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Research on the design of intelligent window System based on STC8051

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ABSTRACT

The ultimategoal of smart home is to solve the needs of "people",in the intelligent stage of the whole house, in various scenes, all intelligent appliances will be united into a unified whole, in order to solve the personalized needs of "people",self-learning users' living habits and characteristics, automatic realization of a full range of linkage.This product can closely follow the pace of the development of smart homes and meet the users' requirements for the pursuit of Internet of Things and intelligence, that is, this product can enable users to manage windows to break the limitations of time and space. At present, most of the smart windows on the market are window closers that smartly close windows when it rains. The function is not perfect and the effect is not smart enough. On this basis, the work finds the most efficient program for processing multiple sensors through continuous experiments. Through experiments, we have obtained STCA8051 single-chip microcomputer combined with different sensors and different sensors and different types of products with different functions.

Keywords: automatic control; Smart home; The Internet of things;

The continuous development of 5G technology, block chain, artificial intelligence and AI technology has promoted the development of the smart home industry. Since 2011, the market has shown a growth trend, and the increase in volume indicates that the smart home industry has entered an inflection point, entering a new round of integration and evolution from a wandering period. In the next three to five years, the smart home will enter a period of rapid development on the one hand, and on the other hand, protocols and technical standards will start to communicate and integrate actively. Led by the development of artificial intelligence and Internet of Things technology, the smart home is still hot, and the industry is booming. Internet giants and emerging startups lay out their hardware, technology, system solutions and other different perspectives, and the smart home system is emerging. With the continuous improvement of artificial intelligence technology, the variety of smart home products is increasing day by day.

This product can closely follow the pace of the development of smart homes and meet the users' requirements for the pursuit of Internet of Things and intelligence, that is, this product can enable users to manage windows to break the limitations of time and space. At present, most of the smart windows on the market are window closers that smartly close windows when it rains. The function is not perfect and the effect is not smart enough. On this basis, the work finds the most efficient program for processing multiple sensors through continuous experiments. Through experiments, we haveobtained STCA8051 single-chip microcomputer combined with different sensors and different types of products with different functions. In addition, infrared sensing equipment and motors are combined to achieve efficient processing of external data, making windows more intelligent, more targeted, and peoples'life experience become stronger.

1. OVERALL SYSTEM OVERVIEW

1.1 Overview of the overall smart window principle

This product is a smart home sliding window. The main

function is to automatically close and open the window according to the changes in the external climate environment; it can also automatically adjust the light according to the degree of indoor and outdoor light, improve the indoor light intensity according to needs, and create a comfortable interior Livable and healthy living atmosphere; users can also intuitively learn the weather conditions of the day through the temperature and humidity on the LCD display; infrared sensing technology can detect the presence of human bodies and obstacles in time to avoid possible damage and wear during operation .

This product incorporates a number of smart sensing technologies. The product's control system consists of mechanical transmission, smart sensing module, infrared sensing protection module, MG995 steering gear, window structure bracket, glass, LCD dimming film, etc. The intelligent window system can be divided into several parts: central control system, intelligent sensor system, infrared protection system, liquid crystal display system, automatic dimming system. The basic principle block diagram is shown as in Fig.1.

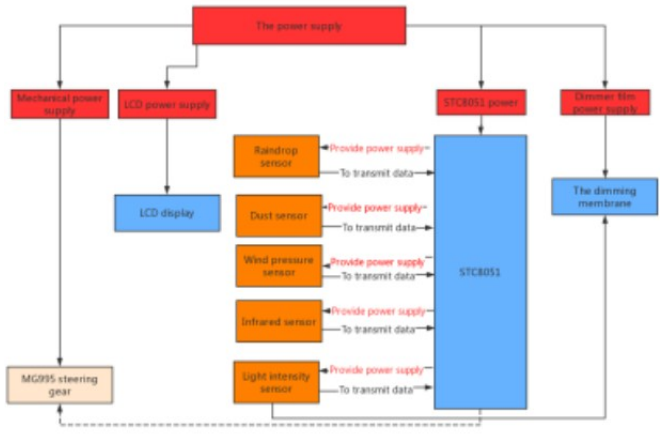

FIG. 1 Basic principle block diagram

1.2 SCM system module

1.2.1 Humidity detection module

The humidity sensor is the simplest humidity sensor. Wet-sensitive elements are mainly composed of resistive type and electric DAO type. They are characterized by covering a film made of moisture sensitive materials on the substrate. When the water vapor in the air is adsorbed on the film, the resistivity and resistance value of the elements change, and humidity can be measured by using this feature. Moisture-sensitive capacitors are generally made of polymer film capacitors, and the common polymer materials are polystyrene, polyimide, acetic acid fiber caseate, etc. When the environmental humidity changes, the permittivity of the humidity sensitive capacitor changes, so that its capacitance also changes. The capacitance change is proportional to the relative humidity.

The humidity sensor HS1100 used in the system is a variable capacitive sensor, which is equivalent to a capacitive component in the circuit composition, and its capacitance value will increase as the detected humidity in the air increases. In order to accurately convert the change of capacitance into a form that is easy for the computer to accept, HS1100 and IC555 are formed into a multi-resonant circuit, and the change of capacitance is converted to the opposite resonant wave frequency signal.

