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Design and Practical Significance of Human Body Sensing Small Lamp

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Abstract:

Human body sensing light is a good lighting device that can automatically turn on or off lights according to human activities, so it can achieve energy conservation and improve the convenience of living or working spaces. The research topics usually focus on improving sensing sensitivity, reducing false triggering rates, optimizing energy management, and enhancing user interaction experience. Research methods include hardware design, system integration, experimental testing, and performance evaluation. Researchers will choose suitable microcontrollers as core processing units, design circuits to integrate sensors (such as pyroelectric sensors, infrared sensors, etc.), and select suitable LED lighting fixtures as lighting components. The human body sensing light can be triggered at a distance of about 50cm from the person. This distance can be increased by adjusting the sensor, but the range will be reduced. The conclusion is that induction lamps have certain practical value, but their false triggering and insensitivity still exist, and further optimization is needed.

Keywords: Amplifier; Transistor; System

1. Introduction

The global resource shortage is particularly prominent in China, with an annual lighting waste of up to 38 billion US dollars according to statistics. It is urgent to develop new intelligent lighting systems. The lighting system in our country is basically in two states: on and off, and there are few lighting systems on the market that adjust the brightness and darkness according to the actual state. At present, domestic controlled light induction lamps and human body induction lighting mainly face small household lighting, which is expensive, while the lighting systems in libraries and classrooms often turn on and off at the same time. Take the university classroom as an example. When the light is sufficient in the daytime, there are many cases where the lights work as usual. When the light is insufficient, there may be people in certain areas and no people in other areas, but the entire lighting system is working. At present, countrymen have insufficient awareness of environmental protection and energy conservation, and must take technological innovation to achieve environmental protection and energy conservation. Early research in this area included clapping hands to assist in getting in and out of bed at night and convenient night lights

[1], as well as touch based delayed lights. They are usually placed next to the bed, and when lighting is needed at night, simply touch the metal plate of the lampshade, and the small light will emit red light, which will automatically turn off after a few minutes, providing convenience for people's lives [2]. There are already many enterprises, universities, and companies engaged in research in this area. For example, the STM32-based infrared human body sensing LED light control project has achieved efficient and stable lighting solutions through intelligent control [3]. The SOTHONG object-sensing night light adopts a magnetic and suspended installation method, making it easy for users to move the lighting position according to their needs [4]. Although the technology of the human body sensing small lights has become relatively mature and widely used in the fields of smart homes and energy-saving lighting, there are still some research gaps and areas for improvement. The human body sensing small lights circulating and sold on the market are basically the same solution, and sufficient improvement suggestions have not been put forward on the advantages and disadvantages of this solution and the reasons for the problems have not been identified yet.

The research objective is to examine the practicality of small lights and their performance include shortcomings in daily use. It can identify the specific advantages and disadvantages of each module and explore the areas where these modules can be optimized in order to determine the direction of improvement for existing human body sensing small lights. This study also makes contributions to smart home systems.

2. Theory

The working principle of the human body induction lamp is mainly based on infrared sensing technology. The human body naturally emits specific wavelengths of infrared radiation, which can be detected by the built-in pyroelectric sensor in the human induction lamp. When the human body enters the detection range of the sensor, the sensor will receive infrared signals and convert them into electrical signals. This electrical signal is then sent to the control circuit, triggering the light to turn on. Once the human body leaves the sensing range, the light will automatically turn off after a preset delay to achieve energy-saving effects.

The human body sensing switch cleverly utilizes the 7-9 μm infrared characteristics emitted by the human body, focusing through a Fresnel lens to enable the infrared sensor to sensitively capture the dynamic thermal energy changes of the human body [5]. When the human body approaches, the infrared sensor senses energy fluctuations, converts them into electrical signals, processes them through precise circuits, and ultimately triggers the conduction mechanism of the thyristor. In the environment with efficient light, the photosensitive element automatically adjusts to a low resistance state, suppresses the triggering circuit, keeps the thyristor closed, and ensures that the light is in the off state.

On the contrary, in dimly lit scenes, the photosensitive element transitions to a high impedance state, releasing control to the infrared sensing part. At this point, if the human body approaches, the infrared sensor controller will be triggered to output a trigger voltage, driving the bidirectional thyristor to turn on, and the light will immediately turn on, providing instant illumination. When the human body leaves, after a set delay time, the thyristor closes again and the light goes out, achieving intelligent and energy-saving automatic control[6].

This design not only highlights the care of technology for daily details, but also embodies the concept of green energy conservation, bringing dual benefits of convenience and environmental protection to daily life.

