A Design of Solar Power Electric Zipper for Tent Based on Microcomputer STC89C52

Yixian Liu
Department of Electrical Engineering, North China Electric Power University, Yonghua North Street, Baoding 071003, China
*Corresponding author e-mail: 376607317@qq.com

Abstract. This paper designs an electric zipper control system for outdoor tents, whose manually controlling zipper is laborious and time-consuming. The system adopts Microcontroller STC89C52 as the main control module. It can control the automatic opening and closing of the zipper according to the light intensity and the setting time. The device provides a solar power supply module to solve the problem of inconvenient charging in the field. The system has the advantages of high cost performance, stable operation, strong anti-interference, etc. It improves the shortcomings of the traditional intelligent zipper control.

1. Introduction
With the development of social economy and Internet of Things technology, a series of intelligent home products have brought great convenience to people's lives. The intelligent zipper designed in this paper is aimed at the problem that the outdoor tent zipper is not easy to pull. Combined with the tent lighting and light protection requirements and safety considerations, the motor controls the motor to pull the zipper through the remote control, realizing the automatic control of the zipper. It can automatically switch the zipper according to the different external light intensity, or control the zipper according to the time set by people, making the tent zipper design smarter and more humanized. The device provides a solar power supply module to solve the problem of inconvenient charging in the field. The electric zipper device not only helps people arrange time reasonably, enhances the safety of equipment, but also cost lowly, which makes people's daily life more convenient.

2. System overall structure design
2.1. Design ideas
Traditional zippers must be manually switched, lacking a device that can control timing and control the zipper according to light intensity. Especially for the large zipper of the outdoor tent, it takes up a lot of strength and time. At the same time, the traditional zipper cannot be controlled remotely. Once the people are away, they have to return to switch the zipper. Meanwhile, People often face the inconvenience of charging outdoors when they are camping. This paper designs an electric zipper control system, which can switch the zipper through infrared remote control, and design the function of automatically switching the zipper according to the light intensity and set time. The technical difficulty of the zipper controller is how to make the automatic switch The zipper can be switched
freely and the downtime is in place. The entire unit is powered by a solar module that is mounted on the roof of the tent. The solar voltage regulator module is installed on the single chip microcomputer.

2.2. Basic system functions
(1) Manual control: This function enables the electric zipper to move forward and reverse rotation and stop function. Moreover, the working status indication is added, and when the motor works in the forward, reverse and stop states, the LED tubes have different working status indications.

(2) Automatic control: “Dark off, dawn on” The design controls the zipper according to the output level of the microcontroller to control the forward and reverse rotation of the motor.

(3) Time control: Automatic time control can be controlled by a timer.

(4) Solar power supply module: The power supply is powered by solar panels. When the sunlight is sufficient, the solar panels are directly supplied to the power supply device through the voltage stabilizing circuit, and the lithium battery is charged through the BQ24200. When the sunlight is insufficient, the power supply is supplied to the power device through the lithium battery.

3. Mechanical structure
According to actual research, the designed electric zipper device should have the function of automatically controlling the zipper. When the zipper is not used, the zipper adjustment device is in a contracted state. When used, the running time can be set as needed, and the zipper can be automatically adjusted as the illumination changes.

According to the above functions, the electric zipper device is mainly composed of a support frame, a belt with a groove, and a motor. Inside the motor, there are gears and belts. The belt connecting the gear with the zipper head drives the zipper head back and forth, so that when the zipper is installed, movement can be achieved. Connected to the built-in motor is a microcontroller control unit.

The electric zipper device is normally in a contracted state. When in use, the infrared remote controller is used to control the single-chip microcomputer to make the motor and the transmission mechanism operate. The motor moves to realize the control of the zipper. The zipper can be switched at the timing as needed. It is also possible to automatically adjust the zipper with the change of outdoor lighting to adjust the brightness inside the tent.

Install a flexible solar panel on the top of the tent, and connect the single-chip microcomputer through the voltage regulator module to supply power to the system.

4. Overall circuit design and its principle description
The overall block diagram of the design of the electric zipper control system is shown in Figure 1.

![Figure 1. system control module diagram](image)

According to the illumination, the main principle of opening and closing the zipper is to collect the light intensity of the outside with a photo resistor. The signal collected from the light sensor is amplified by the signal correction circuit, and filtered and input into the single chip microcomputer. The incoming signal is controlled by the 89C52 microcontroller and responds to forward, reverse and stop the motor. The display module is used to display various states of the electric zipper controller.
The keyboard acts as an input device, and the single-chip microcomputer is used to control various operating states through different buttons.

5. Hardware analysis and design

(1) STC89C52 Microcontroller Overview: STC89C52 is the core control component of the system. In the system, the single-chip circuit as the main control chip first responds to the temperature signal collected by the external circuit, sends a PWM signal to L297, and then drives the stepping motor through L298. At the same time, the button scan realizes manual automatic control. With DS1302 clock chip, DS18B20 temperature sensor, and 1602 liquid crystal, it realizes time and temperature display, as well as alarm clock and temperature alarm function.

(2) Crystal oscillator circuit: The crystal oscillator in the circuit is the quartz crystal oscillator. The frequency stability and anti-interference ability of the quartz crystal oscillator ensure the accuracy of the frequency in the circuit. Meanwhile, it can also generate an oscillating current to send a clock signal to the microcontroller.

(3) clock circuit: The real-time clock circuit chip used in this design is a high-performance, low-power, real-time clock circuit chip DS1302 with RAM produced by DALLAS in the United States. In addition to the function of displaying the time, the clock chip also participates in timing control.

