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Orchard IoT Data Center Based on OneNet Cloud Platform

Bo ZHANG, Bo YANG, Baojian CHEN,Yiwen YANG,Liutong LI, Zhenzhen HUANG, Mingjing LI,Dandan HUANG, Hao YU, Yanxiang WANG, Mingzhu WANG, Ranran ZHANG, Shuokang CHI, Gaoyang WU, Jiangyuan ZHOU, Haodong NIU, Jinying XIE, Fangyuan WANG, Jin ZHANG, Xiaofei FU,Haohao LI, Jiangyuan ZHOU, Jian ZHANG, Xueqin NIU, Yue CAO, Siyuan JIN, Xingyuan LIU, Zhanpeng MA, Luoyan MA, Qingxi YU,Ye YUAN
School of computer science and technology, Henan institute of science and technology, Xinxiang, CHINA
Corresponding Author: Pingchuan ZHANG .

ABSTRACT: *As a big agricultural country, China has an area of more than 1.4 million square kilometers of arable land. With the exponential growth of human beings, i.e. population growth, traditional or ancient farming methods cannot meet the rising demand for food, and more advanced farming methods are needed to meet the food needs of more and more people. Therefore, combining the current advanced science and technology to escort the increase of grain production has become a hot spot of concern in recent years. Among them, intelligent agricultural systems based on embedded systems and the Internet of Things (IoT) have broad application prospects in basic information collection, environmental control, intelligent management, etc., which make them more and more concerned and popularized by people. has a very positive meaning. Smarter farming models are the future. The traditional, industrialized agricultural farming model is bound to become more complex with the continuous expansion of the scale, the types of subsystems and major modules are complex, and the system is cumbersome.In this paper, the cloud platform and the orchard detection system are combined, and the PC upper computer and the single-chip lower computer are combined. Relatively speaking, the system is simpler, the modules are more controllable, and it is more suitable for applications in relatively complex scenarios, and the cost is low. Easy to maintain, it is an ideal choice for orchard measurement and control system.*

Keywords: *intelligent agriculture; embedded system; IOT; wireless sensor network; SQL server*

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I. Introduction

1.1 Topic purpose and significance

According to big data predictions, by 2050, the world's total population may reach around 9.1 billion, and China's population may reach around 1.46 billion. The Food and Agriculture Organization of the United Nations (FAO) has announced that to feed this increasing population, food production will need to increase by approximately 70%. According to a statement from the US Global Change Research Program, in 2018, crop yields, livestock health, and rural economies faced many challenges due to climate change.

We all know that agriculture is the foundation for human survival. About 60% of the world's population is engaged in farming, and the continuous advancement of communication and information technology enables farmers to collect a large amount of on-site and clear information for their farmland. Our farmers still rely on traditional strategies, such as manual circular seeding, twice a year harvesting methods, and unscientific farming frameworks. The uneven accessibility of annual precipitation is a major issue. In addition, farmers rely on traditional strategies to water, fertilize, and spray pesticides on farmland without accurately observing the exact state of the farmland. All of these can lead to insufficient crop growth and low productivity. Due to the convenience and real-time observation of crop growth stages through agricultural programs, agricultural production efficiency can be significantly improved. Implementing scientific strategies in the agricultural field can significantly enhance crop productivity.

Adequate watering, fertilization, and pesticides are crucial to ensure better agriculture and food production. If we create an automated system data center to automatically monitor and collect all this data, it will have a very positive impact on crop growth and yield.

Compared to before the reform and opening up, modern agriculture has made tremendous progress. But compared to traditional industrialized agricultural systems, intelligent agricultural systems have improved by introducing an automated system that can observe crop growth and control small tools through the use of WSN (wireless sensor network). The basic operation of WSN is to perceive information from remote areas and transmit the perceived information through wireless networks that receivers can monitor. WSN technology can be used in agriculture, especially for processing distributed data collection from agricultural environments, and importantly, for guiding farmers to obtain real-time information on farmland.

