Intelligent Window Control System Based on Single Chip Microcomputer

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Abstract: The main traditional method to solve the rain problem in the current domestic living environment is to use manual opening and closing windows. However, manual opening and closing is not only laborious, but also unhumanized in many aspects, which may cause many problems for the users. Design a smart window system that can automatically control window closing and opening in real time based on the surrounding environment. The surrounding environmental parameters are obtained through multiple sensor detections. The STC89C52 main control module is responsible for the integrated analysis of the obtained digital data, thereby controlling the stepping motor to replace the manual operation of the windows. This design can be modified on the basis of the existing traditional windows or integrated factory production, so it has the characteristics of low cost, easy to use and having good market prospects.

1. Introduction

A window that allows light and air to enter the room in architecture refers to a hole in the wall[1]. With the rapid development of the current level of science and technology, the process of intelligence is also developing, and people's living standards have also been essentially promoted. It has already penetrated into all aspects of our lives. Intelligent control products can be seen everywhere in our life. In this context, the design of smart windows emerges as the times require. Compared with traditional windows, it jumps out of the traditional sense that relys on people to make judgments and mechanical operations, and is completely handed over to the system to sense the changes of the surrounding real-time environment. The control system of intelligent windows integrates modern machines, electricity, and communication, and the comprehensive use of sensor technology, modern communication technology, computer technology and automatic control

technology [2].

2. System Design

The system design has the most basic function of the window control system, that is, it can automatically control the opening and closing of windows according to the amount of rain in the external environment. On the premise of basic functions, the design also adds a voice recognition mode, which can automatically Control switch. In terms of design choice and components, the system is based on simple, practical and economical ideas to simplify the power system as much as possible. The system in this article has the following basic functions:

A. Automatic control: This function is to realize the opening and closing control of the window according to the change of the external environment (according to the user's set rainfall amount);

B. Automatic voice control: The system can automatically open and close windows according to the user's voice control;

C. Temperature and humidity display system: The temperature and humidity of the current environment can be displayed on the LED screen in real time by itself;

D. Manual control button to switch the above two automatic modes.

3. System Hardware

The overall hardware design consists of temperature and humidity acquisition module, raindrop sensor module, stepper motor control module, voice module, STC89C52 single-chip microcomputer control module, and LCD display module.
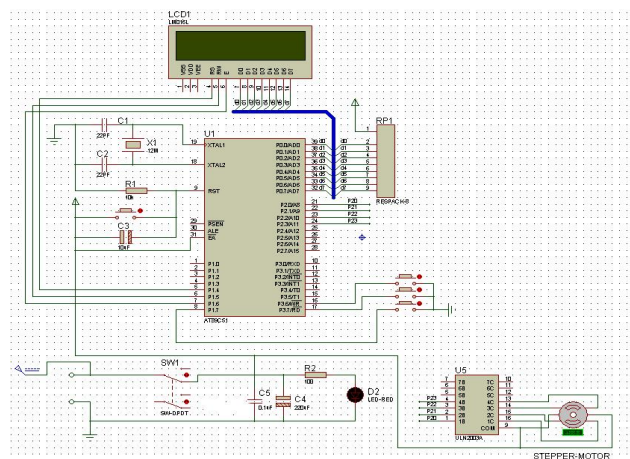

Figure 1: Overall circuit diagram.

3.1. Temperature and Humidity Acquisition Module

Temperature and humidity are the most basic environmental testing elements in daily life and are closely related to people's lives. The system uses DHT11 digital temperature and humidity sensor. Digital temperature and humidity sensor is a sensor device composed of temperature and humidity composite, its output signal is more accurate. Sensor consists of resistance sensor and NTC sensor[3], and connected to a microcomputer with strong logic operation ability. The sensor is
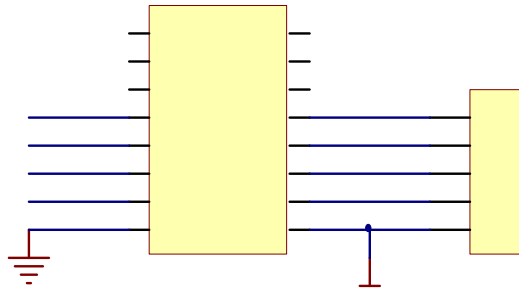
sensitive and the sensing coefficient is accurate. Therefore, compared with other sensors of the same type, this product has accurate output, outstanding anti-interference ability and high cost performance.

