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Design of a Novel Multi-Mode LED Dimming and Color Control System

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Abstract

Aiming at the needs of different lighting applications, combined with the characteristics of LED dimming and color control, and using MSP430 digital control technology, a novel LED intelligent dimming and color control system was designed. The system integrated Bluetooth remote, human infrared sensor, voice/gesture control and other control modes, which could achieve LED multi-mode dimming and color intelligent control. System hardware and software were designed to develop a prototype to experimental verification. The designed method proposes new ideas and information for LED control.

Keywords

LED, Multi-Mode, Dimming and Color, Intelligent Control

1. Introduction

With the development of communication networks, electronic information, LED lighting and other technologies, and the constant improvement of people's living standards and the concept of green lighting, intelligent lighting has to get promotion. People have requirements of intelligence and personalization. Increasingly strong electrical control has become a new economic growth point. Traditional lighting control uses fixed switch, and LED color brightness is mostly not regulated, with portable wireless switching system and the pursuit of energy conservation and environmental protection as well as the concept of changing the light color enhancement. In addition to the LED light brightness, light color and other requirements need to be improved; intelligent lighting control and management, operational flexibility and simplifying other aspects of higher demand are also needed [1]-[5].

Aiming at the needs of different lighting applications, combined with the characteristics of LED dimming and color control, and using MSP430 digital control technology, a novel LED intelligent dimming and color control system was designed.

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The designed system can use APP software and Bluetooth technology to control LED light switches, color and brightness, including the Bluetooth control mode, in order to control the modes of diversification and personalization. The system adds a human infrared sensor, voice, gestures and sensitive control, enabling the intelligent LED lighting control, and creating a comfortable and cozy light condition.

2. System Architecture & Working Principle and Operating Modes

2.1. System Architecture & Working Principle

The system use MSP430 microcontroller as control core, the MSP430 microcontroller acquisition different sensor signal, then through predetermined algorithm, the system output PWM signal to control the size of three-color LED current, thus changing LED lamp brightness and color. The system can choose different control modes depending on the application; system block diagram is shown in **Figure 1**.

2.2. Operating Modes

The system can operate in different modes, in different operating modes to achieve different control function. A multi-mode implementation case control system is shown in **Figure 2**.

Sound control switch can be used as a switch control system detects the sound input then turned on or off

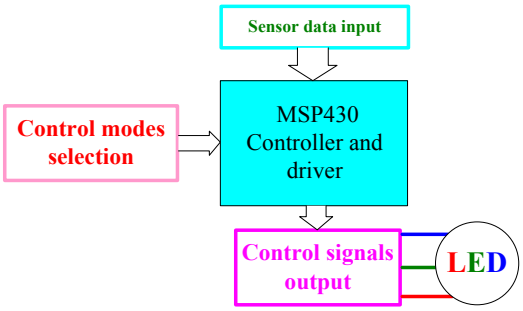

Figure 1. Control system block diagram.

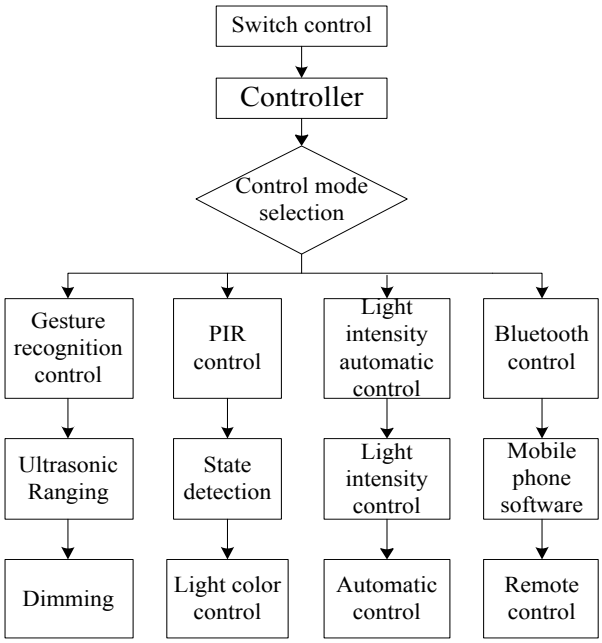

Figure 2. The implementation of multi-mode control case diagram.