1.2 Current research status at home and abroad

According to domestic and international data, the Internet of Things has made great progress since 1999 and has penetrated into every industry field. The agricultural Internet of Things is widely used in relatively enclosed and controllable facility agricultural systems such as greenhouses. A large number of sensor nodes form a monitoring network, collect information, and display it in real-time through various instruments or participate in automatic control as parameters, ensuring that crops have a good and suitable growth environment.[1] Especially in cooperatives and family farms characterized by scale and standardization, the application of Internet of Things technology is widespread. It has gradually shifted agriculture from a human centered and isolated mechanical production model to an information and software centered production model. In developed countries, smart agriculture has entered various aspects of agriculture through knowledge processing, development of automatic control, and application of network technology. It is reported that foreign countries adopt IoT related technologies, and a large number of wireless sensors are used in greenhouse production to manage, regulate temperature and humidity, nutrient supply, pH value (hydrogen ion concentration index), EC value (soluble salt content), etc., so as to achieve the most suitable level of facility vegetable cultivation conditions. [2]

In 2013, the Ministry of Agriculture issued the "Work Plan for Regional Pilot Projects of Agricultural Internet of Things", focusing on the characteristic industries and key areas of agriculture in Tianjin, Shanghai, and Anhui, comprehensively considering the layout of industries and industrial chains, gradually achieving the penetration of Internet of Things technology in the entire agricultural industry chain and the overall promotion of pilot provinces and cities. [3] In recent years, regional pilot projects for agricultural Internet of Things have been implemented in Tianjin, Shanghai, Anhui, Jilin, and Jiangsu, and a series of agricultural Internet of Things projects have been initiated and implemented in various provinces. China is increasingly deepening the application of the Internet of Things in agriculture, applied in greenhouse environment control such as facility agriculture and animal husbandry. Through various sensors such as light, temperature, and carbon dioxide, it realizes the perception of the internal environment of orchards; Realize signal transmission through Wi Fi, 5G, ZigBee and other methods; By setting thresholds and other algorithms, combined with the needs of different environments, reasonable intervals are formulated. By using different feedback methods such as air conditioning, lighting, and carbon dioxide generators, reasonable control of the orchard environment can be achieved.

Other key technologies in agricultural IoT, such as agricultural plant protection drone pesticide application, field planting management, intelligent analysis and control models and systems for breeding environments, animal disease diagnosis technology based on video analysis, precise animal feeding, and aquaculture management, are widely utilized.

1.3 Development goals of the system

Generally speaking, in the field of agriculture, there are various IoT based applications, practices, and models. The IoT assisted agricultural research model combines network platforms, corresponding network architectures, applications, security issues, and challenges. Similarly, in many countries and organizations around the world, unique IoT strategies and guidelines have been implemented in agriculture. This article introduces an intelligent orchard data center system based on embedded electronics, the Internet of Things, wireless sensor networks, and cloud platforms. By deploying IoT technology to supplement existing services, we aim to improve orchard productivity and understand the cyclical environmental changes of orchard crops. Detecting real-time growth environment of orchard crops, etc.

II. System requirement analysis and solution design

2.1 functional requirements analysis

The project is divided into software and hardware parts for the implementation of the orchard data management center. The hardware part collects real-time data from the orchard, while the software part can be detected by users at any time on the computer.

Hardware part: responsible for collecting environmental data from the orchard to the cloud platform.

Choose to obtain temperature and humidity, light intensity, and soil moisture for environmental data in the orchard. The sensor responsible for obtaining temperature and humidity data is selected as DHT11, the sensor responsible for obtaining light intensity data is selected as GY-30, and the sensor responsible for obtaining soil moisture data is selected as the soil moisture sensor. Select STC89352 as the main control chip

Software part: responsible for downloading data from OneNet cloud and displaying it on the upper computer. The upper computer is responsible for obtaining, statistics, and displaying sensor data from the OneNet cloud platform. Implement user login, view data, and periodic data analysis. Implement administrator management of regular user accounts and enable and disable sensor management.

The system structure of this intelligent orchard data management center is designed according to user needs, combined with the characteristics of the Internet of Things control and monitoring system and orchard crops for comprehensive consideration. Its specific functions are shown in the system structure diagram in Figure 2.1:

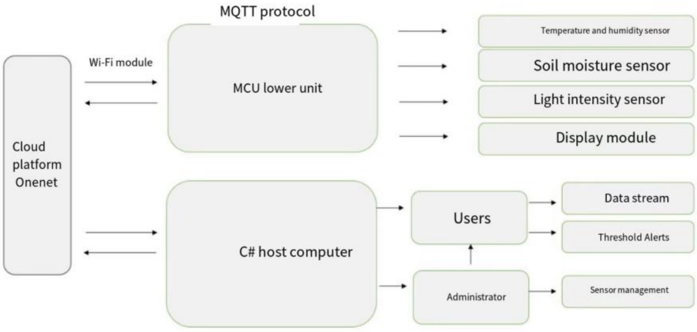


Figure 2.1 System Structure Diagram

2.2 systems solutions

The hardware part first collects this data through sensors and views real-time environmental information of the orchard through the upper computer, which can facilitate the user's ability to handle unexpected situations in the orchard and prepare for them. At the same time, building an orchard data platform can provide extremely detailed records of the status of lighting, temperature and humidity, soil and other data within the orchard. It can also display specific parameters of plant growth environment more intuitively through visual data curves.

This project is a smart orchard research based on the big data cloud platform. The STM32 chip serves as the main control core and sends data to the cloud platform server and upper computer through Wi Fi modules for remote monitoring. This system can effectively monitor and control parameters such as temperature, humidity, and lighting in the orchard environment, and upload the parameters to the OneNet cloud platform,. The traditional manual data collection method is inefficient, prone to human errors, and has the problem of reduced data accuracy. However, intelligent data should be managed intelligently as it does not generate human errors that affect data accuracy, and it can collect data that cannot be manually collected. However, if manual management is carried out, not only is it inefficient and requires a large amount of labor costs, but also the accuracy of orchard environmental parameters is higher for machine collection than manual accuracy.

The number of wireless sensor nodes placed in the orchard depends on the area of the orchard. Each wireless sensor node is equipped with the required sensors described earlier. Each sensor will collect data from the environment and process the data by the corresponding microcontroller. The DHT11 temperature and humidity sensor will detect the temperature and humidity of the field, and the GY-30 light intensity sensor will be used to test the photosynthesis status of plants in the orchard. The soil moisture sensor is used to measure the moisture content in farmland soil, and then the ESP8266 wireless transceiver module is used to transmit the data of each sensor to the central node. Using the ESP8266 module as the receiver, the central node will collect data from each wireless sensor node and corresponding sensor data. Set a certain threshold for each sensor in the MCU of the central node. The central node continuously compares the data from each wireless sensor node, and when the value is above or below the defined threshold, the central node will use the corresponding sensor data to enable users to use the ESP8266 Wi Fi module, and PC can control the sensor data of each wireless sensor node through a separate webpage specified for each sensor node.

In terms of software, the client can browse a series of sensors during runtime. The system can display information to users in various ways. At the same time, the overall page layout should be generous, allowing users to quickly browse environmental data information and view corresponding specific data. Users can log in and operate the upper computer to observe the collected data by registering an account. The upper computer has an administrator account, which can manage user accounts and sensors controlled by the microcontroller.

The upper computer is written in C # language, and its functions include a user login interface, a user registration interface, various sensor data interfaces, an administrator interface, a management user interface, and a management sensor interface

III. System hardware design and implementation

The main function of the lower end of this system is to collect data through various sensors and upload the received data to the cloud platform. The collected data will be saved on the cloud platform and transmitted to the PC upper computer.

3.1 Main controller circuit design

The system uses STC89352 as the main control chip, and STM32 is a 32-bit microprocessor based on ARM architecture. The maximum capacity that can be stored during program burning is 64KB. If the program is too large, overflow may occur. When burning the program, keil5 is used for burning because its architecture is the same as that of STM32 and belongs to the reduced instruction set. The circuit board design is done using Altium Designer software. Altium Designer is a powerful software that can assist in circuit design, including schematic design, circuit simulation, PCB (Printed Circuit Board) drawing and editing, automatic topology and logic routing, signal integrity analysis, and design output. [5] The hardware part uses STC89352 as the core chip to integrate temperature and humidity modules, wind speed measurement modules, and soil moisture modules. The circuit design is shown in Figure 3.1:

