

## Study on Ultrasound Visual Protection System

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**Abstract:** In order to realize the intellectualization of vision protection, a vision protector based on single chip computer is studied. The hardware circuit and software design are also carried out. The main controller is STC89C52, Ranging Principle of HC-sr04 Ultrasound Sensor, Main Controller and Alarm Device, with temperature measurement and clock function, LCD 1602 LCD-Display. C language is used to program and modular design is adopted, including display, ultrasonic ranging, light intensity detection, timing, alarm, key and power module. It has the functions of distance alarm, light intensity alarm and timed alarm. When the distance between users and books, ambient light intensity and learning time do not meet the preset value, alarm will be generated to achieve the purpose of protecting eyesight.

### 1. Introduction

According to China Youth Eye Behavior Big Data Report, only 45.4% of the students use their eyes more than one foot, 28.3% use their eyes less than 20 cm, 83.2% use their eyes more than 40 minutes in a single continuous short distance, of which 53.5% use their eyes more than 120 minutes, 33.7% use their eyes under less than 200 lux of ambient light, which is liable to cause the burden of eyes and cause proximity. Occurrence and development of vision [1]

Professor Kathryn Saunders pointed out, "According to the incidence of myopia and high myopia in children and adolescents, about 20% of these children and adolescents will develop high myopia (myopia degree) in the future, and high myopia can cause many serious complications, such as cataract, macular disease, retinal detachment, which will greatly increase the risk of permanent loss of vision. Danger and related suffering." [2]

As the country with the highest rate of myopia among adolescents in the world, the situation of visual health in China is extremely serious. It is very important to prevent and control the development of low myopia into high myopia. Scientific use of the eye is the most basic, we need to correct sitting posture, that is, the eye is about a foot from the book, chest is about a punch from the table, the hand is about an inch from the tip of the pen when shaking the pen.

### 2. Overall Research Project

#### 2.1. Research Planning

The main circuit with 52 single chip computer as the core realizes sitting posture correction prompt, temperature detection, clock display, manual adjustment of light brightness and alarm device. Firstly, the design of each unit circuit, the selection of components, and the simulation debugging are carried out. Then, each unit circuit is integrated to form a complete circuit, and the overall system debugging is carried out. Finally, the realizability of the function was tested, and a real vision protector was made, which was used in social life practice.

The main functions are as follows: displaying the room temperature and date of the environment through LCD display screen; adjusting the brightness of light manually so that users can choose their own more appropriate brightness; using ultrasonic sensor to measure distance to remind users whether the sitting posture is standard; when there is a need to remind, an alarm device will send

out alarm information.

## 2.2. Design Scheme

The main controller uses STC89C52 single chip computer, LCD1602 display screen, DS13C887 clock chip, DS18B20 temperature sensor. Ultrasound sensor is the core component of sitting posture correction. It can measure the distance between the user and the desk lamp by using the function of ultrasonic distance measurement. When the user is within a certain range, there is no hint; if it is below the minimum threshold, the sensor will send a feedback signal. The MCU receives the feedback signal and immediately drives the alarm device to remind the user. If it is above the maximum threshold, the lamp will automatically cut off the power supply to save energy. The general block diagram of the system is shown in Figure. 1. [3]

