Design and implementation of multifunctional green induction lamp

Changyong Zhang¹, Lixin Yang, Lang Tan, Zhihua Bai and Sheng Liu
Beijing Smart-chip Microelectronics Technology Co., Ltd. Beijing 100192, China

¹Email: william_2882@sina.com

Abstract. In order to meet the needs of society for energy-saving lamps, save energy and reduce costs, this paper designed a multi-function green sensor lamp. The system is based on microcomputer, using LED lighting technology, human body infrared sensing principle, photosensitive sensor principle and acoustic sensor principle to realize a new intelligent lighting tool for automatic control of light source lighting. The intelligent control of the illumination duration from both hardware and software enables the light control and voice-activated illumination functions, and has an anti-theft function, which can effectively improve home safety.

1. Introduction
In recent years, with the acceleration of urbanization speed, people have more and more demand for lamps, and the prospects of multi-function induction lamps are even more impressive. Different types of lamps have appeared one after another, such as incandescent lamps, energy-saving lamps and photosensitive sound-control lamps.

However, with the rapid development of science and technology, the quality of national life has rapidly improved. Energy-saving lamps and photosensitive sound-control lamps have not been able to meet people's requirements in terms of functional diversity or energy consumption, and there are many places for improvement. Lv designed an LED lighting system based on touch screen control, which can effectively identify the touch control signals input by users, intelligently adjust the lighting effect of LED light source according to the preset lighting parameters, realize situational lighting, and effectively improve the comfort and artistry of home lighting system [1]. Gong pointed out that under any driving mode, real constant current driving control must be adopted to ensure the continuous, reliable and stable operation of LED lighting [2]. Xu establishes a model for calculating the control duty cycle of a cold white LED light source, and discusses the constraints of the control parameters duty cycle [3]. Li designed a smart dimming lighting system for multiple fields. The lighting system is based on microcomputers, combined with human body sensors and light sensors for environmental monitoring [4]. Under this background, multi-functional green induction lamps have emerged, which makes the development of induction lamps further, not only from the light, but also from the functional requirements to meet the diverse needs of people, while at the same time, ultra-low power consumption and make our life more intelligent and environmentally friendly.

In this paper, it designs a multi-functional green induction lamp system, which has the functions of anti-theft, light control, voice control and so on. The system has the advantages of high sensitivity, low power consumption, low cost and strong adaptability.
The rest of this article is structured as follows. In Section 2, overall design of the system is introduced. Then, hardware design of the system is introduced in Section 3. Software design of the system is further suggested in Section 4. Performance evaluations are provided in Section 5. Finally, we conclude this investigation in Section 6.

2. Overall design of the system
The multi-function induction lamp system is mainly divided into three parts, namely the power supply, the core module of the microcomputer and the display part. Multiple modules are connected to the microcomputer [5], the microcomputer is used to receive the data sent by each module, and feedback according to the data, respectively realizes multiple functions of the system, voice control function, anti-theft function, light control function, control light-emitting time function, illumination function and visible light communication extension [6]. The microcomputer and each module constitute the system, and the principle of each module constitutes the general principle of the system. The overall structure of the system is shown in Figure 1.

3. Hardware design of the system
The overall hardware structure of the system is shown in Figure 2. Among them, the power supply is a device that can output voltage or current to the outside. In this design, due to the realization of using a microcomputer, the computer is used for programming, and the USB interface of the computer can supply voltage to the circuit and act as a power source. It is expected that the mobile power source will eventually be used as a power supply voltage. In the core module part of the microcomputer, the three-wire photoresistor module is the light detection module, and the HC-SR501 module is the human body thermal infrared sensor module. The sound sensor module MK152 is a sound detecting module and is composed of an LED driving module. The system flow is realized by using multiple sensing modules to ensure smooth system flow and realize various system functions. The display section contains a white LED for illumination and a red LED for anti-theft alarm function.
3.1. Microcomputer
The microcontroller has the following advantages.
(1) Microcomputer integrates many multiple functional components on the crystal chip, so it has many functions. It is also because of the high integration of the microcontroller, its small size, with the smallest space to install the chip that can achieve the maximum function.
(2) Each command system of the MCU has very rich conditions to achieve maximum control of the object.
(3) Low operating voltage and low energy consumption for portable systems. Some microcontrollers have voltages as low as 1.8V and operating currents are only a few hundred microamps.
Therefore, this design uses the core module of the microcomputer, and the chip is selected due to the above characteristics. The microcontroller is the core of the design, it is equivalent to the human brain, information processing, command transmission, control each module, ensure that each module works in order, and complete the function according to the design process.