LED lighting. Corresponding to the four control modes, respectively including gesture control, infrared sensor control, automatic light intensity control and Bluetooth phone remote control, through the key can be selection of different switching modes. The main control modes include: gesture control, human infrared sensor control, automatic light intensity control and Bluetooth remote control.

Among them, the gesture control using ultrasonic ranging sensors to achieve, through gestures of far proximity sensors adjust the brightness of the light; human infrared sensor can detect whether the person to achieve different color conversion control; automatic light intensity control for the controller detects ambient illumination intensity, LED lighting dimming control; Bluetooth remote control, combined with intelligent mobile terminal software to achieve the LED lighting switch / dimming color control.

3. Hardware Design and Implementation

System use MSP430F149 [6] as the control core, MSP430 MCUs are TI produced a 16-bit, ultra-low power consumption, reduced instruction hybrid microcontroller, has a wealth of hardware resources and interfaces to meet the design requirements of the system. The entire system uses modular design hardware, the main function of the hardware circuit modules are used to implement the entire system hardware circuits.

3.1. Sensor Modules [7]-[10]

The sound control module uses MIC and comparator circuit detecting sound input signal, according to the principle of shaking recognize sound, when the input sound signal LED lights, and enter again to close. The module outputs a detection signal to the controller IO port, the detection process is determined by the controller.

Gesture control uses conventional ultrasonic testing module gesture sensing distance, enabling dimming control. Optional ultrasonic ranging module that provides 2 cm - 400 cm non-contact distance sensing functions, ranging accuracy up to as high as 3 mm; module includes an ultrasonic transmitter, receiver and control circuitry. The gesture recognition interface circuit is shown in **Figure 3**.

Human infrared sensor module, this module is based on infrared technology, automatic control module, high reliability, low voltage, high sensitivity operating mode to achieve LED light auto-sensing control. When people enter the sensing range of the module output high electrical level, people left the sensing range is automatically delay off high electrical level and output low electrical level. The human infrared interface circuit is shown in **Figure 4**. The controller detects the electrical level signal, and outputting a corresponding control signal.

Light intensity detection module uses BH1750FVI chip, the module is a digital optical intensity sensor with IC 2-wire serial bus interface. It can detect high-resolution large range of light intensity (1lx-65535lx). When the detected light intensity of the external environment on the LED brightness can be adjusted to achieve the intelligent LED control, while reducing power consumption, to achieve energy saving. The light intensity detection module interface circuit is shown in **Figure 5**.

This system uses the HC-06 Bluetooth serial module. The Bluetooth module interface circuit is shown in **Figure 6**. The module supports UART interface, and supports Bluetooth serial protocol, low cost, small size, receive sensitivity advantages, with only a few external components will be able to achieve its powerful features. In terms of software, support AT command, change the baud rate, device name, password and other parameters can be paired using AT commands needed to use and flexible.

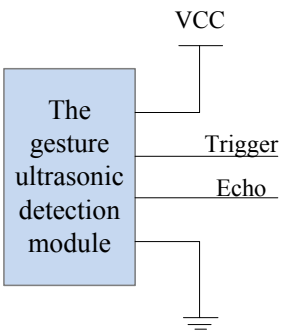

Figure 3. The gesture ultrasonic detection module interface circuit.

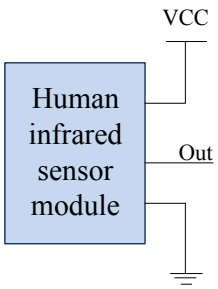

Figure 4. Human infrared sensor module interface circuit.

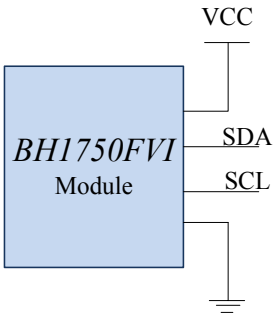

Figure 5. Light intensity detection module interface circuit.

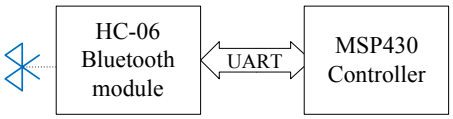

Figure 6. The Bluetooth module connection circuit.

