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Design and Implementation of Automobile Lighting Control Based on Virtual Simulation Technology

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Abstract: With the increasing development of single-chip microcomputer technology, its applications are becoming more and more widespread. This article designs an automobile lighting control system based on the AT89S52 single-chip microcomputer. The system mainly includes the front main lights, left turn signals, right turn signals, and reverse lights of the automobile. Virtual simulation technology is used to assist in software and hardware debugging. Combined with the reset circuit and drive circuit, instructions are input through keys, signals are input to the single-chip microcomputer. After receiving the instructions, the single-chip microcomputer outputs high and low level control signals to control the on, off, and flashing of the indicator lights, realizing the indication function of automobile lights with flexible applications.

Keywords: Single-chip microcomputer; Automobile lights; Virtual simulation

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1. Introduction

Automobile lights are essential for driving safety. In addition to providing illumination, automobile lights also serve as warning signals for pedestrians and other vehicles during maneuvers such as turning, meeting, and braking. For example, the control of automobile turn signals is a typical case. Automobile signal lights are sign signals of the vehicle's movement direction and body status, directly affecting the safe driving of the vehicle. With the continuous increase in the total number of automobiles and the improvement of automobile intelligence, people have put forward higher requirements for the safety performance and work efficiency of automobiles. As an important part related to the safety and work efficiency of automobiles, the signal light system has gradually attracted people's attention[1-3]. Currently, the signal indication on automobiles is generally in the form of lights. The automobile lighting system controller based on a single-chip microcomputer has been a hot topic in the field of automotive electronics technology research in recent years.

2. Design of the automobile lighting control system

2.1. Overall system design

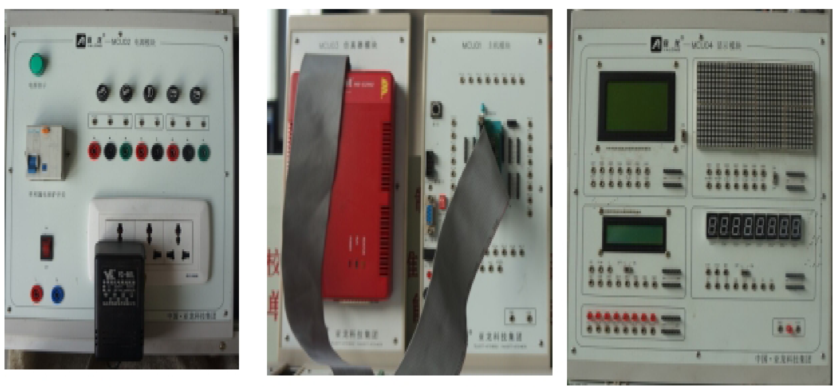
The automobile lighting control system uses the AT89S52 single-chip microcomputer as the core device to design the lighting controller. The automobile lights mainly include the front main lights, reverse lights, left turn signals, and right turn signals. Their states are shown in **Table 1**, the Automobile Light Operation Table[4]. The state of the lights is controlled by switches, and an alarm will be given when a fault occurs.

Table 1. Vehicle indicator operating table

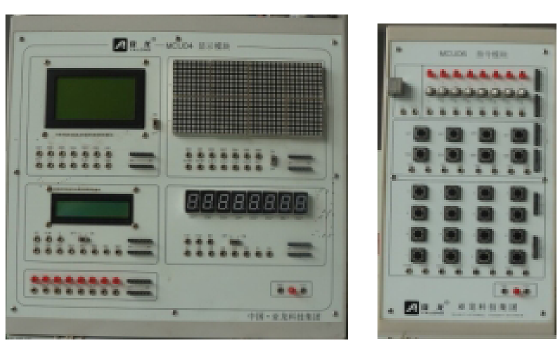
Driver's Instruction	Right Turn Indicator		Front Main Indicator	Reverse Indicator
	Left Turn Indicator	Right Turn Indicator		
No Instruction Issued	Off	Off	Off	Off
Left-Turn Instruction	Flashing	Off	Off	Off
Right-Turn Instruction	Off	Flashing	Off	Off
Turn on the Main Indicator	Off	Off	On	Off
Turn on the Reverse Light	On	On	Off	Off
Turn on Both Left and Right Lights Simultaneously	Off	Off	Off	Off

2.2. System hardware design

The hardware part of this system mainly consists of a computer, a single-chip microcomputer, a display module, and an input instruction module. The modules used in this design are shown in **Figure 1**.