Since there is no time to charge the capacitor C when the power supply is connected to the circuit, Vc = 0v, so the output Vo is high. When the capacitor C is charged, the circuit temporarily enters a stable state, and then a periodic output pulse is generated in the circuit. The holding time of transient steady state I, that is, the forward pulse width of output vo, will be $t1 \approx 0.7(r1 + r2)c$. In the transient steady state, the maintenance time of II is $T2 \approx 0.7R2C$.

Therefore, the oscillation period T=T1+T2= 0.7(R1+2R2)C, and the oscillation frequency f=1/T. The ratio of the forward pulse width T1 to the oscillation period T is called the duty cycle D of the rectangular wave. According to the above conditions, D=(R1+R2)/(R1+2R2), if R2>>R1, then DH"1 /2, that is, a rectangular wave (square wave) with the same positive and negative pulse width of the output signal. As shown below, Figure 2 is its schematic diagram. Figure 3 shows the relationship between frequency and humidity.

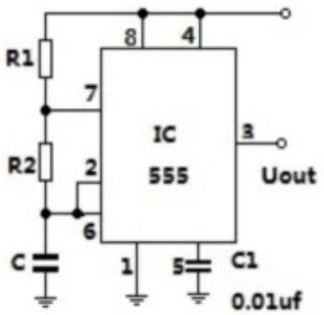

Fig 2 Schematic diagram of humidity sensor HS1100

Humidity (T)	Frequency(f)	Humidity (T)	Frequency(f)
0%	7355	60%	6642
10%	7230	70%	6462
20%	7102	80%	6328
30%	6980	90%	6187
40%	6855	100%	6033
50%	6733		

Fig 3 Frequency and humidity relationship diagram

1.2.2 Light Sensor Module

Light sensor is a sensor for detecting light intensity, referred to as the intensity of illumination, the working principle is to light intensity values into voltage value, tell from the working principle, intensity of illumination sensor is a kind of using hot effect principle, this kind of sensor is the most important is the use of the reaction of weak light has higher detection components, these original induction actually like camera sensitive matrix, internal winding plating type multijunction thermopile, its surface coated with high absorption rate of the black coating on the hot junction on the induction, while cold joints in the body, hot and cold junction temperature electric potential. In the linear range, the output signal is proportional to the solar irradiance. The visible light from the filter hits the imported photodiode, which is converted into an electrical signal based on the visible light. The electrical signal then enters the sensor's processor system and outputs the desired binary signal.

The GL5549 photoresistor used in this system has a light resistance of 100-200 $K\Omega$, Its dark resistance is 10 $M\Omega$, works between $-30°C \sim +70°C$ 0 The response time of resistance value rising is 20ms, and the response time of resistance value falling is 30ms. The temperature characteristic curve is shown in Figure 4.

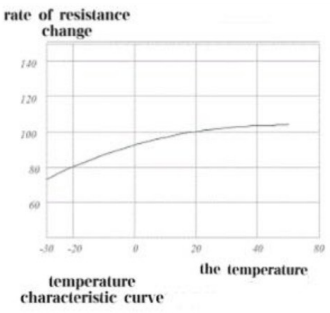

FIG 4 Temperature characteristic curve

Considering that the monitoring environment may be in a high humidity and high temperature environment, the CdS type photoresistor with high temperature and humidity resistance is selected. The detection principle of photoresistor is to use the internal photoelectric effect. When the light intensity is high, its resistance value will decrease. The stronger the light intensity rises, the faster the resistance value will decrease. If the light intensity is low, the resistance value will increase. The sensitivity of the photoresistor to light (that is, the spectral characteristics) is very close to the human eye's response to visible light (0.4 to 0.76), so if the human eye can detect light, these will cause resistance changes.

In the application circuit using the photoresistor, the signal collected by the photoresistor GL5549 is an optical signal, and the output signal is an analog quantity. Therefore, when connecting with the STM32 main controller, the optical signal needs to be converted into an analog signal and then converted into a digital signal. Therefore, it is necessary to connect to the pin capable of digital-to-analog conversion, and then transmit the light intensity to the microcontroller.

1.2.3 Piezoelectric raindrop sensor module

Raindrop sensor is a sensing device, which is mainly used to detect whether it is raining or not and the size of the rainfall. It is widely used in auto automatic wiper system, intelligent light system and intelligent skylight system. Piezoelectric raindrop sensor makes use of the piezoelectric effect of its piezoelectric vibrator to change the mechanical displacement (vibration) into electrical signal, and then controls other elements according to the voltage waveform of the energy transformation of raindrop impact. And according to the variation of voltage waveform, the amount of rainfall can be obtained, so as to control the vehicle wiper more accurately.

The system uses yl-83 piezoelectric raindrop sensor. The energy of raindrop impact is collected on the vibration plate inside the sensor, and the vibration is carried out according to its own natural vibration frequency. The data of mechanical vibration is converted into electrical signal by the piezoelectric effect of the electric vibrator in the sensor. The voltage waveform generated by the sensor will be amplified, and the circuit signal will be input into the circuit to charge the circuit composed of capacitor. When the capacitor voltage rises, the comparison circuit will compare the voltage with the

input voltage, and feedback the information to the STM32 main controller.The schematic diagram of piezoelectric vibrator is shown in FIG 5. The relationship between rainfall and output voltage is shown in FIG 6.

