Design of Greenhouse Temperature and Light Intensity Control Circuit

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Abstract In view of domestic scientific and technological achievements at present, real-time control circuit for greenhouse temperature and light intensity has been designed in line with the principle of cost saving and easy control. With advanced temperature sensor and light sensor applied to measure the temperature and light intensity, an execution unit is controlled by single-chip microcomputer (SCM) to regulate the temperature and light intensity, creating a hardware design scheme and software design idea. In case of high temperature and high light intensity in greenhouse, the sunshade net will be put down and the blower will be started automatically; in case of low temperature and light intensity, the sunshade net will be folded up and the heating valve will be turned up automatically. In this way, the temperature and light intensity in greenhouse will be controlled within the designed range.

Key words Single-chip microcomputer (SCM), Temperature, Light intensity

With the continuous development of modern society and constant improvement in technology, the control technology for greenhouse temperature and light intensity is increasingly mature. Compared with the traditional greenhouse, the current control tends to be automated with real-time performance and high efficiency. Therefore, in view of domestic scientific and technological achievements at present, we designed a system consisting of appropriate temperature sensor, light sensor and suitable drive circuit on the basis of single-chip microcomputer technology in line with the principle of cost saving and easy control.

1 System composition

Taking AT89S52[1] as the main body, the design applies temperature sensor SHT11 and light sensor TSL2561 as detecting elements so as to realize real-time control of temperature and light intensity. The hardware diagram is shown below in Fig. 1.

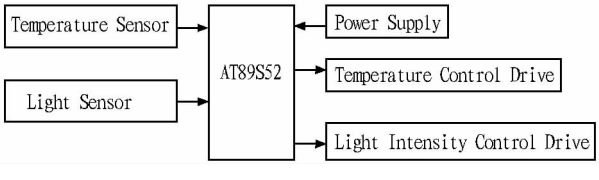

Fig. 1 Hardware structure

The design idea is that external temperature is converted to digital signals to be fed into the single-chip microcomputer AT89S52 through SHT11 temperature sensor. The actions of temperature control circuit are driven by the internal program reactions of the single-chip microcomputer so as to control greenhouse temperature within the preset temperature range. External light intensity is converted to digital signals to be fed into the single-chip microcomputer AT89S52 through TSL2561 light sensor. The actions of temperature control circuit are driven by the internal program reactions of the single-chip microcomputer so as to control the light intensity in greenhouse within the preset light intensity range. As the voltage and current of the single-chip microcomputer are insufficient to drive the 12V relay, an additional power circuit is needed to drive the relay.

1.1 Temperature detection circuit SHT11 single-chip sensor[2] is a compound sensor with the function of calibrating the temperature and humidity of digital signal output. It is mainly applied in the micromachining technology for industrial COMS process so as to ensure high reliability and relative stability of products. The sensor consists of a capacitive polymer humidity measuring element and an energy-gap humidity measuring element, which are connected with the serial interface circuit and a 14-digit A/D converter on the same chip. Therefore, this sensor has the advantages of high quality, instant reaction, strong anti-interference performance and high cost performance *etc*. In this study, the temperature sensor is applied. Each SHT sensor is calibrated in the extremely precise calibration laboratory of light intensity. The calibration coefficients are saved in the OTP memory in the form of programs, and these calibration coefficients need to be adjusted manually during the internal signal detection process of the sensor so as to ensure data accuracy.

1.2 Light intensity detection circuit In the design, light intensity detection is mainly conducted on the basis of TSL2561[3] digital light intensity detection circuit. The light signals detected are fed into the single-chip microcomputer through A/D conversion in the working conditions as shown below: When the light intensity falls within 2 000 - 10 000 lx, the light control circuit does not work; when the light intensity is greater than 10 000 lx, the light drive circuit will drive to put down the sunshade net so as to reduce light intensity; and when the light intensity is less than 2 000 lx, the light drive circuit will drive to fold up the sunshade net and turn on the fluorescent lamp. In this way, the greenhouse

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temperature can be controlled within the designed light intensity range.

1.3 Design of drive circuit As the output voltage and current of the single-chip microcomputer are insufficient to drive the 12V relay, triode amplification should be performed to drive the relay, as shown in Fig. 2.

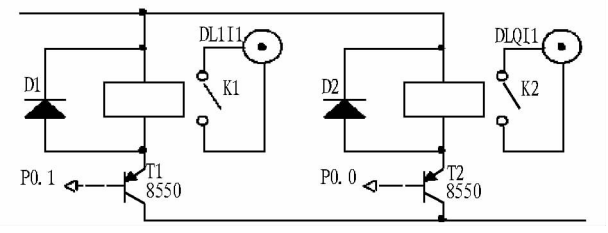

Fig. 2 Drive circuit

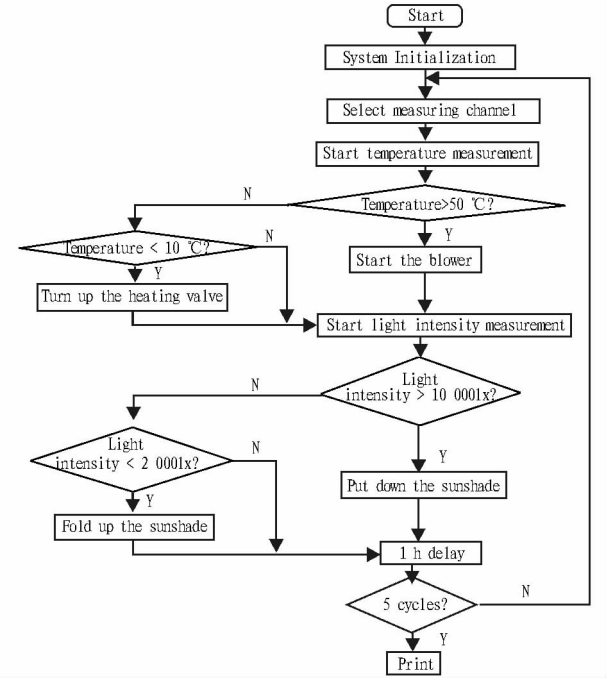

Fig. 3 Process Flow

2 Software design

Feed the signals collected by SHT11 digital temperature sensor into the single-chip microcomputer AT89S52 through P1.5 interface; feed the signals collected by TSL2561 light sensor into the single-chip microcomputer AT89S52 through P1.6; connect the temperature and light drive circuits with the interface of single-chip microcomputer AT89S52. The program flow chart is shown in Fig. 3.

After program initialization, select to start temperature measurement first: when the temperature exceeds 50℃, the P0.1 interface of the single-chip microcomputer AT89S52 lies at "0" and the PNP triode T1 drives the relay to start the blower so as to reduce the temperature; when the temperature is lower than 10 ℃, the P0.0 interface of the single-chip microcomputer AT89S52 lies at "0" and the PNP triode T2 drives the relay to turn up the valve so as to increase the temperature. Start light intensity measurement: when the light intensity is > 10 000 lx, the P0.7 interface of the single-chip microcomputer AT89S52 lies at "0" and the PNP triode T3 drives the relay to put down the sunshade net; and when the light intensity is > 2 000 lx, the P0.6 interface of the single-chip microcomputer AT89S52 lies at "0" and the PNP triode T4 drives the relay to fold up the sunshade net and supply power to the fluorescent lamp. Set the program as detecting once another hour and repeat the cycle so as to control the greenhouse temperature and light intensity within the designed range.

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