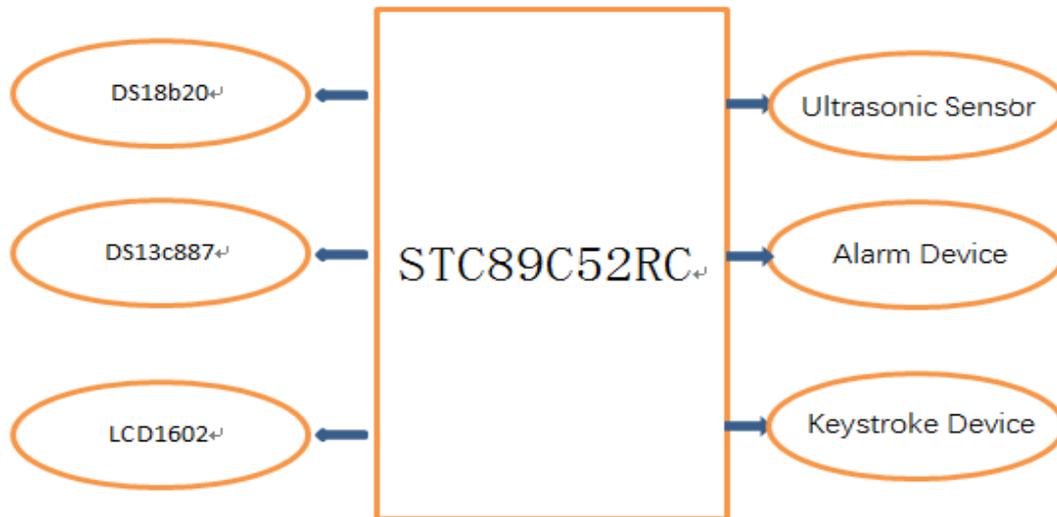


Figure 1 General block diagram of the system

## 2.3. Working Principle

The transmitter emits ultrasonic waves, which are reflected back when encountering obstacles, and the receiver receives the return wave. At the same time, the main controller starts timing, continues to receive the return wave, and calculates the time difference. According to the propagation speed of the wave in the air, the test distance is calculated. [4]

The whole working process mainly revolves around the ultrasonic ranging. Display the current time and record the continuous working time. Display the ambient temperature and effectively control the working ambient temperature. Realize manual adjustment of light brightness, choose a comfortable eye brightness, to achieve the effect of eye protection. When working, the system has been working, real-time monitoring users' sitting posture, real-time ranging by ultrasonic module; when you are below the minimum of 45 cm, the main controller triggers buzzer alarm, reminding users to adjust their sitting posture in time, when the maximum of 2 m or more, the system will automatically cut off the power supply of the lights.

## 3. Building Function Modules

In order to realize the function of the system, it mainly constructs the main controller, display module, alarm module, sitting posture detection module, temperature display module, clock module, LED module, etc. Under the control of the main controller, the system runs accurately and cooperatively to achieve vision protection. The corresponding main circuit is shown in Figure 2.