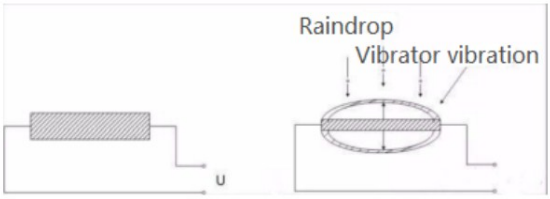

Fig. 5 Schematic diagram of piezoelectric vibrator

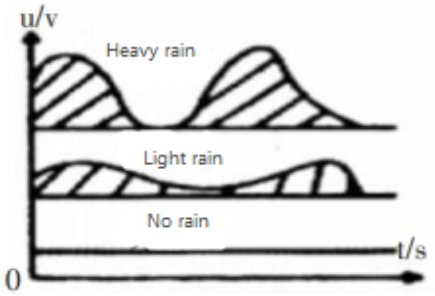

Fig. 6 Relationship between rainfall and output voltage

1.2.4 Infrared sensor module

The human body has a constant temperature, so it will emit infrared rays of about 10 ìm at a specific wavelength.The passive infrared probe works by detecting the wavelength of about 10 ìm emitted by human body.Infrared sensor is a kind of sensor which uses infrared to process data. It has the advantages of high sensitivity.The infrared rays emitted by the human body are enhanced by a Fresnel lens and concentrated on the infrared sensor source.The pyroelectric element is used in the infrared induction source, which will lose the charge balance and release the charge when receiving the radiation temperature change of human body.FIG. 7 is the schematic diagram of Fresnel lens, and FIG. 8 is its equivalent circuit diagram.

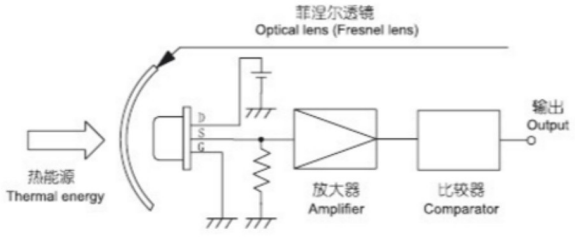

Fig. 7 The schematic diagram of Fresnel lens

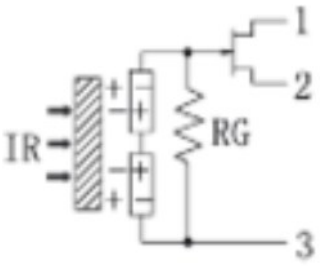

Fig. 8 Equivalent circuit diagram

The dual-element pyroelectric infrared sensor SDA02-54(PD632) is adopted in this paper.Its external dimensions are shown in FIG 9.The sensing angle is shown in FIG 10.According to the experimental experience, the most suitable size and shape of infrared sensor are selected as shown in FIG 11.The parameter characteristics are shown in FIG 12.

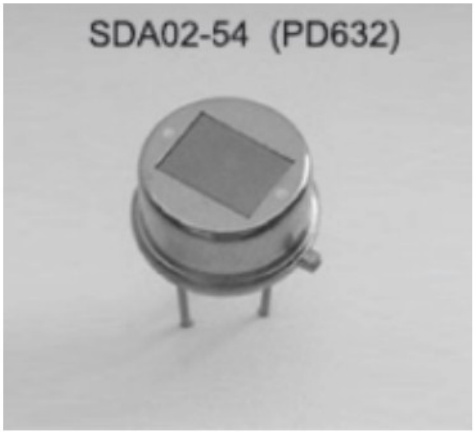

FIG. 9 External dimensions

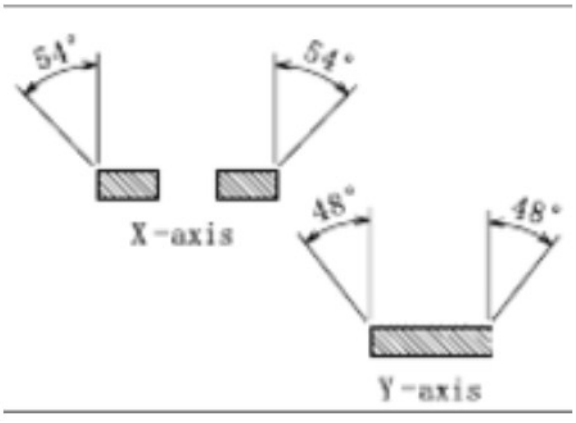

FIG. 10 Sensing angle

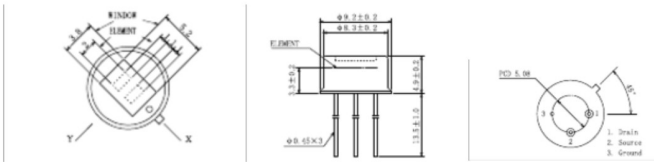

FIG. 11 Size and shape

Sensitive Area	2*1 2 elements
Spectral Response	7-14
Signal Output	3200
Sensitibity	3400
Detectivity	1.4*100000000
NEP	1.0*0.000000001
Noise	70
Offset Voltage	0.8
Supply Voltage	2.2-15
Operating Temp	-30-70
Storage Temp	-40-80

