International Core Journal of Engineering Volume 6 Issue 7, 2020
ISSN: 2414-1895 DOI: 10.6919/ICJE.202007_6(7).0048

# Design and Implementation of Intelligent Greenhouse System based on STM32

Youchan Zhu and Wenhua Zhang

School of Control and Computer Engineering, North China Electric Power University, Baoding, China.

## Abstract

**With the development of modern science and technology, the technology of Internet of things has been applied more and more in every walk of life. This paper mainly introduces the design idea and simulation experiment of an intelligent greenhouse system. The system mainly uses MQ-2 gas sensor, photosensitive resistance sensor and DS18B20 temperature sensor to collect data and is written in C language, Bluetooth serial port to mobile terminal. The data processing is divided into four modules: acquisition, transmission, receiving and processing. The data collection and processing of temperature, illumination and carbon dioxide content are realized in the intelligent greenhouse system. The intelligent greenhouse system can be widely used in indoor breeding, as well as indoor planting of vegetables, flowers and other industries with strict environmental requirements, providing people with accurate on-site environmental information, and automatically adjust the necessary indoor environmental information, save People's physical labor, to achieve energy saving and consumption reduction.So the Internet of things technology and people in the production and life of all walks of life each other is a bound to be the general trend.**

## Keywords

**Stm32, Internet of Things, Greenhouse,Automatic regulation, Sensor.**

## 1. Introduction

Today's society is developing from informationize to intelligentize, and how we achieve the intelligent society, this is the Internet of things.The most important thing for an intelligent society is data.And the Internet of things is the key to collecting data.Therefore, it is an inevitable trend that Internet of Tings technology and people's production and life influence each other.

With the continuous adjustment of China's industrial structure and the continuous development of various indoor planting and breeding industries, the requirements for indoor environment are more and more stringent, which requires more intelligent equipment.The intelligent greenhouse system in this paper is designed around the management of indoor environment.Through a number of different smart sensor pairs to collect indoor indicators data, such as temperature, light, carbon dioxide content, etc., and according to the per-set value range to achieve automatic adjustment of the site environment.The collected data will be displayed on the LCD screen so as to be monitored at any time. At the same time ,the data can be transmitted to the mobile APP through the Bluetooth module, so the indoor environment information can be controlled in real time to ensure timely understanding and maintenance.The system is divided into two parts: data collector and receiving server.The data collector needs to realize two functions of data collection and transmission,The important environmental information in the room is collected and transmitted to the mobile phone terminal through the Bluetooth module, which is convenient for us to observe and manage.The receiving server needs to realize two functions of data receiving and parsing,compare the received data with the preset

ISSN: 2414-1895 DOI: 10.6919/ICJE.202007_6(7).0048

values set by the user and make corresponding processing,which is realize intelligent management.In the whole system function realization process, needs to adopt is the data acquisition, the analysis and the optimization technology[1].In order to make the functions of the Internet of things system more stable, we need to do:

(1) how does the sensor transmit the collected data to the mobile phone terminal？The accurate transmission of the collected data to the mobile phone terminal is the key technology of the Internet of things system.We used a complete set of Bluetooth solutions,using the hc-06 Bluetooth module, Bluetooth built-in 2.4GHz antenna, no need for manual user debugging.

(2) how to update the data?Because the environmental information is different at different times inside,Therefore, it is necessary to update the collected data in real time.We use a “While (1)” loop in our program,Set “times” in the loop function to increase the value of the function itself.When times>= 30,Set times=0, and conduct data communication,Thus the real-time update of data value is realized.

## 2. Design outline

### 2.1 Hardware configuration

The hardware platform of the simulation system adopts STM32F103C8T6 development board.The temperature sensor uses DS18B20 temperature digital sensor. The co2 content sensor uses mq-2 gas sensors.The information transmission function is realized by the hc-06 bluetooth module[2].

STM32F103C8T6 chip includes three timers, two 12-bit analog-to-digital converters and nine communication interfaces,72MHz CPU operating frequency, 2V to 3.6v power supply and I/O pin, 4MHz to 16MHz crystal oscillator, programmable voltage monitor.The chip is a medium capacity enhanced product,ARM 32-bit Cortex™ -m3 CPU is adopted,provides good interrupt system response and computational performance[3].