(a) Power Supply Module (b) Main Machine Module



(c) Display Module (d) Key Module

Figure 1. Main modules used in this design

2.2.1. AT89S52 single-chip microcomputer

This system selects the AT89S52 single-chip microcomputer as the control core of the entire system. The AT89S52 single-chip microcomputer is a low-power-consumption and high-performance CMOS 8-bit micro-controller with 8K system-programmable Flash memory. It is manufactured using Atmel's high-density non-volatile memory technology and is fully compatible with the instructions and pins of industrial 80C51 products. The on-chip Flash allows in-system programming of the program memory and is also suitable for conventional programmers[5-6]. With a smart 8-bit CPU and in-system programmable Flash on a single chip, the AT89S52 single-chip microcomputer provides a highly flexible and cost-effective solution for many embedded control systems.

2.2.2. Crystal oscillator

A crystal oscillator, abbreviated as “crystal”, is a stable electronic oscillator that can provide a high-precision clock signal. The crystal oscillator provides a stable and accurate time reference for the single-chip microcomputer, allowing the internal synchronous operation of the single-chip microcomputer and enabling it to work at a reliable frequency. The clock speed of the single-chip microcomputer can be controlled by adjusting the oscillation frequency of the crystal. In this design, the crystal oscillator X1 = 12 MHz.

2.2.3. Keys

Independent keys are used. Independent keys do not share the input port with other keys and are connected to the single-chip microcomputer through external pin interfaces. Pressing a key can provide an event signal for the single-chip microcomputer, and the single-chip microcomputer will respond accordingly after receiving the signal. Each independent key is connected to the single-chip microcomputer through an I/O port line, and the working state of each key does not affect the working state of other I/O ports. In this design, the key input end is the interface P1 port, and the output end is connected to the light-emitting diodes D1-D4. The switches are K1-K4, which are respectively connected to P1.0-P1.3.

2.3. Software design of the automobile lighting control system

The program design flowchart is shown in **Figure 1**. The program is written in the Mediwin environment. The system adopts a modular design, including system initialization, input module, display module, etc. The technical solution of this system is as follows: First, judge the state of the main light switch. If it is pressed, the main light will be turned on. If the main light switch is not pressed, then judge the state of the reverse light switch. If the reverse light switch is pressed, the reverse light will be turned on. If not, then judge the states of the left and right turn signal switches in sequence. The lighting control program is written according to the flowchart[7-9].