FIG. 12 Parameter characteristics

Infrared detectors can be divided into two categories according to their sensitive elements, namely “thermal detector” and “photoelectric detector”.The thermal detector responds to all kinds of wavelengths, while the photodetector only responds to a wavelength range below its long wavelength limit.The thermal detector does not need to be cooled while the photoelectric detector needs cooling.Generally, the responsivity of thermal detector is lower than that of photodetector, and the response time of thermal detector is longer than that of photodetector.The performance of the heat detector is related to the size, shape and process of the device. Therefore, the process is very important, and the product specification is not easy to be stable.The infrared sensor used in this system is pyroelectric infrared sensor.The basic principle of thermal detectors in detecting infrared radiation consists of two main processes.The first process is that the temperature of the thermal detector increases with the absorption of infrared radiation energy. With the change of incident radiation power, the temperature of the element also changes correspondingly;The second process is to convert the temperature change caused by radiant energy into corresponding electrical signals by using some temperature sensitive characteristics of the element.FIG 13 shows the frequency characteristics of the amplifier in the equivalent circuit of the infrared sensor. FIG 14 shows the relationship between infrared relative sensitivity and shading frequency.

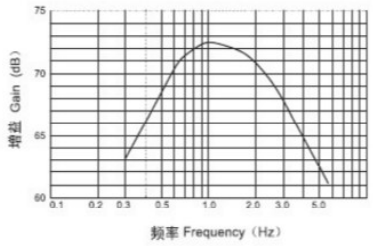

FIG.13 Frequency characteristics of the amplifier in the equivalent circuit

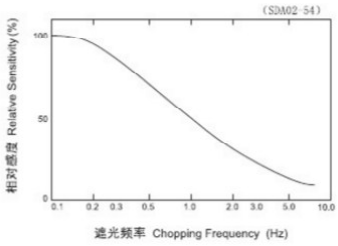

FIG.14 Relationship between infrared relative sensitivity and shading frequency.

1.2.5 Dust sensor module

The dust concentration sensor is an intrinsically safe product. It adopts the principle of light scattering to detect the dust mass concentration of underground air in coal mines. It has a variety of standard signal output and alarm functions and can be used alone or in conjunction with the coal mine safety monitoring system. Dust concentration sensor is a kind of intelligent instrument. The functions of zero setting, preset K value, alarm setting and so on can be realized by remote control. It is stable, reliable and easy to use.

There is a hole in the center of the sensor that allows air to flow freely and emit LED light directionally.The content of dust is determined by detecting the light refracted by dust in the air.FIG 15 shows its schematic diagram.

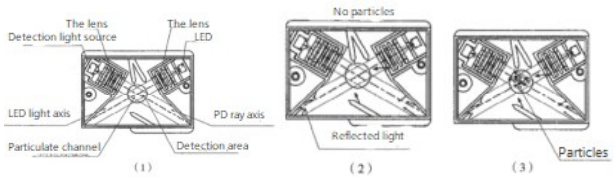

FIG.15 Schematic diagram

The system adopts GP2Y1010AU0F dust sensor, its shape is shown in FIG 16, and its simulation circuit is shown in FIG 17.The specific parameters of the dust sensor selected by this system are shown in FIG. 18.In

this system, the analog signal of different dust concentration is detected by dust sensor and converted into different voltage value, so as to judge whether the value of window closing action is reached in MCU.The relationship between dust concentration and different output voltage values is shown in FIG 19.

FIG.16 Shape of GP2Y1010AU0F dust sensor

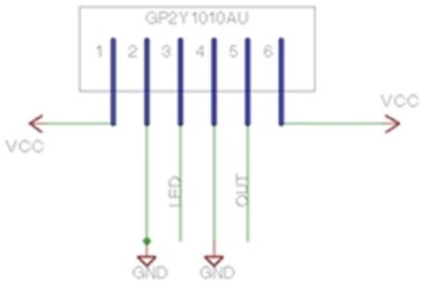

FIG.17 Simulation circuit

The power supply voltage	DC5±2V
Working current	20mA
sensitivity	0.5V/(0.1mg/m3)
Minimum particle detection value	0.8¼m
Clean the voltage in the air	0.9V
Working temperature	-10~65!
Storage temperature	-20~80!
service life	5 years
size	46mm×30mm×17.6mm
size of the weight	15g

FIG.18 specific parameters

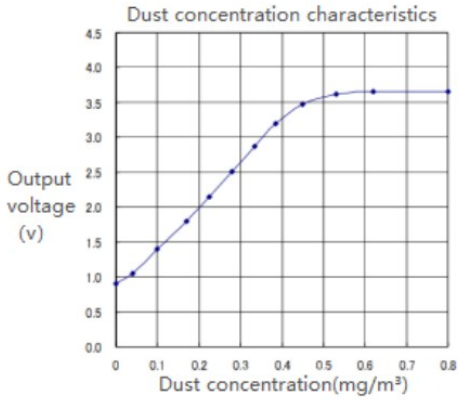

FIG. 19 Relationship between dust concentration and different output voltage values