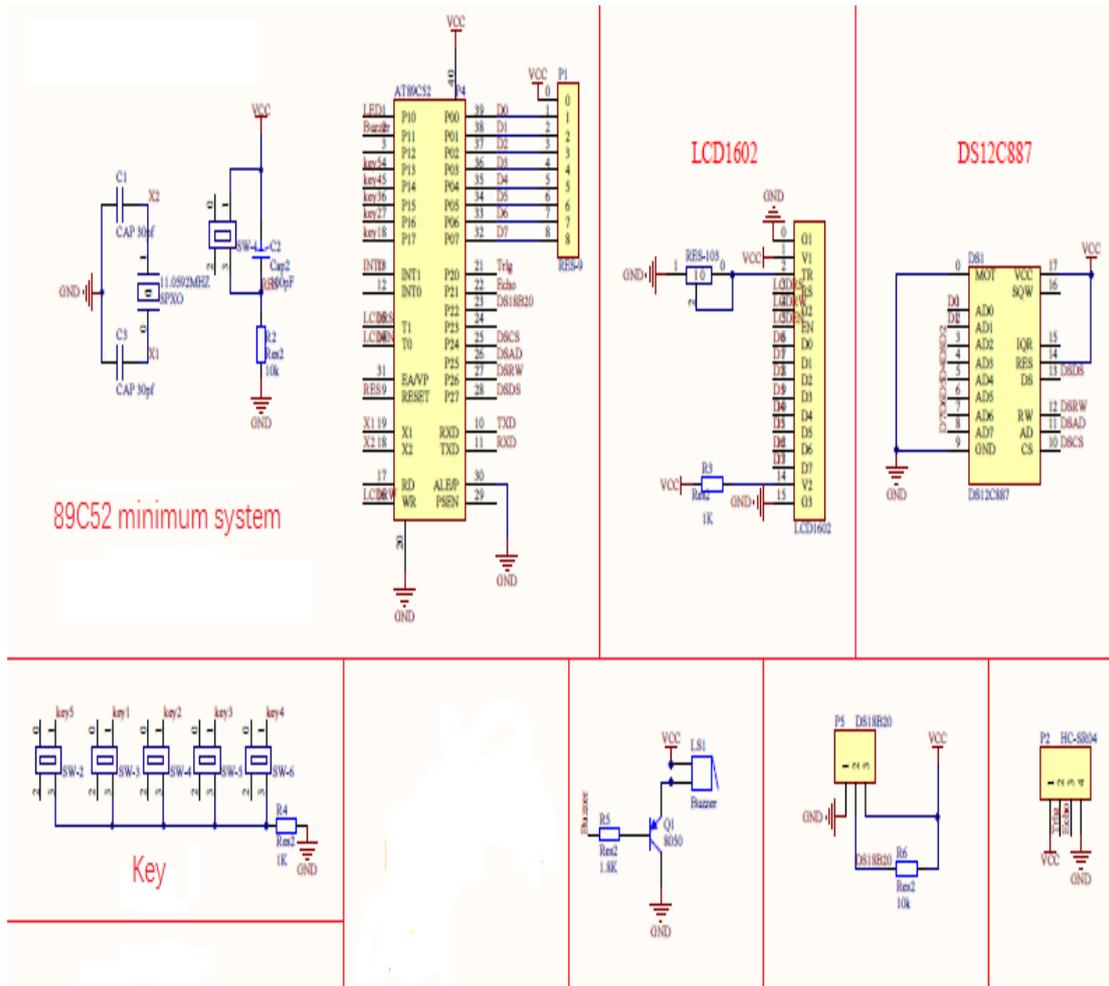


Figure 2 Main circuit diagram

### 3.1. Main Controller

According to the requirement of the system, STC89C52 single chip computer is used as the processing controller of intelligent vision protector. The key function of the system is to realize automatic alarm and reminder, to process the signal collected by ultrasound, to process the temperature coefficient taken by DS18B20, and to display it on the LCD screen. It has the advantages of low power consumption, ultra-low price, high speed, high reliability, PDIP packaging, and fully conforms to the core controller of the system. [5]

STC89C52 MCU is composed of three main functional units: central processing unit, program memory (ROM), data memory (RAM), timing/counter, parallel interface, serial interface and interrupt system. The three main functional units are data bus, address bus and control bus. The core is in-chip mask ROM program memory.

### 3.2. Display Module

LCD1602 LCD display screen is a dot matrix module, which can display numbers, letters, symbols, etc. Each dot matrix character can display a character, but can not display graphics. This module has the advantages of adjustable contrast, internal reset circuit and low power consumption.

LCD1602 has 16 pins. The three pins used in programming are: data command selector, R read and write selector, enabling signal terminal. In the process of using, the three pins are mainly used to initialize, write commands and write data.

### 3.3. Alarm Module

The main body of the alarm device is a passive buzzer, which is an electronic loudspeaker. It is usually represented by the letter 'H' or 'HA' in the circuit diagram.

The alarm device can work only by using triode to drive buzzer. When the detected distance is less than the set distance, the alarm will be prompted. When the maximum range of the set distance is larger, the power supply will be disconnected. In MCU, using its timing function, a square wave of oscillating pulse is generated through the I/O port to produce a high-level output, which makes the transistor in the on-state and the current through the buzzer to make the buzzer sound. Without this oscillating square wave, the buzzer is at a low level, while the transistor is cut off and will not make sound without the current flowing through the buzzer.

### 3.4. Sitting Posture Detection Module

Based on the principle of ultrasonic sensor ranging, the specific ranging scheme is to take the distance from the desk lamp to the user's chest as one side, and the distance from the user's eyes to the desktop as the other side, form a triangle, and calculate the third side by Pythagorean theorem. When the detected distance is less than 45 cm, the alarm device triggers to remind the user to adjust the sitting posture, and automatically disconnects the power supply when the distance is greater than 2 m, so as to achieve the effect of energy saving.

Ultrasound uses HC-SR04 type sensor, which has a non-contact distance sensing function of 2cm-400cm, ranging accuracy can be up to 3mm, including ultrasonic transmitter, receiver and control circuit. [6] [7]

### 3.5. Temperature Module

Temperature acquisition system chooses temperature sensor DS18B20, whose core function is to read digital directly. User programmable precision is 9, 10, 11 or 12, increasing by 0.5, 0.25, 0.125 and 0.625, respectively. The default precision is 12 bits when the sensor is powered on. The low power consumption waiting state is maintained before starting. When temperature measurement or AD conversion is needed, the master controller will send out. Command, the generated data is stored in a high-speed register in one or two bytes, while the sensor remains in a waiting state. [8]

### 3.6. Clock Module

The selected clock chip is DS12C887, which is a clock chip with crystal oscillator and lithium battery. It will not stop timing due to external power failure.