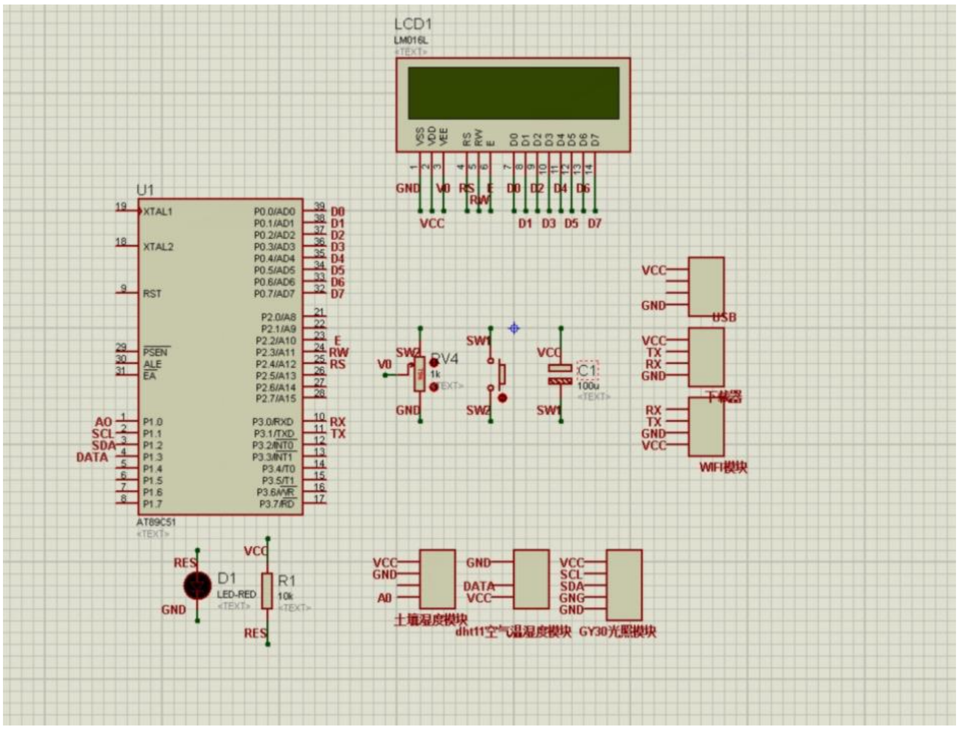


Figure 3.1 Circuit Design Diagram

The hardware 3D diagram, PCB bottom layer, PCB upper layer, and PCB wiring for this project are shown in Figures 3.2, 3.3, 3.4, and 3.5, respectively:

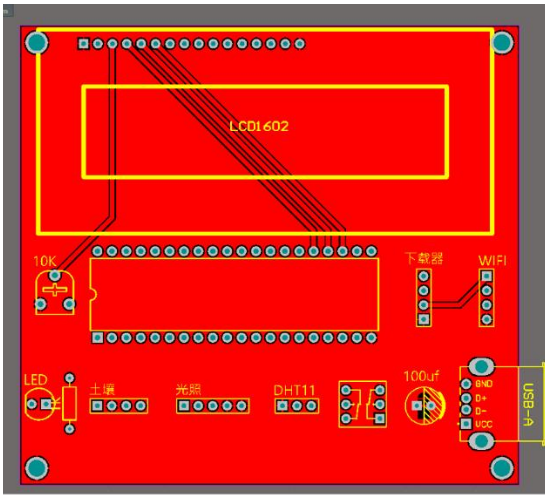


Figure 3.2 Hardware 3D Diagram

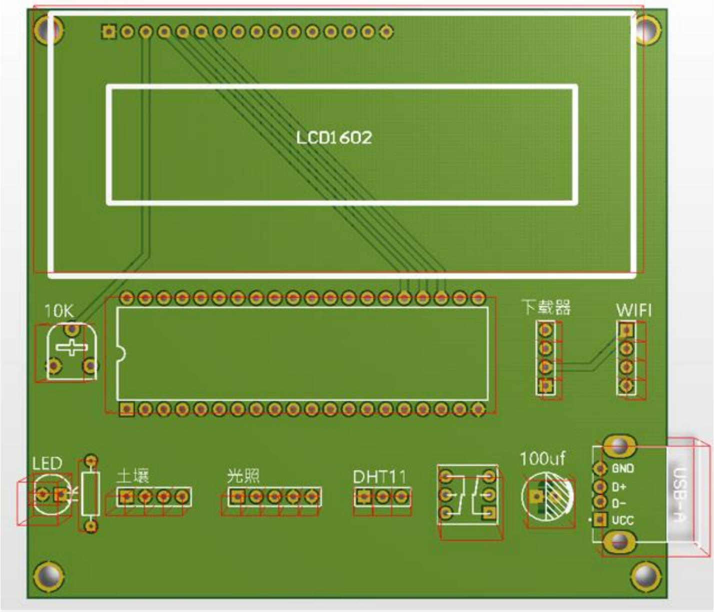


Figure 3.3 PCB Top Layer

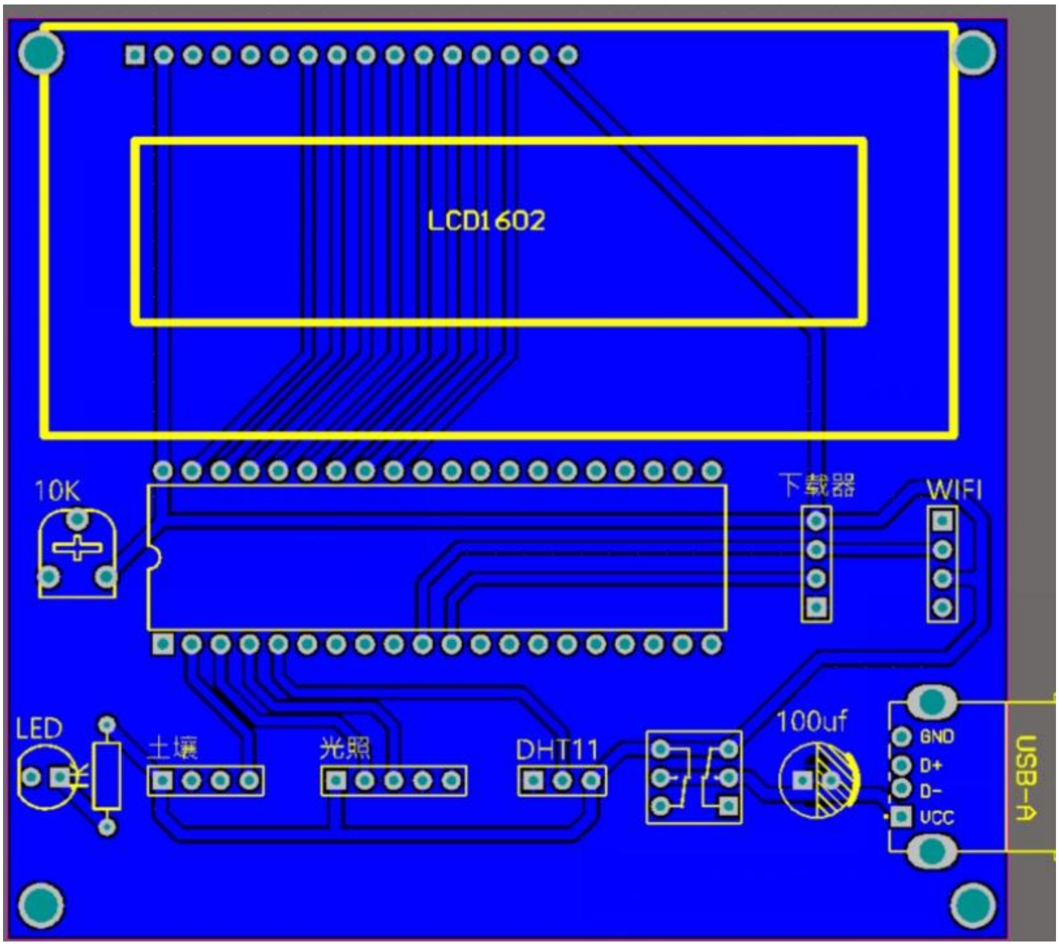


Figure 3.4 PCB Bottom Layer

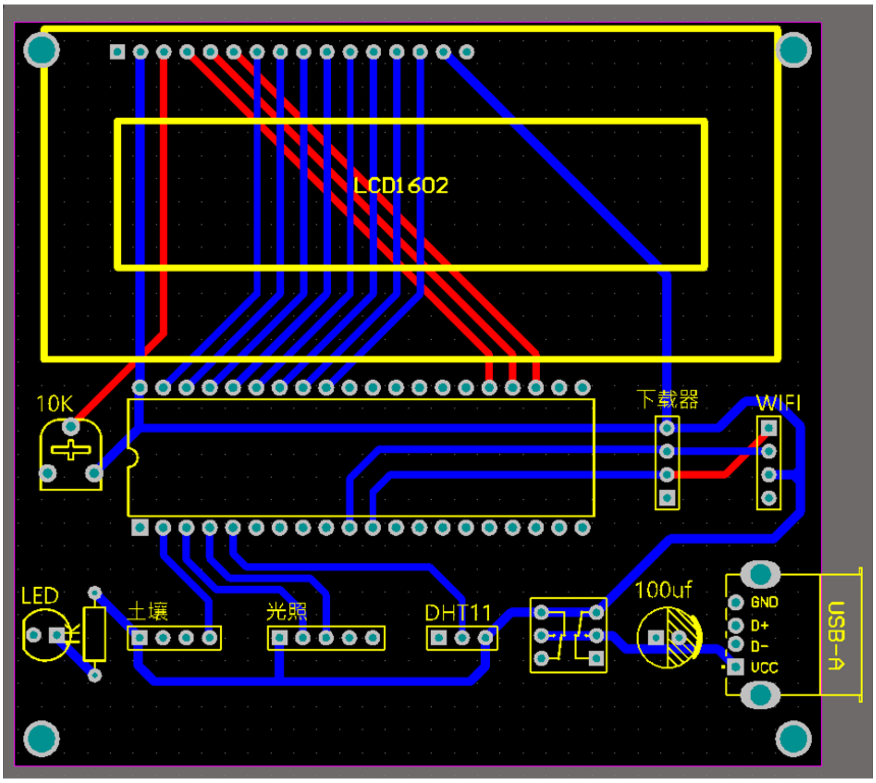


Figure 3.5 PCB Circuit Wiring Diagram

3.2 Selection and design of each module

3.2.1 Design of temperature and humidity collection circuit

The components of the temperature and humidity module use the common DHT11. The measurement range of the DHT11 temperature and humidity sensor is from 0 ℃ to 50 ℃, and the measurement results vary linearly with the received temperature. The signal used is similar to the one-way protocol. The physical diagram of the temperature and humidity module is shown in Figure 3.6, and the schematic diagram of the DHT11 circuit is shown in Figure 3.7:

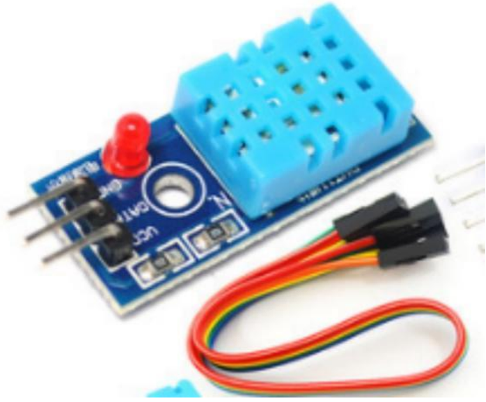


Figure 3.6 DHT11 physical image

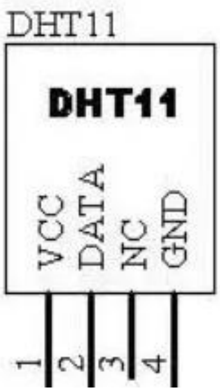


Figure 3.7 DHT11 Circuit Wiring Diagram

The pin parameter characteristics of DHT11 temperature and humidity sensor are shown in Table 3.1:

Table 3.1 DHT11 Sensor Pin Definition

Pin	Name	Pin function
1	VCC	power supply
2	Date	Data, bus
3	Nc	Idle pins
4	Gnd	Power supply ground

The input power of this sensor is 3.3V. When data is uploaded to the cloud, temperature and humidity data occupy 8 bits each. DHT11 obtains external temperature and humidity data through its own temperature and humidity measurement components. The processor is idle without uploading data, and the temperature and humidity sensors will be in a high-level state. A resistor needs to be connected in parallel to achieve current limiting to protect the circuit. Here, a 10k Ω resistor is selected to protect the circuit.