Generally, cigarette smoke is fine particles, high density, will diffuse large-scale drift.Compared with this, dust is a large particle, low density, intermittent into the detection field of dust sensor.As shown in the figure below, smoke is continuously showing a higher output voltage, and dust is spaced to show a higher output voltage.Therefore, according to the output voltage value (luminous element and pulse output voltage value of the same period) of the sensor, it can be read from the microcomputer software whether there is dust / smoke / dust, no matter which state it is, and how much the air pollution is.The relationship between different dust and its output waveform is shown in FIG 20.

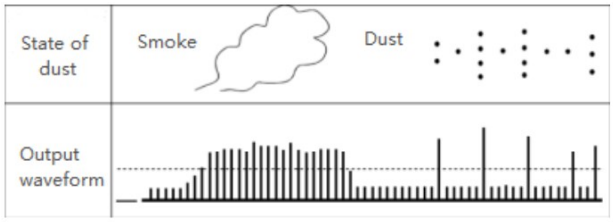

FIG.20 Relationship between different dust and its output waveform

1.3 Principle analysis of stepping motor

When the stepper driver receives a pulse signal, it drives the stepper motor to rotate a fixed Angle in the set direction, that is, the stepping Angle. The angular displacement is controlled by controlling the number of pulses so as to achieve the goal of accurate positioning. At the same time by controlling the pulse frequency to control the motor rotation speed and acceleration, so as to achieve the purpose of speed regulation. The stepper motor has the following characteristics:

1. The moment of stepper motor will decrease with the increase of speed. When the stepping motor rotates, the inductance of each phase winding of the motor will form a reverse electromotive force, the higher the frequency is, the greater the reverse electromotive force will be. Under its action, the phase current of the motor decreases with the increase of frequency or speed, which leads to the decrease of torque.
2. The stepper motor can run normally at low speed, but if it is higher than a certain speed, it cannot start, and accompanied by a loud noise. The stepping motor has a technical parameter called no-load start frequency, that is, the pulse

frequency that the stepping motor can start normally under no-load condition. If the pulse frequency is higher than this value, the motor cannot start normally, and step-loss or stalling may occur. Under load, the startup frequency should be lower. If the motor is to reach high speed rotation, the pulse frequency should have an acceleration process, i.e. the starting frequency is low, and then the desired high frequency is increased according to a certain acceleration (motor speed is increased from low speed to high speed).

3. The maintaining torque of stepper motor refers to the moment when the rotor is locked by the stator but not rotated. It is one of the most important parameters of stepper motor, usually the moment of stepper motor at low speed is close to the holding torque. As the output torque of the stepping motor decreases with the increase of the speed, the output power also changes with the increase of the speed, so maintaining the torque has become one of the most important parameters to measure the stepping motor.
4. the stepper motor must be driven to run, drive signal must be pulse signal, no pulse, the stepper motor is static, if the appropriate pulse signal is added, it will be at a certain Angle (known as the step Angle) rotation. The speed of rotation is proportional to the frequency of the pulse.
5. The stepper motor has the superior characteristics of instant start and rapid stop.
6. Changing the sequence of pulses can easily change the direction of rotation. Therefore, at present, the printer, plotter, robot and other equipment with stepper motor as the power core.

Because the rotation angle of stepper motor is proportional to the number of pulses, the motor has the maximum torque when it stops (when the winding is magnetized), the accuracy of each step is between 3% and 5%, and the error of one step will not accumulate to the next step, so it has better position accuracy and motion repeatability, and the stepper motor has excellent start stop and reverse response.This system uses 25BY2406 stepping motor, its rated voltage is 12V, phase resistance is 20Ù, step angle is 15°.According to the experimental requirements, the power on sequence of step motor is A->AB->B->BC->C->CD->D->DA->A.And the rotation direction of the stepper motor is controlled by the output port of the single chip microcomputer and the phase winding one by one.In this experiment, P1.0, P1.1, P1.2 and P1.3 are respectively connected to the four phase windings A, B, C and D of the stepper motor, as shown in Fig. 21.

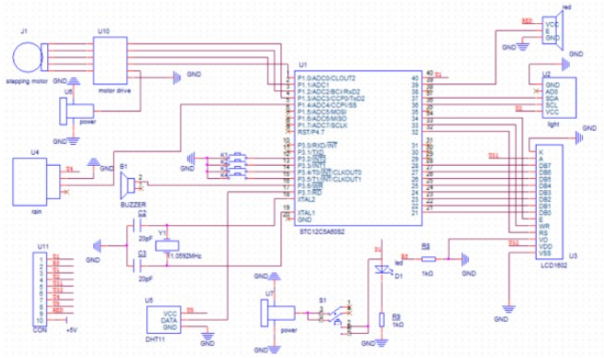

Fig. 21 Connection circuit diagram of sensor, stepper motor and STC12C5A60S2

In this experiment, the uln2003apg chip is used as the driver module, as shown in Fig.22. The pulse sequence and direction control signal of single chip microcomputer are output from P1.0 ~ p1.3 port, and transmit to ULN2003 chip for power amplification directly. The driving current and voltage are achieved to drive the 57BYG250-56 (2A, 0.9 N · m) stepper motor to work. The hardware circuit diagram of the motor drive module is shown in Fig.22.

