Indonesian Journal of Electrical Engineering and Computer Science
Vol. 3, No. 2, August 2016, pp. 331 ~ 335
DOI: 10.11591/ijeecs.v3.i2.pp331-335

The Research on Intelligent Seating Position Type LED Table Lamp

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Abstract

Taking STC89C52RC single-chip as control core, this research realizes intelligent control function, which can automatically detect whether there is someone in the room and turn on/off LED table lamp; brightness of LED lamp can be adjusted with manual mode. In addition to that, it also has other functions such as displaying time and date, and posture correction. In general, time, data and brightness can be regulated through key module. 8 high brightness white LED are used in illumination module, among which, light sensitive module is applied for testing luminous intensity of environment; ultrasonic distance measuring module is utilized for detecting the distance from men to table lamp through transmitting and receiving ultrasound. In the evening, light is on when the distance from men to table lamp is within certain range; and light is off when exceeding this range. However, if the distance is lower than the specified minimum distance, buzzer will alarm to warn user that the seating position needs to be corrected. C language programming is employed for the integrated software to achieve the overall control function.

Keywords: *LED controller, posture correction, intelligent control, ultrasonic ranging module*

1. Introduction

Table lamp has become a necessary household appliance; however, huge energy waste has caused by often forgetting to turn off the lamp. In China, power consumption takes up 12% of total power generation (exceeding 10 billion per kilowatt-hour). Most of modern table lamps are common filament lamp, fluorescent lamp, energy saving lamp, and spiral lamp; and the control mode is mainly adopted hand switch, which cannot be adjusted continuously, let alone auto adjustment[1]. When night comes, it is very inconvenient for people to turn on the light in the dark. It is contradicted to the concept of intelligent, humanization and low carbon design on modern appliance [2].

LED luminescent device is cold light source with high lighting efficiency and low working voltage; moreover, it has low energy consumption and good controllability without any radiation. The energy consumption of LED is 10% of filament lamp and 50% of fluorescent lamp under the same. In terms of lifetime, LED rises up to 100 thousand hours, which is 10 times of fluorescent lamp and 100 times of filament lamp. Besides, spectrum of LED is almost exclusively focused on visible spectrum and its luminous efficiency can reach 80～90%. Power source of traditional table lamp is alternating current, so 100~120 times of strobe is generated every second; in contrast, LED lamp immediately converts alternating current into direct current and blinking phenomenon is hence not produced; in this way eyes can be protected and “soft” lighting environment can be gotten [3, 4].

On the other hand, about 30% of Chinese people have vision problem with different degree among which, shortsighted is the major problem. In recent years, rates of mypoia in China is the second highest in the world, which is next only to Japan; but the total number of myopes ranks global one. The principle cause for mypoia is unhealthy eye behavior; such as use of eye for a long time, and seat position is not correct during reading and learning. This paper emphasizes on seating position type LED lighting controller. It not only has high energy efficiency, but also has many other functions like correction of seating position and time and date displaying [5, 6]. The most important is that this LED controller has intelligent switch, which can detect the distance from individual within dark room, and auto turn on the light for facilitating people’s life [9].

Received March 2, 2016; Revised June 25, 2016; Accepted July 10, 2016

2. General Block Diagram of Intelligent Control System Like Seating Position Type LED

This system takes STC89C52RC as master control chip; the multi-functions of LED intelligent table lamp such as light off with people leaving, manual dimming, time and data displaying, and eyesight protection are realized by controlling ultrasonic ranging module HC-SR04, clock module DS1302, photosensitive sensor module MG-52B, DS18B20 temperature detection, 1602 liquid-crystal display, LED circuit driven by IRF630N, eyesight protection module and so on [7, 8].