3.2. Raindrop Sensor Module

As the name suggests, the raindrop sensor is now used to detect the amount of raindrops. The most commonly used is the wiper on the car[4]. In this system, the working principle of the raindrop sensor is: when there is no raindrop on the glass, since most of the light emitted is refracted out of the glass, the intensity of the light that is reflected back is very small; when there are more raindrops on the glass , The light intensity reflected by the glass increases, so the sensor output changes[5]. When the water droplet does not drop on the detection glass of the raindrop sensor, its output port outputs a high level, and the high level signal is output to the single-chip microcomputer. The single-chip microcomputer receives the signal to control the stepper motor to start working. Otherwise, it outputs a low level to control the corresponding operation.

Figure 2: Circuit diagram of raindrop sensor module.

3.3. Stepper Motor Control Module

In order to achieve the precise control of the window switch, a four-wire two-phase stepper motor[6], and select ULN2003 as the drive chip for the stepper motor. We use ULN2003 provides the pulse signal for the stepper motor. The open collector output and continuous clamp diode in the circuit are used for transient suppression. It is can be very good to use low-level logic operation circuit requirements, and it also can replace manpower at high speed and effectively to achieve window switching.

Figure 3: Stepper motor control module circuit diagram.

3.4. Voice Module

In this system, the module mainly controls the ability to open and close the window under the voice module. The voice module used is the LD3320 speech recognition chip. More energy saving and high efficiency are considered to be the advantages of this chip, which can achieve direct connection Effect, so it can be integrated directly into existing products to achieve speech recognition / sound control / human-machine dialogue. In addition, the keywords for speech recognition can also be set arbitrarily, and the list of keywords can also be stored internally accordingly.
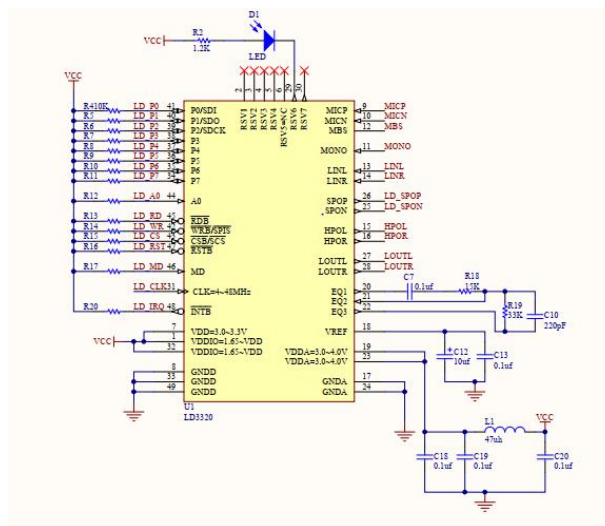
Figure 4: Voice module circuit diagram.

3.5. STC89C52 Microcontroller Main Control Module

Although the minimum system of the single-chip computer sounds small, the sparrow is small and complete[7].STC89C52RC is a low-power, high-performance CMOS 8-bit microcontroller produced by STC, with 8K bytes of system programmable flash memory[8]. The working voltage range of the STC89C52 microcontroller is 4v-5.5v, so it is usually powered by an external 5v DC power supply. The connection method is that the 40-pin vcc in the microcontroller is connected to a

positive 5v, and the 20-pin vss is connected to the power ground[9].