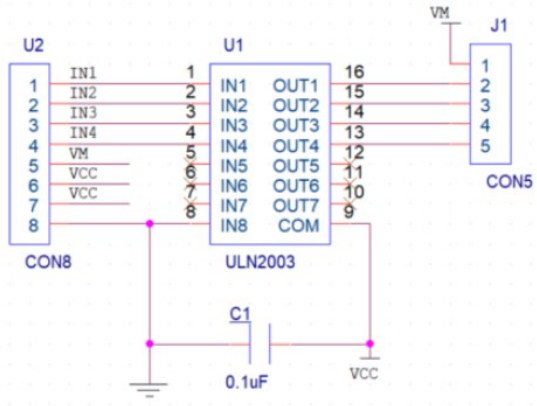

Fig.22 Hardware circuit diagram of drive module

In order to realize the precise control of windows' opening and closing, this experiment uses four phase six wire stepping motor, and selects ULN2003 APG as the driving chip of the stepping motor. The motor circuit simulation diagram is shown in Fig.23.

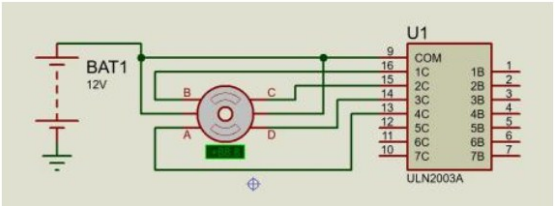

Fig.23 Circuit diagram of four phase six wire stepping motor

2. WORKING PROCESS ANALYSIS OF INTELLIGENT WINDOW

2.1 Working process analysis of each part

2.1.1 Analysis of overall working process

This system has a lot of functions, but the hardware part has replaced most of the software functions, that's why the software is relatively simple. The control tasks in the system are ultimately realized by software, and the design of software will affect the control performance of the whole system directly. The system will use modular structure, and integrate the modules to achieve the control requirements eventually.At the power electronics level, packaging multiple power electronic devices in one module can reduce the device size, the cost and improve the reliability. In this system, we have assembled power electronic devices and logic, control, protection, sensing, detection, self diagnosis and other information electronic circuits on a single chip to form a power integrated circuit. In terms of modular design, the system is mainly composed of three modules: function subroutine module, interrupt service module and stepper motor operation mode module. Among them, the function subprogram module includes A/D conversion control subroutine, judgment of external rainfall amount subroutine, judgment of external light intensity subroutine, judgment of external temperature and humidity subroutine, judgment of external dust concentration sensor, judgment of external wind pressure subroutine; interrupt service program includes 1s timing interrupt program of T0 and 1s counting interrupt program of T1, and judgment of whether there is an object to start interrupt mode while running the window closing action.The software module structure is shown in Fig.24.

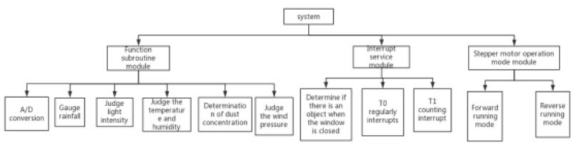

FIG. 24 Software module structure diagram

2.1.1 Working process analysis of temperature and humidity module

The main program flow of the system is shown in Fig.25. First of all, the system initialization, set the interrupt mode and turn itself on, set the interrupt mode, open interrupt, etc., then set the timer / counter working mode, turn on T0,and T1, T0 generates 1s timing interrupt, the 1s timing time generated by T0 is the gate time of the counter, while T1 counts the output frequency of STC8051 chip in Fig. 25, and the count value in 1s is the frequency of the resonant square wave, the relative humidity is used to determine the current by the frequency. Then repeating the cycle, the system reads the resonant frequency of the square wave every 1s, and continuously judges the weather conditions to control the operation of the stepping motor.

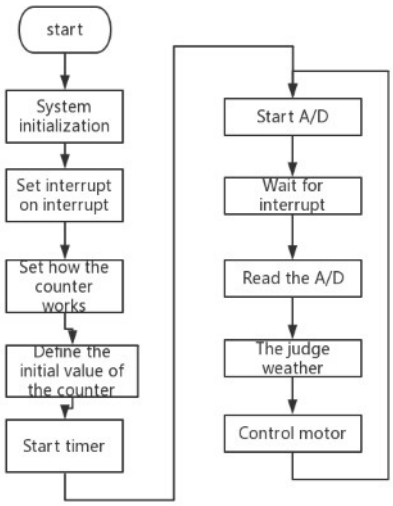

FIG. 25 Flow chart of main program of the system

2.1.1 Working process analysis of lighting module.

When measuring the light condition, according to the photoresistance is a negative resistance characteristic device, the greater the light intensity received, the smaller the resistance value, the smaller the voltage distributed in the series circuit; on the contrary, the smaller the light intensity, the greater the voltage distributed on the photoresistor. ADC0809 converts the analog voltage signal from the photoresistance into digital signal and transmits it to the single chip microcomputer, which judges the light intensity at that time. By comparing the intensity of light with the value specified in the program, the MCU determines the power output to the liquid

crystal dimming film system. The principle of liquid crystal dimming film "transparent on power, atomization off power" is used to achieve the best indoor light conditions.