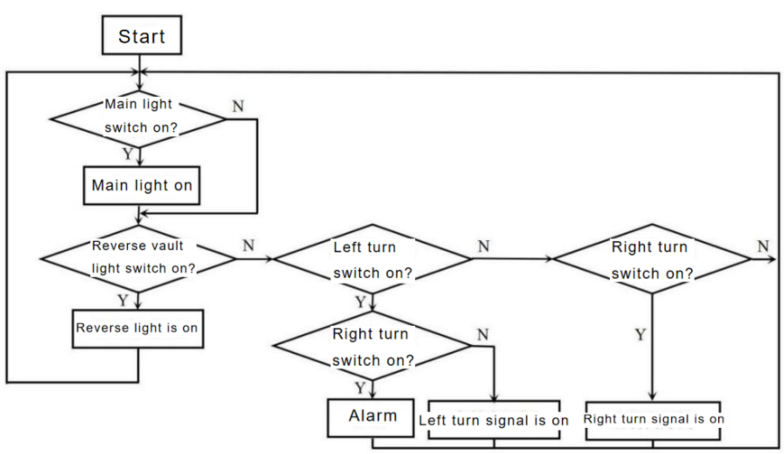


Figure 1. Program design flowchart

3. Virtual simulation

To improve the design efficiency and reduce the equipment damage rate, Proteus software simulation is carried out before using the equipment for debugging, as shown in **Figure 2**. The compiled program is imported into the single-chip microcomputer. Key instructions: P1.0 is set to be connected to the left turn signal D1 controlled by the switch K1. When the switch K1 is pressed, D1 flashes. P1.1 is connected to the right turn signal D2 controlled by the switch K2. When the switch K2 is pressed, D2 flashes. P1.2 is connected to the front main light D3 controlled by the switch K3. When the switch K3 is pressed, D3 is turned on. When the switch K3 is pressed, D1 and D2 are turned on simultaneously as the reverse lights[10].

D4 is the fault light. When the switches K3 and K4 are pressed simultaneously, the fault light D4 is turned on.

K1-K4 Independent Keys

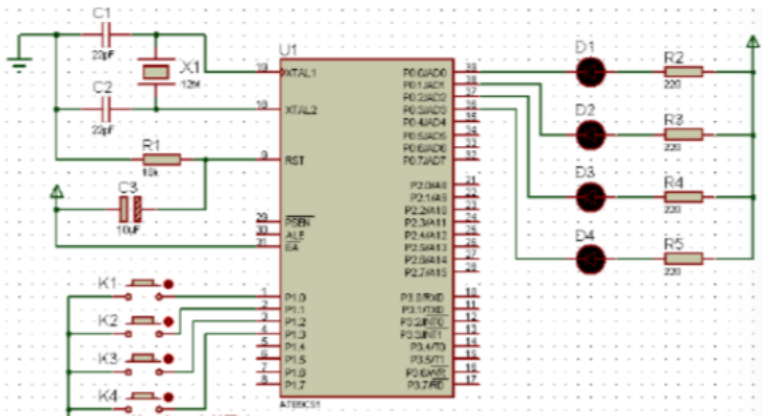


Figure 2. Automobile lighting control simulation diagram

4. Software and hardware debugging of the automobile lighting control system

After the simulation is completed, power on the power supply module of the system, insert the data cable of the integrated circuit CPU, and use the serial port module to achieve communication between the single-chip microcomputer and the upper-computer through RS232. Import the error-free compiled program into the AT89S52 single-chip microcomputer and run the debugging[11-12]. Some debugging is shown in **Figure 3**. Working requirements: The keys K1-K4 correspond to controlling the states of the lights D1-D4 in sequence. The left and right turn signals cannot flash simultaneously, and at most one light can be turned on at the same time.

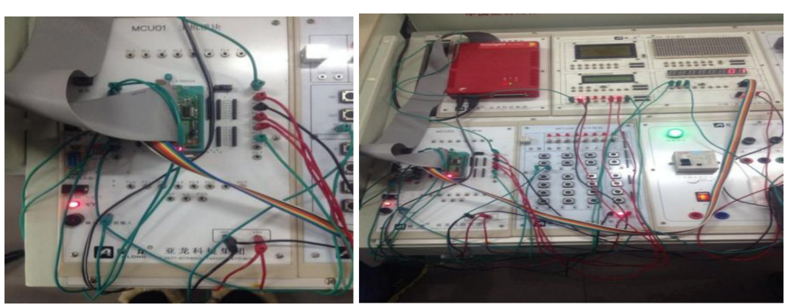


Figure 3. Software and hardware debugging diagram of the automobile lighting control

5. Conclusion

This article uses the AT89S52 single-chip microcomputer to control the front main lights, left turn signals, right turn signals, and reverse lights of the automobile. Combined with virtual simulation, instructions are input through keys, signals are input to the single-chip microcomputer. After receiving the instructions, the single-chip microcomputer outputs high/low levels to control the on, off, and flashing of the indicator lights, realizing the indication control of automobile lights. It is easy to operate and has flexible applications[13-15].

Disclosure statement

The author declares no conflict of interest.

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