DS18B20 single-wire intelligent temperature sensor,using 1-wire bus protocol, the voltage range is 3V to 5.5v,and the temperature range it measures is from minus 55 ℃ to 125 ℃ above zero,the temperature is exactly 0.1 degrees,applicable to a variety of single chip microcomputer.The chip contains 64-bit ROM code, 8-bit cyclic redundancy check code generator and high-speed register for storing intermediate data.The temperature sensor has two power supply modes, one is external power supply mode and the other is data bus power supply mode[4].

Among the important components of mq-2 gas sensor, the gas sensitive layer is made of tin dioxide, the measuring electrode lead is made of platinum, the heater is made of nickel-chromium alloy, the ceramic tube is made of aluminum oxide, and the needle-shaped pin is made of nickel-plated copper[2].The sensor has the characteristics of wide detection range, high sensitivity and strong stability.It can be used for the detection of methane, ethane, alcohol, carbon dioxide, hydrogen, etc.Because the element has different resistance values in different gas concentrations, it can be used to monitor changes in carbon dioxide concentration.

Photoresistor is a light-sensitive element, its resistance value can change with the change of light and darkness in the outside world. When the light is sufficient, its resistance value is very low. When the light is weak, the resistivity will increase, and the resistance value will increase accordingly. Photoresistor have high sensitivity and good spectral properties.Under the condition of reasonable control and adjustment, its service life can be called infinitely long and its performance can be stable.Due to its low price and small size, photoresistor are widely used in various automatic measuring instruments and various measuring circuits.

The hc-06's property is that its host can remember the device was paired last.At the same time, hc-06 Bluetooth module adopts wireless transceiver, sensitivity can reach 80dBm[5]. built-in 2.4ghz antenna, no need for manual debugging, external 8Mbit FLASH, using pin half-hole process, low power consumption, low cost, high performance.

ISSN: 2414-1895 DOI: 10.6919/ICJE.202007_6(7).0048

### 2.2 Overall function.

The intelligent greenhouse system based on STM32 uses various sensors to collect the corresponding data.The three buttons on the development board set the different indicators in advance.The temperature sensor is used to collect the current temperature. When the temperature is below the standard value, the relay controls the cement resistance to make the temperature rise.When the temperature is higher than the standard value, start fan 1 to cool down.The photosensitive resistance controls the light to be kept in a certain range.The gas sensor collects the current carbon dioxide concentration,When the carbon dioxide is above the standard value, the warning light is turned on, and fan 2 is activated for ventilation to reduce the carbon dioxide concentration;When the co2 concentration falls below the standard value, the warning lights go off and fan 2 stops.The nokia 5110 liquid crystal display is used to display the collected data.The Bluetooth module transmits data to the mobile terminal, and the information displayed on the APP is the same as that on the LCD screen. The buttons on the APP correspond to the buttons on the development board,can be in the mobile terminal and development board to achieve the same function, remote control of the preset value of the device. After the system is powered on, each sensor is activated first to collect data and display it on the LCD screen.

## 3. Program design

### 3.1 Flow chart

After the system is powered on, each sensor is activated first to collect data and display it on the LCD screen. The system will compare the collected data with the set value and automatically make corresponding processing to adjust the environmental information.Connected to the mobile phone via Bluetooth, the user can monitor in real time on the mobile phone.The keys on the APP correspond to the keys on the development board. The same function can be realized in the mobile terminal and the preset value of the device can be remotely controlled.The flow chart of the main program is shown in Figure 1.

