expected results.

Through system software debugging and hardware debugging, the system can realize that the light is on when someone approaches, the light is off when no one approaches, the light is off when the light is strong during the day, and the light is off when the light is weak at night, and the performance is stable and reliable.

6. Conclusion

The design and application of the intelligent energy-saving street lamp control system has made a huge contribution to society's energy saving, emission reduction, and green travel. The intelligent energy-saving street lamp control system designed this time is energy-saving, environmentally friendly, cost-effective, safe and reliable. Despite this, this system still has a lot of room for improvement. With the continuous development of society, the intelligent energy-saving street lamp control system will bring great convenience for our urban social life.

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