The clock circuit is the core part of the entire microcontroller control circuit, which is controlled by it. The clock circuit is an oscillating circuit that provides a sine wave signal to the microcontroller as a reference to determine the execution speed of the microcontroller XTAL1 and XTAL2 are the inputs and outputs of the inverting amplifier, respectively, and can be configured as on-chip oscillators. If you use an external clock source to drive the device, you should not connect XTAL2[10].
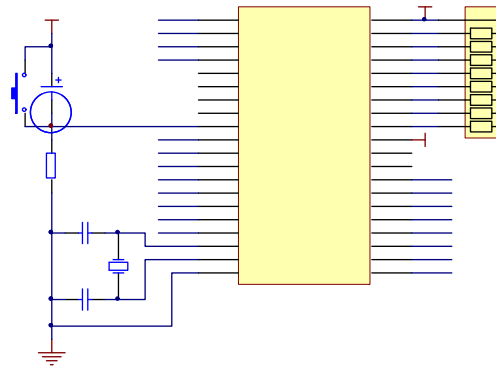
Figure 5:SCM circuit diagram.

3.6. Liquid Crystal Display Circuit

The LCD module used in this system is LCD1602. Its dot matrix LCD module can display letters, numbers, symbols, etc. Each line displays 16 characters, which can realize 4 lines of LCD display. LCD 1602 control requires only 3 control lines Normal operation, data can be sent to the monitor in parallel via the data cable[11], the liquid crystal is composed of M rows and N columns of display cells. Assume that the LCD display has 64 rows, each row has 128 columns, and each 8 rows corresponds to 1 byte of 8 bytes, that is, each row contains 16 bytes. The screen has a total of 28 dots, 64 * 16 display units and a 1024-byte display ram. The content of each byte corresponds to the light and dark positions on the screen[12].
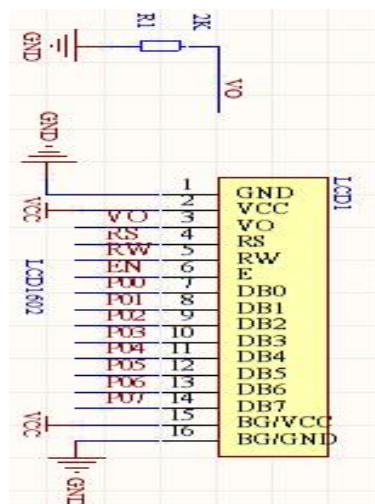

Figure 6: LCD1602 circuit diagram.

4. Software Design

4.1. Program Flow Realized by Environmental Parameter Acquisition Function

The subroutine is mainly for the process of external information collection system, including the sensing of temperature and humidity, sensing of rainfall, recognition of external voice, etc.[13].

The main function of smart window system design is to realize the function of data collection of environmental parameters. The hardware program is mainly composed of clock system program, timer interrupt program, analog-to-digital conversion program, rainfall calculation program, etc. Rainfall calculation is based on when raindrops drop to the sensor on the surface, the piezoelectric effect of the piezoelectric vibrator is used to convert the mechanical displacement into an electrical signal, and then analyze the voltage fluctuations generated by the electrical signal to achieve precise control of the window. The completed control program is to start the main program and then initialize Register, initialize the display content, and then perform the key query and perform the corresponding operation. After a period of time, the stepper motor starts the corresponding work and stops after the work is completed. If the motor control key is used, the corresponding work will also be performed If they are not, then it is a reset key for reset operation[14].

4.2. .Temperature and humidity measurement program design

The temperature and humidity of the current environment is detected by DHT11 and the parameters are uploaded to the microcontroller, temperature and humidity measurement is performed every 1s.This allows the temperature to be measured once in a second. The main function of the main program is responsible for displaying the temperature in real time, reading and processing the current temperature value of DHT11, and displaying it on the display.