2.1.2 Working process analysis of raindrop module

It is a piezoelectric raindrop sensor, which is used to measure rainfall. The piezoelectric raindrop sensor uses the piezoelectric effect of its piezoelectric vibrator to change the mechanical displacement into electrical signal, and controls other components in order to the voltage waveform transformed by the energy of raindrop impact. In the setting of raindrop sensor's program, timer T1 works to make TMOD = 0x20, SCON = 0x50 and set the baud rate to 9600. Generally speaking, through the digital analog interface of STC8051, the rainfall detected by the sensor is transformed into electrical signal, which will be judged in the internal program of the chip. The set value of the system program is 128. If the rainfall exceeds the set value of the internal program 128, the program judges that the rainfall is large and reaches the window closing value. Then program transmits the stepper motor the very signal, so that the stepper motor reverse to close the window. The flow function diagram is shown in Fig.26.

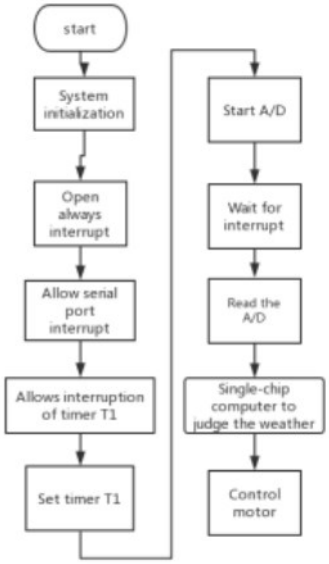

FIG. 26 Raindrop sensor flow chart

2.1.1 Working process analysis of dust detection module

When measuring the dust concentration, the phototransistor in the sensor can detect the reflected light of dust in the air, even the particles of tobacco can be detected. The infrared light-emitting diode emits light when encountering the dust to produce emission light. The receiving sensor monitors the light intensity of the reflected light and outputs the signal, then judges the dust concentration according to the light intensity, the measured concentration is compared with the concentration standard value of the program in the chip to determine whether to start the step motor to close the window.

2.1.2 Working process analysis of wind pressure detection module

When measuring the wind pressure, the pressure of the wind pressure sensor acts on the film directly, which changes the resistance of the sensor. The output pin of the wind pressure sensor connect to the STC8051 single chip microcomputer. The change of resistance affects the electric signal value of the input single chip microcomputer. The internal comparison of the wind pressure in the single chip microcomputer can make step motor to close the window.The flow chart of motor software is shown in Fig.27.

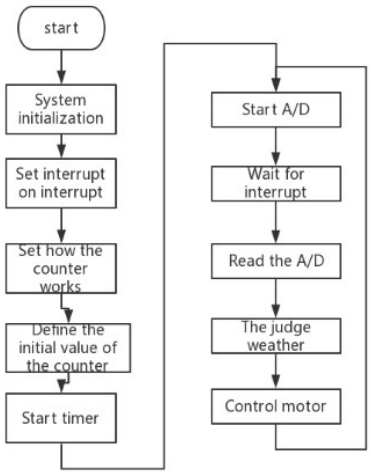

FIG. 27 Flow chart of motor software

2.1 Read A/D program design

In this system, ADC0809 analog-to-digital converter converts the analog voltage signals of piezoelectric vibrator, photosensitive resistor and photoelectric transistor into digital voltage signals, and then transmits them to the single chip microcomputer, which judges the light intensity, dust concentration and rainfall intensity. The flow chart is shown in Fig.26.

First of all, judge the digital signal after A/D conversion, i.e. rainfall. If the value after A/D conversion is greater than a certain value, take 500 in this paper, then it is considered that the rainfall is large and the motor reverses to close the window; if the A/D conversion value is less than 500, it is considered that the rainfall is small and the motor rotates forward to open the window.

As the digital signal after A/D conversion, judge the dust concentration. If the concentration is higher than a certain value, this paper takes 0.3ug/m³, which means the output voltage is higher than 1.5V, it is considered that the dust concentration is high, and reverse the motor to close the window. If the dust concentration monitoring is lower than 0.3ug/m³, which means the output voltage is lower than 1.5V, it is considered that the dust concentration is low, and forward rotating motor to open the window. A/D conversion diagram of dust sensor is shown in Fig. 28.