3.2. Light detection module
(1) Module features:
The photosensor is a sensor made of the characteristics of a photosensitive element. The photosensitive element can convert an optical signal into an electrical signal. The output signal of this module is clear, the waveform is stable, and the localized adjustable light sensitivity is suitable for different environments. It is compact, portable and simple to fix.
(2) Reason for choosing this product
The choice of three-wire photoresistor can meet the design requirements, mainly for the detection of light intensity. When the daytime light is sufficient, the light detection module continuously performs the light intensity detection, the system is in the standby state, and does not respond to the sound trigger signal. Only when the light intensity is insufficient, the system enters the working mode, responds to the trigger signal, and decides whether to turn on the light. The lighting module determines the mode of the system, which is a prerequisite for triggering conditions.
Figure 3 is a circuit diagram of a photosensor module.
3.3. Sound detection module

(1) Module features:
   It can detect the sound intensity of the surrounding environment. The sound module is most sensitive to the ambient sound intensity. It has an adjustable ambient sound intensity rating, which is convenient for use in different environments. The microcontroller uses the module to generate high and low level changes to judge the presence or absence of sound. When the ambient sound intensity is lower than a certain decibel, a high level is emitted, and when the ambient sound intensity is higher than a certain decibel, a low level is issued. The detection of the ambient sound intensity by the microcomputer is judged by the high and low level changes, and the small board digital output OUT can directly drive the store relay module to form a voice control switch.

(2) Reason for choosing this product
   This sound detection module is the basic requirement of the Manchu design, low price and high sensitivity. When the system is running, the sound detection module detects the environmental capacity of the surrounding environment. When the ambient volume exceeds a certain decibel, the module outputs a low level, triggering the microcomputer, and the computer performs data analysis on the response to determine whether the state of the light is on or off. However, if the system is in standby mode, that is, the current illumination is sufficient, no matter how high the decibel is, the system will not respond. The circuit diagram is shown in Figure 4 [7].

![Figure 3. Photosensitive sensor module circuit diagram.](image1)

![Figure 4. Sound detection module circuit diagram.](image2)
3.4. Human body infrared sensor module

(1) Module features

This module is aimed at detecting human radiation. Therefore, thermoelectric elements must be very sensitive to infrared radiation with a wavelength of about 10 MW; humans are warm-blooded animals, and the body temperature is normally maintained at 37 degrees, at which temperature people emit about 10 microns of infrared light. Passive infrared detectors work by detecting this 10 micron infrared light. Thermoelectric components are the core components of most infrared sensors. The thermal characteristics of such thermoelectric components make them the best choice for making infrared sensors. When such components receive infrared radiation from the human body, their original charge balance is broken, releasing electrons outward. This release of electrons produces a detectable level change and produces an alarm signal.

(2) Reason for choosing this product

The HC-SR501 consists of a lens, a light sensitive element and a control circuit. The main function of this module is to detect the infrared pyrolysis of the human body and output high and low level changes that can be detected by the microcomputer. This sensing module satisfies the basic requirements of this design, is used for human body detection, data feedback to the microcomputer, and the microcomputer responds to realize the anti-theft function [8]. The physical object is shown in Figure 5 [9].

![Figure 5. Digital Temperature Sensor DS18B20 Pin Diagram.](image)

3.5. LED driver module

The main function of the LED driver module is to integrate multiple LEDs, increase power, and ensure that each LED reaches its own rated voltage and normal lighting. And because of the constant current in the driver module, the life of the LED of the pharmaceutical factory can be effectively utilized. In the scene of large-scale LED use, it can be said that the LED driver module is an indispensable module. The module was not actually used in this experiment, only a single LED was used as a lighting demonstration [10].

4. Software design of the system

The system design is written in C language. It has rich data types, strong language logic and high execution efficiency. The power consumption of the system is greatly reduced.

The main goal of this design is to realize the automatic control of LED lighting time. The difficulty and complexity of the program are also concentrated in this node. According to the system flow in the system design, when the light is dark, the trigger condition of the photosensitive sensor is achieved, and the sound detection is performed. When there is enough decibel sound, the sound sensor feeds low
level, the microcomputer receives the sound sensor signal, issues an instruction to the LED drive module signal, and illuminates the white LED.

When the illumination time is over, the white LED is off and the timer is timed. The system sends data to the sound detection module to continue the sound detection. If the sound signal is received within 5 seconds, the microcontroller issues an instruction to turn on the light and illuminate the white LED for 20 seconds. If within 5 seconds, the sound detection module does not receive the sound signal, send data to the MCU, the MCU feeds back to the LED driver module, the white LED goes out to stop the illumination; after the white LED lights up for 20 seconds, the timer continues to count down for 5 seconds. If within 5 seconds, the sound detection module receives the sound signal, the microcomputer gives the LED drive module, and continues to light the white LED for 20 seconds; if the sound signal is not received within 5 seconds, the microcomputer gives the LED drive module signal, extinguishes the white LED, and the microcomputer. The loop is interrupted.

The above is the automatic control of the illumination duration of the LED in this design. In the program, Count_night0, Count_night1, and Count_night2 are used respectively. Count_night0 means 10 seconds timing; Count_night1 is 10 seconds to 6 seconds later; Count_night2 means 20 seconds timing. These three variables are used to control the illumination duration.

The software flow chart is as follows in Figure 6.