3.2. Drive Control and Key Circuits

LED control driver circuit design PWM step-down constant current drive circuit, three independent design, by the MCU's three independent PWM control circuit to adjust the duty cycle control, thereby changing the three-color LED drive current, achieve LED color and dimming control.

The designed system conversion in the various operating modes is controlled through the key implementation, which provided four function keys. Each key functions as follows: Key 1 selects gesture control mode, brightness control LED lights; Key 2 selects human infrared sensor mode, the function performed color LED lights; Key 3 selects the light intensity detection mode, brightness adjustment function LED lights and displays on the display light intensity rating; Key 4 selects the Bluetooth control mode, Bluetooth module connection system for remote control of color LED dimming and switching functions via the mobile software.

4. Software Design and Development

The system controller software compiler development in IAR integrated development software, program composition structure diagram and main program flow chart are shown in **Figure 7**.

Design and development an intelligent APP software based Bluetooth technology, through blue tooth remote control can achieve the LED intelligent dimming and color control. Bluetooth control diagram is shown in **Figure 8**.

5. System Testing and Experimental Verification

A new multi-mode color LED dimming control system prototype based on above design was developed; the prototype was shown in **Figure 9**.

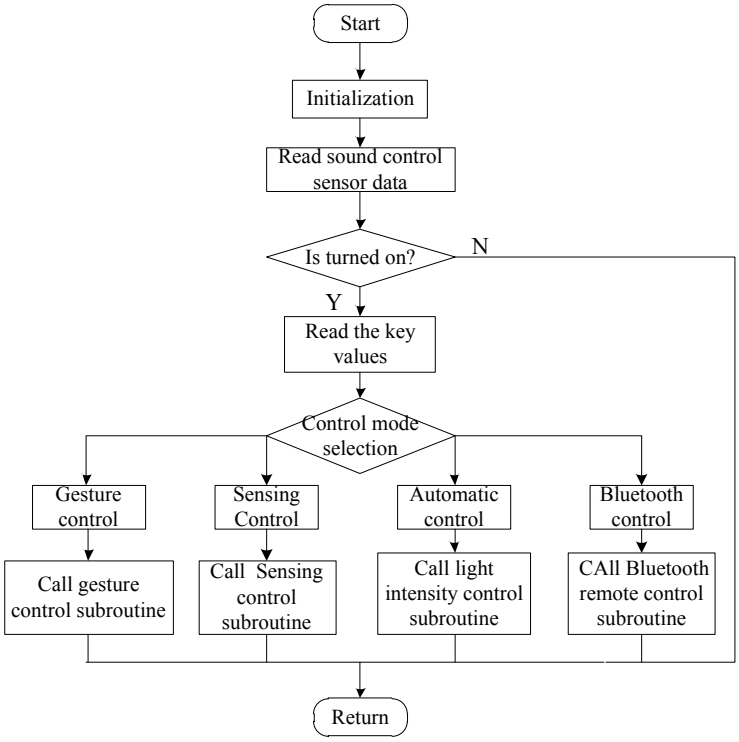

Figure 7. The software flow chart.

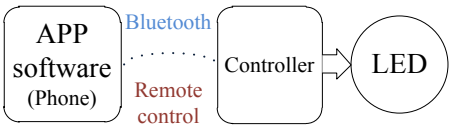

Figure 8. The Bluetooth control block diagram.

Figure 9. System prototype.

Experimental verification tests on prototype systems in different control modes were carried out respectively, and the partial control mode results were shown in **Figure 10**.

(a)

(b)

Figure 10. Prototype control test results. (a) The human body sensing automatic light change; (b) Bluetooth control lights change.

As can be seen from the test results, the system can be controlled according to the designed control mode, which achieve the prediction design goals and control effect.

6. Conclusion

This paper presented a new multi-mode LED dimming and color control system. The composition and implementation of the system were analyzed and introduced, the developed system prototype was verified, and the system could change the control mode according to different needs. It has good dimming and color control effects, and can meet the needs of different lighting engineering applications and situations. The system has good control effect and advantages, which proposes new ideas and information for the LED control system design.

Acknowledgements

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