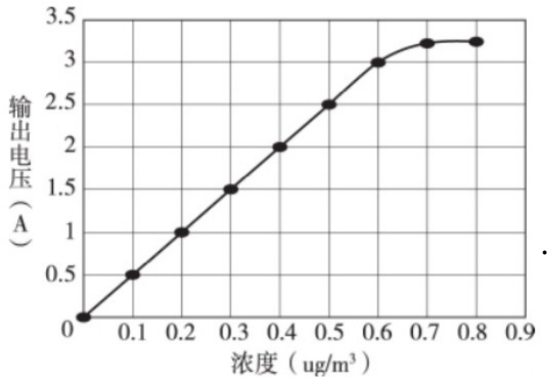

Fig.28 A / D conversion diagram of dust sensor

Finally, the digital signal after A/D conversion, i.e. the light intensity, is judged. If the digital signal after A/D conversion is not less than a certain value, 125 is taken as the light intensity in this paper. If the A/D conversion value is less than 125, the light intensity is strong (the photosensitive sensor is a device with negative numerical characteristics), The liquid crystal dimming film is used to adjust the light to reduce the indoor light intensity. If the output frequency of the humidity conversion circuit is in a certain range, take 30%~70% in this paper, the corresponding output frequency is 6468 ~ 6976, the humidity is considered to be appropriate, and the motor is required to turn forward to open the window; if the output frequency of the humidity conversion circuit is not within the above frequency range, it is considered that the humidity is not appropriate and the motor reverse to close the window. The flow chart is shown in Fig.29.

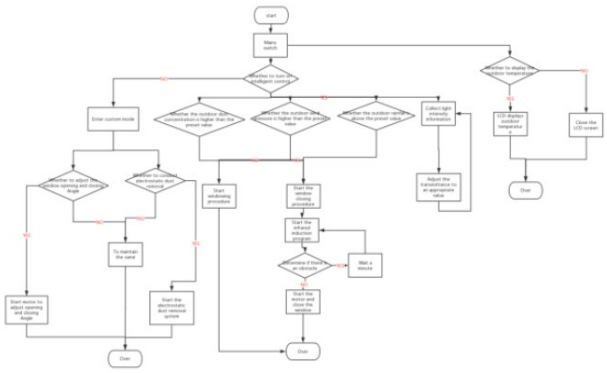

FIG. 29 Overall functional flow chart

2.1 System main program design flow

The software design of this system is based on keil and C speech. The whole system is based on STC8051 MCU. STC8051 development board is used as the main control unit of the system. Raindrop sensor, wind pressure sensor and dust sensor are installed on the window. At the same time, the window is equipped with safety device human body infrared induction electronic module. The function realization of the product is combined with the Internet of things. Users can select the intelligent degree of the window, whether the outdoor temperature and humidity are displayed, and whether the window external self-cleaning function is activated in the corresponding app. At the same time, the different sensors are used to monitor the outdoor environment in real time, and the algorithm is used to judge whether the environmental value exceeds the corresponding preset value, so as to rotate the motor for corresponding action. The software flow chart is shown in Fig.30.

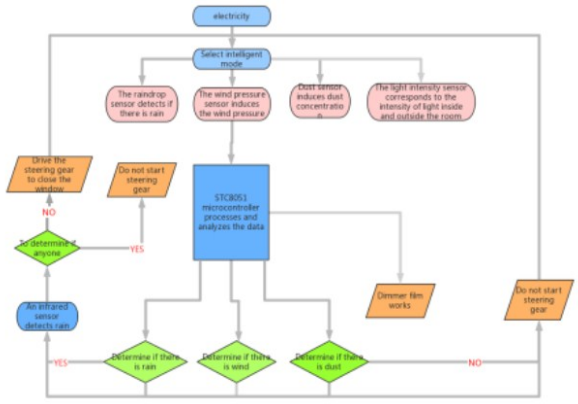

FIG. 30 Software flow chart

THE CONCLUSION

The intelligent window switch system based on STC8051 single-chip microcomputer designed in this paper realizes automatic window closing according to the external environment, so that people do not have to worry about the situation that they cannot close the window timely because they are not at home in a bad environment. The system has the characteristics of high integration, simple and convenient operation, and can control the window switch intelligently, stably, safely and reliably.

In the hardware selection of the system, STC8051 MCU as the control core, and additional external data memory and signal acquisition and processing circuit, control circuit, display circuit and so on. Our design has a beautiful overall layout, low power consumption, complete functions and low cost. Different hardware directly connected appropriate, independent operation without interference, and the connection of low delay, high precision, almost at the same time.

The software part mainly includes the main program, the system initialization program, the display subroutine, the software USES the single-chip microcomputer assembly language, USES the state matrix unit program thought to design, the program is written in the Windows XP environment by Keil software. Software compatibility is high, the overall speed is fast, no redundant unnecessary procedures, very simple, clear logic.

According to the survey, China's smart home has boomed in recent years with the development of 5G technology, artificial intelligence and the Internet of Things. At present, most of the smart home products are mainly concentrated in smart air conditioning, refrigerator, lighting, shading and other modules. In the development of smart Windows, it only stays in the simple, single intelligent window opener and curtain stage, with slow response speed and insufficient intelligence. In comparison, the processing speed of this product is 10% higher than that of the alternative products on the market. A variety of additional sensors, sensing accuracy, to different areas of a variety of climate conditions can achieve accurate grasp and timely treatment; With the acceleration of people's living standards, the strong desire for consumption upgrade, and the deterioration of environmental air quality, the demand for smart Windows is increasing, so this design will be widely applied and research value in the future.

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