3. Method

An intelligent and efficient lighting control system was constructed using the HC-SR501 human body sensing module as the design core. This module, with its 3.3V/0V level output characteristics, can sensitively recognize human movement and trigger high-level signals. The duration and sensitivity of this signal can be adjusted as needed, providing a reliable signal source for maintaining low levels in unmanned detection states and lighting control[7]. Determine whether the human body is close to the switch by sensing the pyroelectric signal sent by the human body, and sending the signal to the next module.

The integrated operational amplifier LM358, as a dual channel signal amplifier, cleverly connects the human body sensing module with the subsequent circuit. The second pin is firmly grounded to ensure the stability of the circuit foundation, while the third pin is closely connected to the output terminal of the sensing module, which can instantly capture and convert the high and low-level signals emitted by the module. Under this design, regardless of the output state of the sensing module, LM358 can replicate the same level change at output terminal 1, ensuring accurate signal transmission[8].

The BU508A transistor, with its NPN structural characteristics, serves as an electronic switch in circuits. By regulating the base current, saturation conduction between the collector and emitter is achieved, providing a key control mechanism for circuit disconnection [9].

The light-emitting diode board, as the final execution

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unit of the system, undertakes the lighting task. When the transistor conducts due to the induction signal, the current flows smoothly, exciting the LED to emit light; On the contrary, if the signal is missing, the diode will be in an off state, forming an intelligent lighting mode based on human body sensing [10].

By carefully arranging and orderly connecting these components, a fully functional and responsive human body sensing light system has emerged, achieving intelligent and humanized environmental lighting control. The specific connection circuit diagram can be seen in Figure 1.

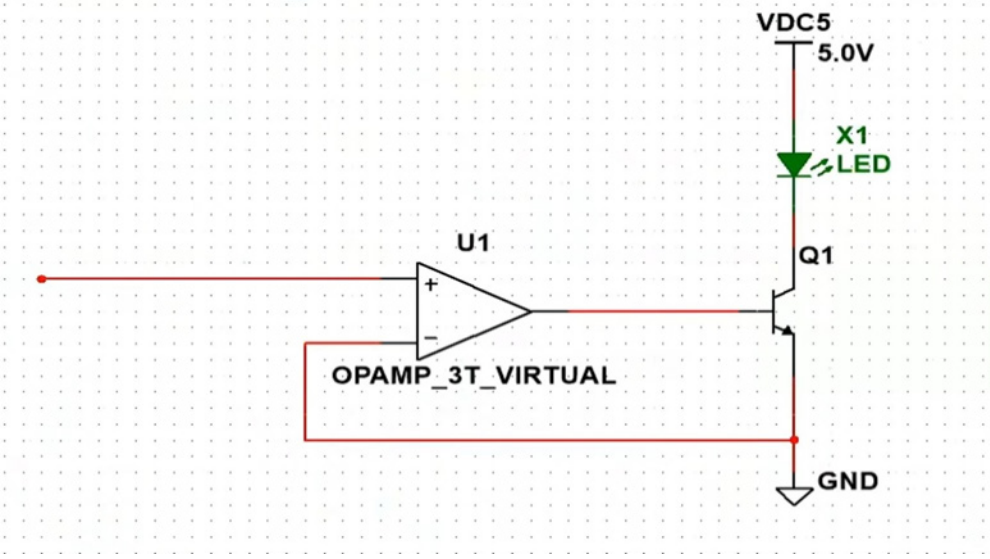

Figure. 1 Circuit connection diagram.

4. Results

First, use the hand as a reference to approach the sensor sensing module, and the small light bulb will start to emit light when approaching a position of about 30-40 centimeters. Then move your hand away from the sensor until it is no longer detected, at a distance of approximately 2 meters. After about 7 seconds, the small light went out. When the hand is moved to the sensor again, the small light will repeatedly light up. Keep the hand still for 7 seconds and the small light will still turn off and will not continue to light up. The duration of the light can be controlled up to 10 minutes through the knob on the sensing module. In addition, it was accidentally observed in the experiment that the small lamp may exhibit abnormal reactions in specific environments, such as accidental touch or delayed response in very weak light or rapid movement. This phenomenon has occurred in multiple experiments and should be closely related to the sensing mode of the human body sensing module. The lighting of the small light may also have a delay, sometimes requiring multiple movements of the hand before the light can continue to light up. Additionally, due to the simple use of components, there may be a problem with the components, causing the screen flash of the small light to be a bit severe. After repeatedly plugging and unplugging the connecting wires and firmly fixing them, this problem of the small light was roughly solved, but it still occasionally occurs.

The main problem is the insufficient sensitivity of the sensor, which leads to inaccurate response of the lamp or the phenomenon of triggering out of thin air. The output current of the induction module is small, which cannot drive the load or even saturate the transistor for conduction. Therefore, when using a small lamp, it is necessary to use a higher voltage current to avoid this problem. The use of low-power switching tubes can cause severe heating, and attention must be paid to the parameter specifications of the switching tubes when assembling the circuit.