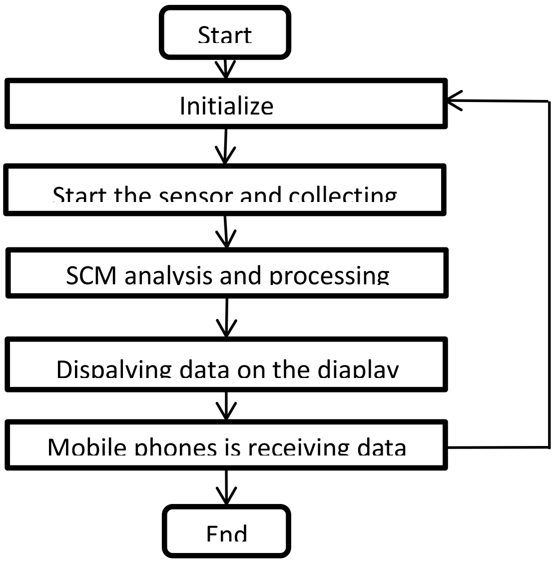


**Figure 1.** Main program flow chart

### 3.2 Experimental code.

Communication is the most important in system research and design. Since the indoor environment is changing in real time, software design needs to constantly read the data detected by sensors and send the data information to the server for analysis and collation. The software programming USES the modular design idea, each program module function is independent, the interface between the modules is connected[6].The system running program consists of initialization part and cyclic part. In the main function, the various peripherals used are initialized first, and then the data of each sensor

ISSN: 2414-1895 DOI: 10.6919/ICJE.202007_6(7).0048

is continuously read to monitor the environment. After all the circuits are connected, the serial port assistant program is loaded on the MCU, and the data is sent to the Bluetooth device connected to the MCU through the serial port assistant. It only needs to be set once to connect the Bluetooth of mobile phone with the Bluetooth of development board. It can be connected automatically every time it is used in the future [7]. The communication between Bluetooth adopts simple character parsing protocol. Through analog-to-digital conversion, data information can be displayed on the phone, analyze the collected data and trigger the corresponding events according to the agreed protocol.(Only part of the experimental code is shown here)

The following code implements the function of sending data:

```
// Non-interrupt transmission
  void USART2_Send_Char(unsigned char DataToSend) //Send a character
  {
     USART_SendData(USART2,DataToSend);
     while(USART_GetFlagStatus(USART2, USART_FLAG_TXE) == RESET);        }
    void USART2_Send_String(unsigned char *Str)//Sends a string of a specified length
    while(*Str)    / / value
     {
        if(*Str=='\r')USART2_Send_Char(0x0d);
          else if(*Str=='\n')USART2_Send_Char(0x0a);
        else USART2_Send_Char(*Str);
        Str++;//Pointer ++ points to the next byte
     }
  }
```

After receiving the data, the system realizes the code of various functions is as follows:

```
void Warning(void)
{
  if(temp_value_int<temp_warn)// attemperation
  {
      JDQ=0;
      FS=1;
  }
  else
  {
      JDQ=1;
      FS=0;
  }
  if(light>light_warn) //Control light
```

ISSN: 2414-1895 DOI: 10.6919/ICJE.202007_6(7).0048

```
    {
        LED=1;
    }
    else
    {
        LED=0;
    }
    if(MQ2<MQ2_warn) //Regulating carbon dioxide content
    {
        FS_LED=1;
        FS1=1;
    }
    else
    {
        FS_LED=0;
        FS1=0;
    }
}
```

## 4. System testing

Based on the design requirements of the above software and hardware, we carried out simulation experiments after reasonably establishing the system. The whole intelligent greenhouse system based on STM32 was tested, including whether the sensor could collect data correctly and send the collected data to the service side in a timely manner, so that people could monitor various indicators through liquid crystal display screen or mobile phone terminal; Whether the server receives the data correctly and analyzes the received data according to the communication protocol to achieve the goal of intelligent regulation. Figure 2 shows the development board situation when all the values of the equipment meet the requirements after power on.

Then we block the photosensitive resistance and use the lighter to raise the temperature and carbon dioxide content. Figure 3 shows that the collected data is inconsistent with the preset value, and the system automatically takes corresponding measures. Among them the light is insufficient, automatically turns on the light to enhance the light, the green warning light is on, indicating that the CARBON dioxide content is too high, fan 2 is started for ventilation, if the temperature is too high, fan 1 will start to cool down.