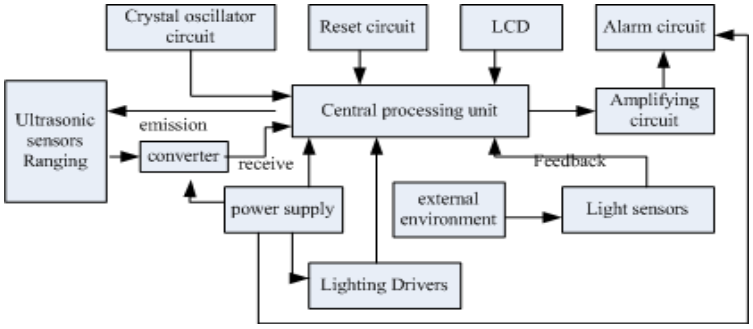


Figure 1. General block diagram of intelligent control system

3. DC/DC Switching Circuit

Figure 2 describes DC/DC switching circuit. U_i is DC input voltage after rectification filter and U_o is the needed DC output voltage. Its input and output are controlled by chip; inverting input terminal of comparator monitored output voltage by external attachment of divider resistance R1 and R2. According to the equation, output voltage $U_o = 1.25(1+\frac{R_2}{R_1})$ is only related to the value of R1 and R2. As reference voltage U_i is constant, the U_o is stable when R1 and R2 are in stability; so that, voltage stabilization is thus realized. If $R_2/R_1 = 3$, there is $U_o = 1.25(1+\frac{R_2}{R_1}) = 1.25\times(1+3) = 5v$。

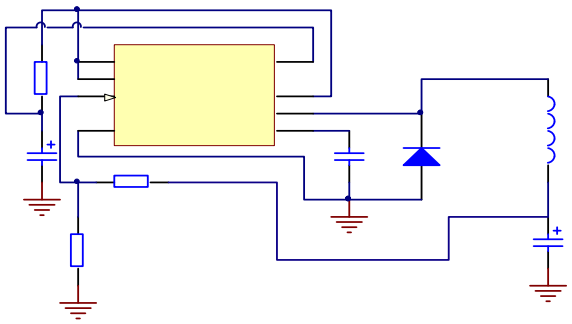


Figure 2. Regulator circuit schematics

Output voltage U_o is varied with the change of input voltage U_i, output current I_o and environment temperature T,there is $U_o = f(U_i, I_O, T)$. The simple form of output voltage

variation can be expressed as input adjust function in equation $\Delta U = \frac{\partial U_o}{\partial U_I}\Delta U_I + \frac{\partial U_o}{\partial U_I}\Delta U_o + \frac{\partial U_o}{\partial T}\Delta T$. Where is input adjustment function: $K_V = \frac{\Delta U_O}{\Delta U_I}\Big|_{\Delta T=0}^{\Delta I_O=0}$, K_V reflects the impact of input voltage fluctuation on output voltage; in practice, it is often indicated by the relative variation of output voltage,which is induced by changes of input voltage. It is called voltage regulation. Rejection ratio RR: $RR = 20\lg\frac{V_{IP-P}}{V_{OP-P}}dB$, V_{IP-P} and V_{OP-P} were respectively known as peak value of input ripple voltage and peak value of output ripple voltage.

4. Circuit of Ultrasonic Ranging Module

HC-SR04 ultrasonic ranging module has the function of 2CM-400CM non-contact distance measurement with the measuring accuracy rising up to 3mm. The module consists of ultrasonic emitter, receiver, and control circuit.

1) I/O port TRIG ranging is adopted and at least 10us of high level signal is provided;

2) the module sends 8 square waves of 40KHz automatically and auto-detects whether there is signal return;

3) if there is signal return, a high level signal is sent through ECHO of I/O port. The duration of high level signal is the time of ultrasound transmitting from emission to return. Measuring distance=(high-level time*sound velocity (340m/s))/2.

5. MOS Driving Circuit

The lighting circuit is amplified and driven by MOS pipeline, and the adjust control is realized through single chip I/O port. The driving circuit is presented in Figure 3. MOS pipeline IRF630N is selected, cathode of LED is connected to the drain with grounded source, resistance is linked to grid and it is controlled by single-chip I/O port. LED brightness is adjusted through regulation of duty ratio [10].

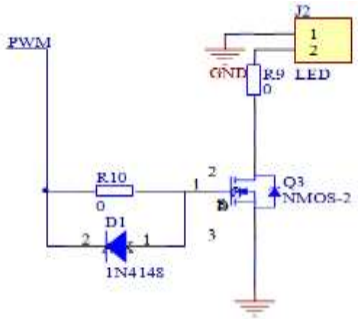


Figure 3. LED circuit amplified and driven by MOS pipeline

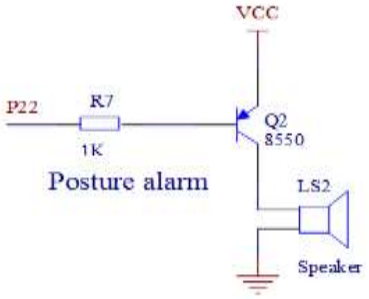


Figure 4. Posture correction circuit

6. Detection Circuit of Photosensitive Sensor

The brightness of surrounded environment is detected through photosensitive sensor and it is compared by using comparator LM393. Sensitivity of output state can regulate working voltage 3.3-5V; the output type is digital switch output and analog voltage output. If ambient light does not reach threshold value, high-level signal will be output at DO port; while, if ambient light exceeds threshold value, low -level signal will be output at module DO. The output port DO can be connected with any IO port of single-chip (it depends on process definition); variation of electric levels can be tested by single chip and changes of surroundings is thus detected. Digital output DO can directly drive single relay and photoelectro switch is therefore constituted.