5. Functional Test of the System

Press the power button to enter the working mode selection. If pressing the button again it will enter the mode selection into the automatic mode. When the water drops do not fall on the detection glass of the raindrop sensor, its output port outputs a high level, and the high level signal is output to the single-chip microcomputer. The single-chip microcomputer receives the signal to control the stepper motor to start working; otherwise it outputs a low level to control the corresponding operation. By processing the data onSTC89C52, the forward and reverse rotation of the stepper motor is controlled to achieve the curtain Control. Because the conditions are limited, the curtain switch is indicated by the forward and reverse of the stepper motor. Selecting the automatic mode by pressing the button displays zd on the display, and can display the current stepper motor (curtain) status. Pressing the button again will select the voice mode, and then yy will be displayed on the display, and it can also display the current status. At this time, the stepper motor starts to forward or reverse according to the corresponding settings, thereby achieving the original goal.

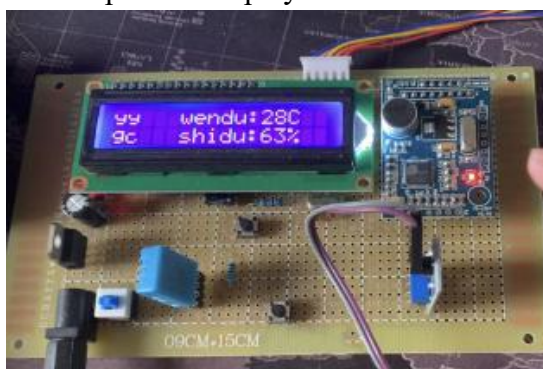Figure 7: Open the display in the automatic state.

Figure 8: Close the display in the voice state.

6. Conclusions

This system design takes STC89C52 as the core, and relies on sensors such as raindrop sensors, DHT11, and analog-to-digital conversion in combination with stepper motors to achieve automatic control in function, and also expands and innovates functions, adding more Simple voice mode, which recognizes voice commands through the voice sensor LD3320, thus realizing highly intelligent household items. The entire system design covers the steps of standard source design[15], circuit design, hardware selection, program algorithm design, welding, and debugging. The system design is simple and convenient, and it can realize voice control at a certain distance, and the market prospect is very good.

Acknowledgments

References

[1] Wang Fangliang. Application of "window" symbol in product design [J]. Film Review, 2013 (10): 98-100.

[2] Xing Tingting. Intelligent window based on single chip microcomputer [J]. Science & Technology Economics Market, 2019 (03): 5-5.

[3] Ji Shuang. Design of temperature and humidity monitoring system for grain silos based on gprs [J]. Agricultural Machinery Use and Maintenance, 2013 (12): 29-29.

[4] Wang Li. Design of automotive wiper system based on arm architecture [J]. Mechatronics, 2010 (01): 73-74.

[5] Wang Hao. Research on smart window system based on stc51 [J]. Information Communication. 2019 (01): 151-154.

[6] Liu Haifeng. Design of intelligent controllable switch windows based on multiple sensors [J] Automation Application. 2019 (06): 153-154.

[7] Zhang Yu. Design of intelligent temperature-controlled seat [J]. Foreign students. 2015 (11): 2-2.

[8] Chen Zhixin. Design of smart window based on stc89c52 single-chip microcomputer [J]. Science and Technology Innovation, 2017 (15): 15-15.

[9] Du Deyin. Analysis of design circuit of street light control system based on photoelectric sensor [J]. Science and Technology Information, 2013 (36): 138-140.

[10] Lv Xiaoying. A bed call system for short-range wireless data communication [J]. Application of Single Chip Microcomputer and Embedded System, 2018 (08): 4-4.

[11] Zhang Lixiong, Liu Hong. Intelligent curtain control system based on msp 4 30 [J]. Science & Technology Economics Guide, 2016 (20): 1-1.

[12] Ye Jianbin. GPS application based on single chip embedded system [J]. Electronic Quality, 2008 (07): 23-31.

[13] Bai Chenjiao. Design of Intelligent Window Control System [J]. Communication World, 2018 (06): 241-242.

[14] YU Zuojun. Design of temperature-controlled light-control intelligent curtain based on single-chip microcomputer [J]. Control Engineering, 2016 (10): 4-4.

[15] Xu Wei, Feng Xiaoyu, Wu Rui. Design of Weak Standard Source Based on Analog Devices [J]. Electronic Devices, 2019, 42 (05): 1195-1200.