![Figure 6. Software flow chart.](image)

(1) Variable definitions
There are mainly five variables for the use of the timer and the red LED, as shown in Figure 7.

```c
#include<stdio.h>
#define uchar unsigned char
#define uint unsigned int

uchar night0;
long int Count_night0 = 0;
long int Count_night1 = 0;
long int Count_night2 = 0;
long int Count_alarm0;
```

![Figure 7. Program-variable definition.](image)
(2) Pin connection statement
Includes three sensing modules, one white LED and one red LED. The pin descriptions for these five devices are shown in Figure 8.

```c
    sbit red=P3^6;
    sbit led_alarm=P1^1;
    sbit led_white=P2^7;
    sbit sound=P2^6;
    sbit light=P2^0;
```

Figure 8. Program-pin connection statement.

(3) Initialization
Includes three modules, one white LED and one red LED. The initialization of these five devices is shown in Figure 9.

```c
    void Time0_Init()
    {
        TMC0 = 0x01;
        TH0 = (65536-45872)/256;
        TL0 = (65536-45872)%256;
        IE = 0x82;
        TR0 = 1;
    }
```

Figure 9. Program-initialization.

(4) Main loop
It is used to control the duration of white LED illumination, as shown in Figure 10.

```c
void Time0_Int() interrupt 1
{
    TH0 = (65536-45872)/256;
    TL0 = (65536-45872)%256;
    if(Count_night>0)
        Count_night1--;
    if(Count_night>0)
        Count_night0--;
        if(Count_night0==0)
            led_white=1;
        Count_night1=6*20;
    if(Count_night2>0)
        Count_night2--;
        if(Count_night2==0)
            led_white=1;
        Count_night1=6*20;
    if(Count_alarm>0)
        if(Count_alarm==0)
            led_alarm=1;
```

Figure 10. Program-main loop.

(5) Main function
The specific functions are implemented as shown in Figure 11.
5. Experimental results and data analysis

5.1. Full illumination infrared sensor module test

(1) When the light is sufficient, no object is close to the circuit display

At this time, the illumination brightness is high, the environment decibel is not considered, and no object is approaching. At this time, the state of the white LED is off, the red LED is also off, and the system is in the standby state. The status of the hardware system is shown in Figure 12.

(2) When the light is sufficient, objects are close to the circuit display.

At this time, the illumination brightness is high, the environment decibel is not considered, and the object is close. At this time, the state of the white LED is off, the red LED is in the on state, the system is in the working state, and an alarm is issued. The status of the hardware system at this time is shown in Figure 13.
5.2. Insufficient illumination infrared sensor module test
(1) When the light is insufficient, no object is close to the circuit display
   At this time, the illumination brightness is low, the environment decibel is low, and no object is close. At this time, the state of the white LED is off, the red LED is also off, and the system is in the standby state. The status of the hardware system at this time is shown in Figure 14.

![Figure 14. Physical display - when there is insufficient light, no object is close to the circuit display.](image1)

(2) When the light is insufficient, there is an object close to the circuit display
   At this time, the illumination brightness is low, the environment decibel is low, and the object is close. At this time, the state of the white LED is off, the red LED is in the on state, the system is in the working state, and an alarm is issued. The status of the hardware system at this time is shown in Figure 15.

![Figure 15. Physical display - when the light is insufficient, there is an object close to the circuit display.](image2)

5.3. Under-light sensor test
(1) When there is insufficient light, no sound circuit is displayed.
   At this time, the illumination brightness is low, the environment decibel is low, and no object is close. At this time, the state of the white LED is off, the red LED is off, and the system is in the standby state and is shown in Figure 16.

![Figure 16. Physical display - when there is insufficient light, no sound circuit is displayed.](image3)
(2) When the light is insufficient, there is a sound circuit display
At this time, the brightness of the light is low, the environment is high in decibels, and no object is close. At this time, the state of the white LED is turned on, the red LED is not turned on, and the system works to illuminate and is shown in Figure 17.

![Figure 17](image17)

**Figure 17.** Physical display - when the light is insufficient, there is a sound circuit display.

5.4. Insufficient illumination with sound infrared module test
(1) When the light is insufficient, there is no sound, no object is close to the circuit display.
At this time, the illumination brightness is low, the environment decibel is high, and no object is close. At this time, the state of the white LED is turned on, the red LED is not turned on, the system works, and the illumination is turned on. The status of the hardware system at this time is shown in Figure 18.

![Figure 18](image18)

**Figure 18.** Physical display - when the light is insufficient, there is no sound, no object is close to the circuit display.

(2) When the light is insufficient, there is sound and there is an object close to the circuit display.
At this time, the illumination brightness is low, the environment is high in decibels, and the object is close. At this time, the state of the white LED is on, the red LED is in the on state, the system is in the working state, and the alarm is also illuminated. The status of the hardware system at this time is shown in Figure 19.
Figure 19. Physical display - when there is insufficient light, there is sound, and the object is close to the circuit display.

6. Conclusions
This paper explored the design of a multifunction green induction lamp with features on (i) Intelligent control of Illumination duration (ii) antitheft (iii) sound control. The system has many advantages like high functionality, high sensitivity, and low power consumption, low cost and strong adaptability.

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