7. Design of Seating Position Circuit

As output current of single-chip I/O pin is smaller, TTL level output by single-chip can not drive buzzer on the whole. a circuit with amplified current needs to be added. Buzzer is amplified and driven by a audion C8550. The driving circuit is shown in Figure 4.

The positive pole of buzzer is connected to VCC（+5V）power supply and its negative pole is linked to emitter E of audion. The base B of audion is controlled by the pin of single-chip after passing through current-limiting resistance R_1. When the pin outputs high-level single, audion T1 cut off, there is no current pass through coil and the buzzer is silent. While, when the pin outputs low-level single, audion breakover, and the current forms return circuit andbuzzer rings. Buzzer tone can be controlled and adjusted by changing frequency of output waveform for single-chip pin in procedure, and various sounds with different pitches and timbres are produced. In addition, volume of buzzer can be controlled by altering duty ratio of high-low level for output level of single-chip pin.

8. Testing Result

1) Temperature module test

Power switch is turned on to response the surrounding temperature and display. There is no error in the test.

2) Ultrasound module test

When the distance between man and table lamp is lower than the set minimum distance, buzzer begins to work. When table lamp is in auto mode and in the dark environment, table lamp will auto turn off, if the distance between man and table lamp exceeds setting distance 100cm. The test runs normally.

3) Test of illuminating module

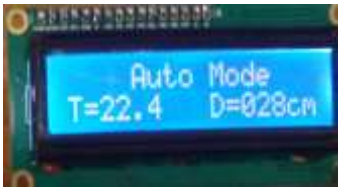
Level of brightness is consists of 5 grades. All test run normally.

4) Test of display module

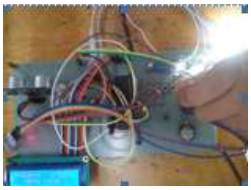
Time, data, week and temperature value can be displayed correctly. The test runs normally.

5) Test of environment responsive module

When the table lamp is in auto mode and in dark environment, LED lamp will auto sensing and output bright.The test runs normally.



a) Temperature display



b) Ultrasonic Ranging Circuit

c) Dimming circuit diagram

d) Time and date display

e) Environmental sensing module

Figure 5. Operating results

During the test, it is discovered that this design still has some defects. For example, resolution of LCD will decrease with the increase of brightness level of LED lamp; and the screen displays fuzzy the at level 5. This part needs to be modified. Except that, the operation becomes more complex due to the additive function, which is also a problem [11].

9. Conclusion

1) White light LED is employed as lighting source. Under the same light intensity, it is 50% of traditional incandescent lamp; moreover, LED has longer service life and is difficult to damage, which can reduce the waste generation, and the environment is thus protected.

2) Intelligent and manual dimming mode: in intelligent dimming mode, LED illumination intensity can be adjusted according to light intensity. In this way, the table lamp can produce suitable light at any time. In terms of manual mode, proper light intensity can be kept through manual adjustment. The two modes can protect our eyesight.

3) Through infrared detection of human body, light is on when man coming and light is off when man leaving without needing to turn on light manually in the dark. Such design is more energy-saving and humanization. In addition, LCD1602 displays time and date, on time sound-light prompts rest and sleep. There are also buzzer sound alarms and green light flashing warns for users.

4) Correctness of seating position: buzzer circuit is controlled by balance buttons. When the seating position leans, the switch is on and buzzer alarms to suggest you to adjust seating position. When seating straights, the switch is off and correct seating position can thus be kept.

Acknowledgements

Thanks to the strong support of the Science and Technology Department of Shaanxi Province Project No. 2014K06-43. Thanks to the strong support of the Xi'an Science and Technology Project No. CXY1443WL24. Thanks to Shaanxi Key Laboratory of Surface Engineering and Remanufacturing (Xi'an University).

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