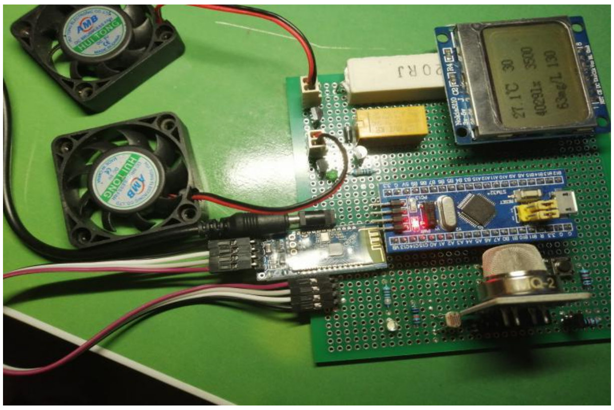

**Figure 2.** All values are normal

ISSN: 2414-1895 DOI: 10.6919/ICJE.202007_6(7).0048

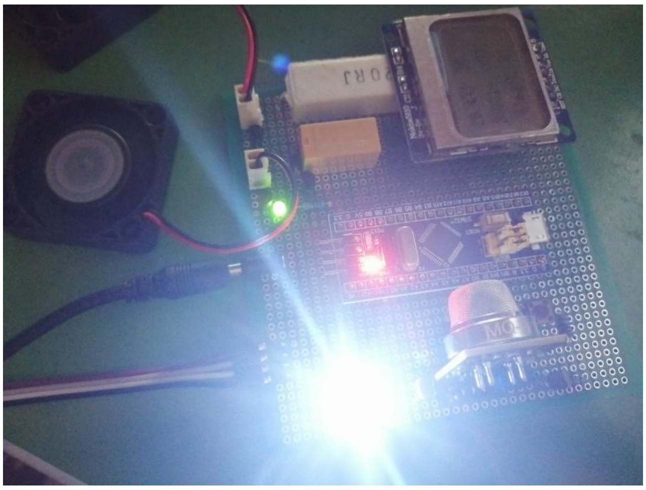

**Figure 3.** The system automatically starts all the regulating devices

## 5. Conclusion

In the modern society with rapid development of science and technology, Internet of Things technology has gradually penetrated into all walks of life. In particular, it is the general trend of the development of modern society to combine the innovative concept of Internet of everything with traditional industries, upgrade and transform traditional industries, and serve the public. The STM32 single chip microcomputer, sensor equipment, Bluetooth equipment, mobile terminal equipment used in this design have the characteristics of small size, stable operation, fast speed, so that they can work together to complete a real-time indoor environment monitoring and intelligent regulation of the system. Replacing people with machines for complex physical and mental activities can facilitate management, save labor, and achieve energy conservation and consumption reduction. However, due to the limitation of equipment and the limited adjustment capacity, we should continue to improve and strengthen the adjustment capacity.

## References


[1] Gengning Ying , Qidong Chen , Zehua Lou, Qixing Liu, Zhiwei Zhang. Design and Research of intelligent Ventilation system for Greenhouses based on STM32[J]. Electromechanical Engineering Technology.Vol. 48 (2019) NO. 06, P. 149-151.

[2] Lihua Liu, Yuanbao Man. Sensor Principle and Application[M]. People's Posts and Telecommunications Press, 2004, P. 37-40. China National Standardization Management Committee. Specifications of Crane Design (China Standardization Press, China 2008), p. 16-19.

[3] Hongwei Shen. Design and Implementation of intelligent System based on SINGLE Chip Microcomputer[M]. Beijing Electronics Industry Press, 2015, P. 18-20.

[4] Kaijie Tang, Can Li, Di Wang, Qin Zhang . Design of digital Temperature acquisition and alarm System based on DS18B20 [J]. Sensor and Microsystem. Vol. 33 (2014) No. 3, P.99-102.

[5] Jingyang Hu. Research on Bluetooth Technology [J]. New Communication in China. Vol. 19 (2017) No. 01, p. 75-76.

[6] Xicun Yu, Guohua Cao.Microcontroller principle and Interface Technology [M]. Xidian University Press, 2010, P. 19-22.

[7] Zhonghua Yun, Yongfeng Li, Hongchun Liu, et al. Design and Research of home environment monitoring System based on STM32 microcontroller. Automation and instrumentation[J]. Vol. 10 (2015) NO. 12, p. 227-229.