(4) temperature detector module: This design uses the DS18B20 single-line intelligent temperature sensor produced by the semiconductor company to collect real-time ambient temperature and display it on the LCD screen. When the temperature exceeds the set upper limit, a temperature alarm is issued. The DS18B20 can directly read the measured temperature, only need to read and write information on the single-wire interface, and the data bus can also supply power without additional power supply. This makes the system structure simpler, more reliable, and lower cost.

(5) display circuit: The liquid crystal display module used in this design is the LCD 1602. LCD1602 liquid crystal display has many advantages such as micro power consumption, small size, rich display content, ultra-thin and light weight.

(6) Photosensitive sensor: This design use a photoresistor to realize the function of automatically switching the zipper according to the intensity of the light. The operational amplifier consists of a comparison circuit. Apply the principle of light control to determine the voltage value at the inverting input.

(7) stepper motor: In the electric zipper control system, a three-phase reactive stepping motor of the type 130HZ308-450 is selected, which has the advantages of large torque and high precision.

(8) Solar power supply module: The power supply is powered by solar panels. When the sunlight is sufficient, the solar panels are directly supplied to the power supply device through the voltage stabilizing circuit. At the same time, the lithium battery is charged by the BQ24200, and the lithium battery and the super capacitor are used as backup power sources. When the sunlight is insufficient, the lithium battery is used to supply power to the power device. The power supply design adopts temperature protection and can be in-Safe operation in the range of 30 ~ 65 ° C.

6. Program analysis and design

The main program flow chart is shown as Figure 6-1.

6.1. Main program design

The main program constitutes an infinite loop, which mainly completes the functions of initializing the microcontroller, initializing the menu, scanning the keys, running the motor, and timing.

6.2. Stepper motor program design

The main tasks of stepper motor programming are:

The rotation direction is judged, and the control pulse is transmitted in order to determine whether the required number of control steps is transmitted.
6.3. Keyboard program design
The contact of the button will produce vibration when it is closed and disconnected. At this time, the logic level of the contact is unstable. Now use the software delay method to avoid the jitter phase.

![Software workflow chart](image)

**Figure 2.** Software work flow chart

7. Summary
This design system introduces the electric zipper control system from hardware circuit design, software design and component selection. In this design, a photoresistor is used as a signal for transmitting signals, a stepping motor is used as an actuator for signal output, STM 89C52 is used as a main control component, and a button and a display circuit are applied. The photoresistor transmits the external illumination signal to the microcomputer controls the stepping motor to perform corresponding actions to control the opening and closing of the zipper. On the basis of the general application, the timing component circuit is added to further improve the automation performance of the zipper. The photosensitive resistor has good photosensitivity, the structure of the stepping motor is simple, and the overall system is stable and practical.

References
[1] Yao Fuan. Electronic circuit design and practice. Jinan: Shandong Science and Technology Press, 2005.
[2] Xicai He, Yang Jing, Ren Liying. Practical sensor interface circuit example. Beijing: China Electric Power Press, 2007.
[3] Shouyi Liu. Application Technology of Single Chip Microcomputer. Shaanxi: Xi'an University of Electronic Science and Technology Press, 2007.
[4] Guangdi Li. The basis of single-chip microcomputer. Beijing: Beijing University of Aeronautics and Astronautics Press, 2001.
[5] Guirong Qi. Infrared remote control circuit for electric curtains. Home Electronics, 2005, 2: 35-36.
[6] Lijun Wang, Weifeng Yang. Research on the design of motor wireless remote control system
Volkswagen Technology, 2009, 11: 124-125.
[7] Peizhi Zhang, Wei Lu. Qiuzhi wireless remote control home lighting system based on single chip technology. Instrumentation user, 2008.
[8] Damao Liu. Intelligent Instrument: Design of Single-Chip Application System. Beijing: Aviation Industry Press, 1998.
[9] Hangci Zhou, Zhaoyou Zhu. Principle and design of intelligent instruments. Beijing: Beijing University of Aeronautics and Astronautics Press, 2005.
[10] Yinchun Liu. Principle of sensor. Beijing National Defense Science and Technology University Press, 2006.
[11] Zhiyong Meng. Microcontroller peripheral circuit design. Beijing: Publishing House of Electronics Industry, 2004.
[12] Xiaoming Wang. Single-chip control of electric motor. Beijing: Beijing University of Aeronautics and Astronautics Press, 2002.
[13] Zhanyou Sha. Practical Handbook for Integrated Sensors in China and Foreign Countries. Beijing: Publishing House of Electronics Industry, 2005.
[14] Hancai Hu. The principle of single chip microcomputer and its interface technology. Beijing: Tsinghua University Press, 2003.
[15] Junfang Lu. Sensor Interface and Detection Instrument Circuit. Beijing: Beijing University of Aeronautics and Astronautics Press, 1995.
[16] HI-TECH Software. PIC C User’s Manual. www.htsoft.com.
[17] S.L.Loyka. A Simple Formula for the Ground Resistance Calculation. IEEE Trans. On Electromagnetic Compatibility, 1999, 41(2): 152-154.
[18] Microchip Technology Inc. Microchip 2006 Product Selector Guide. 2006.
[19] W.Harold Parady, J.Howard Turner. Electric Motors. Georgia: The american association For vocational instructional materials, 1978.
[20] John B. Peatman. Design With PIC Microcontrollers. Prentice-Hall Inc, 1997.
[21] Jullian, E. Electromagnetic radiation. RBM-Revue Europeenne de technologie Biomedicale, Vol.20 NO.4 June, 1998.
[22] Yu Xuelian, Hu Yingwei, Li Jiafeng, et al. High-efficiency solar charging treasure based on BQ24195 chip.