DS12C887 clock chip has two bus modes, one is MOTOROLA mode INTEL mode, the other is MOTOROLA mode when pin M chooses to connect VCC, and the other is INTEL mode when pin M is suspended or grounded. At this time, clock chips are also two power supply modes. When VCC is higher than 4.25V, the chip can be controlled by external programs. When VCC is lower than 4.25V, the chip enters the write protection state and the output is in high resistance state. When VCC is lower than 3V, the chip will automatically switch to internal battery power supply. [9]

### 3.7. LED Key Module

The final effect of the system is validated by the LED module. The light-emitting elements are replaced by the light-emitting secondary tube, and the brightness adjustment is completed by the key module and the main controller. The principle of PWM broadcasting is used to control the lamp, control the duty cycle of PWM to adjust the current, realize the manual adjustment of the lamp, select the comfortable lamp brightness, so as to protect the eyesight.

$$I_L = \frac{t_{on}}{T} I \quad (1)$$

Using the above formula, the current can be controlled by adjusting the duty cycle of PWM.

The main function of the key module is to adjust the brightness of the lamp, and to adjust the brightness and direction of the lamp by manual keys, so that users can choose the brightness of comfortable eyes.

## 4. System Software Design

The main program of the controller is written in C language. The general flow chart of the

system is shown in Figure 3.

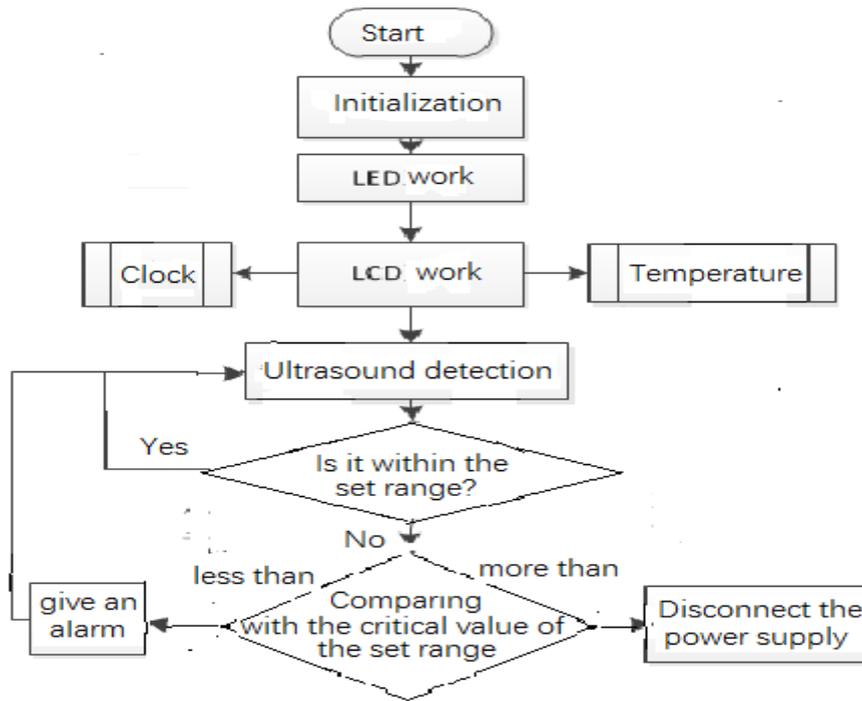


Figure 3 General flow chat of the system

When the system starts to work, it initializes first. Then light up the LED, light up the LCD1602 display, drive the temperature sensor and the clock chip, respectively, to get the information of two sensors, and display it to the LCD1602 display screen by the main controller analysis, drive HC-sr04 to start ranging, receive the signal from the transmitter and reflect back by the receiver, and feedback to the main controller to get the measured distance, and the program set. If the distance is less than the set distance, give the alarm a high level, urge it to send out the alarm, and return to continue monitoring, if in the set range, then continue testing, if larger than the maximum detection range, indicating that no one is using at this time, then automatically disconnect the power supply, to achieve the purpose of saving energy [11].

## 5. Conclusion

On the hardware platform, a kind of visual protector based on STC89C52 MCU is made. The design circuit is modular and programmed in C language. It is easy to modify and misappropriate. It can be used in the design of other controllers and has practicability. After functional testing, it basically meets the design requirements and achieves the basic functions of each module. The idea of using single-chip computer to make vision protector promotes the practical application of intelligent vision protection.

The research of visual acuity protection system only takes into account the aspects of writing and reading, without considering other factors that cause myopia, such as watching TV for a long time, computer, playing mobile phones, etc. It still needs further development and application.

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