It is worth noting that several key details appeared in the experiment: when the hand approached the small light within the detection range, the light did not immediately light up and there was a delay of nearly 1 second, indicating a problem with the sensing mode of the sensing module. In addition, during long-term use, there is no significant heating of circuit components except for the small light, which indicates that the safety of using the human body induction small light can be guaranteed. However, due to the use of AC power, the lifespan of the small lamp is not long. The reason may be that the light bulb used is a very cheap product, and the brightness decreases after about one week of use. Moreover, the small lamp no longer emits light after about a month. It is speculated that

using high-quality light beads or other types of lamps should be able to avoid this problem.

5. Discussion

The significance of studying human body induction lights lies in energy conservation and emission reduction. They can be automatically turned on and off by human movement, effectively preventing unnecessary consumption when people are not around. Contribute to the mainstream of energy conservation and environmental protection in modern society. Secondly, it can improve the convenience of using the lamp. This type of lamp can automatically provide lighting according to the situation without manual switching through an internal switch diode, thus providing convenience in daily life, especially when getting up or going to the bathroom at night. The non-contact sensing technology used in the human body induction lamp is safe and reliable, completely avoiding any form of radiation release and ensuring that the user's health is not affected; The design details reflect the emphasis on user comfort experience, such as soft lighting with no hurt, avoiding potential harm to vision, and creating a warm and safe lighting environment.

The technology of human body sensing lights is constantly advancing, integrating more intelligent functions and improved sensing mechanisms. For example, the latest patent shows that researchers are developing control methods that can more accurately distinguish between human activity and interference from other objects, which can help reduce unnecessary lighting caused by misoperation, thereby improving energy efficiency and user experience. There are still many aspects that need improvement in the human body sensing small lights. To improve the accuracy and response speed of human body sensing, reduce false triggering, and explore more efficient power supply methods, LED light technology and intelligent light control modules can be used to automatically adjust the intensity of light according to the environment. With the continuous innovation and expansion in the field of smart homes, human body-sensing small lights are showing broad market prospects due to their excellent energy-saving effect and convenient use. They not only significantly optimize the living experience and improve the quality of life, but also lead the construction and home lighting industry towards a new era of green, energy-saving, intelligent and efficient, becoming a key force in promoting industry transformation.

6. Conclusion

In summary, this design has become an ideal choice in many scenarios due to its innovative and practical characteristics. Whether in the office areas of enterprises, hotel corridors, corners of shopping malls, or inside residential buildings, such as corridors, stairs, elevators, bathrooms, and even warehouses, they can be perfectly integrated to achieve intelligent lighting management of "people in the light start, people away from the light rest". This not only demonstrates the convenience of modern technology, but also a powerful practice of energy conservation and emission reduction concepts.

Especially in terms of security protection, the human body sensing light can also serve as an invisible barrier, deterring potential illegal intrusion behavior. This design is simple yet functional, with no radiation hazards, minimal power consumption, and affordable cost. In addition, it is easy to hide characteristics make it highly versatile in a wide range of fields. Through flexible expansion, it can easily adapt to various practical needs, making it a perfect combination of wisdom and aesthetics.

References

[1] Xue, Cheng. Clap your hands and turn on the convenient night light Small and Medium sized Enterprise Technology, 2000, (10): 20.

[2] Xie, Chunlin Self-made touch type delayed extinguishing small light. Electronic Manufacturing, 1999, (12): 22-23.

[3] Lian Y, Wu D, Ji Z .STM32-Based Intelligent Desk Lamp Design and Implementation.Open Access Library Journal, 2021

[4] López-Higuera, J.M. Sensing Using Light: A Key Area of Sensors. Sensors 2021, 21, 6562.

[5] Wei, Dongxue. Teaching Design of Infrared Human Sensing Module in Wireless Sensor Networks.Popular Technology, 2021, 23 (02): 83-85

[6] http://file-nas.yyboxdns.com:12110/Fulltext Design of an Intelligent Lighting System with Human Infrared Sensing.

[7] CSDN - Detailed Explanation of HC-SR501, Human Infrared Sensor.

[8] Wang. Yongqi, Application of constant current charging for dual operational amplifier LM358 Shandong Industrial Technology, 2015, (19): 167-168.

[9] Chen, Ziyu, Micro course Design on the Working Principle of Transistors. Computer Products and Circulation, 2018, (04): 199.

[10] Li, Hongqi, Analysis of Light Emitting Diode Technology and Application. Computer Products and Circulation, 2020, (11): 5