3.2.2 Design of Light Intensity Collection Circuit

The device of the light intensity acquisition module adopts the common GY-30, and the GY-30 light intensity sensor adopts an I2C bus interface (supported by f/s mode). The measured spectral range is not much different from the perceptual range of the human eye. By using an illuminance digital converter, the light intensity is converted into digital output, and no external parts are needed to complete the function of converting light intensity into digital, GY-30 has a relatively wide measurement range and a high degree of decomposition

(1-65535 lux), with level conversion function, and can operate at voltages of 3V-5V. It has powerful functions and is the primary choice for the lighting acquisition module in this project. The physical diagram of the light acquisition module is shown in Figure 3-8, and the circuit schematic of the light intensity acquisition module is shown in Figure 3-9:

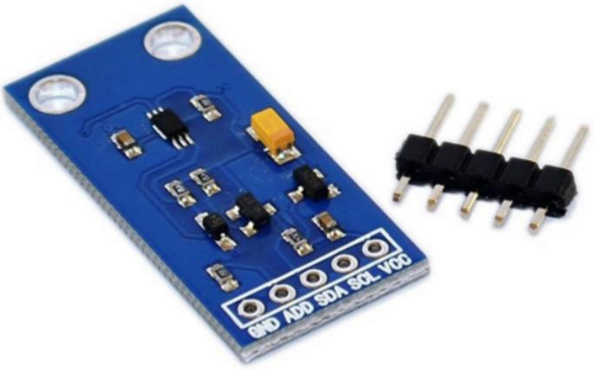


Figure 3.8 Physical image of GY-30

The pin parameter characteristics of GY-30 light sensor are shown in Table 3.2:Table 3.2 Definition of GY-30 Light Sensor Pins

Figure 3.9 GY-30 Circuit Schematic

Pin	Name	pin function
1	VCC	power supply
2	SCL	IIC bus clock pin
3	SDA	IIC bus data pins
4	ADDR	BH1750 IIC device address pin
5	GND	Power supply ground

3.2.3 Design of Soil Humidity Circuit

The soil moisture sensor can automatically detect the soil environment of crops in the orchard by adjusting the soil temperature control threshold through a potentiometer. The application principle of soil moisture sensors is to set a value one by one. When it meets this value, D0 will not output a high level or a low level. When it is above the set value, D0 will output a low level. When it is below the set value, D0 will output a high voltage. The output level enters the microcontroller, is detected internally by the microcontroller, and finally outputs the result. The physical diagram of the soil moisture module is shown in Figure 3-10: The schematic diagram of the soil moisture sensor small board circuit is shown in Figure 3.11:

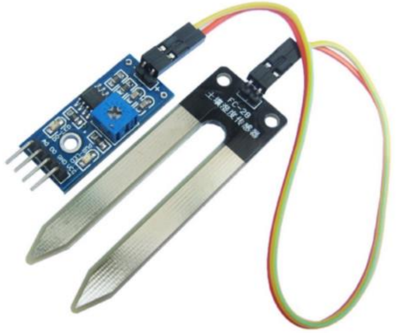


Figure 3.10 Physical image of soil moisture sensor

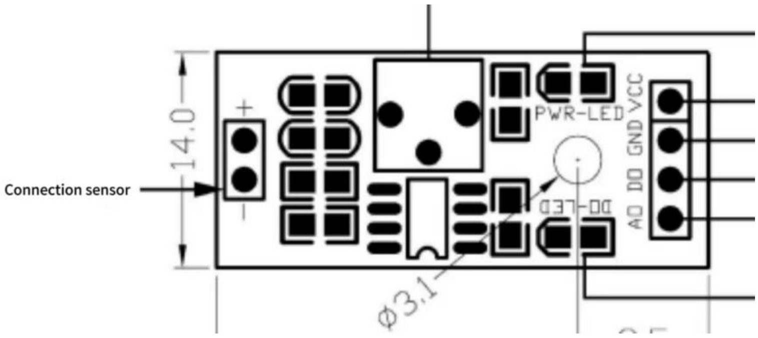


Figure 3.11 Small class circuit diagram of soil moisture sensor

The pin parameter characteristics of the soil moisture sensor are shown in Table 3-2:

Table 3.3 Definition of each pin of soil moisture sensor

Pin	Name	pin function
1	VCC	power supply
2	GND	Power grounding
3	D0	Switch signal output
4	AD	Analog signal output

3.2.4 LCD1602 circuit design

This time, LCD1602 lattice is used to display data on hardware. I chose LCD1602 because of its low price and cost, and the output data is sufficiently displayed in LCD1602. In addition, LCD1602 has a small size, light weight, and low power consumption, which meets the hardware requirements of this project in the orchard. The LCD1602 LCD screens are all digital, and the interface with the microcontroller system is simpler and more reliable, making operation more convenient. The physical diagram, circuit principle, and definitions of each pin of LCD1602 are shown in Figures 3.12, 3.13, and Table 3.4, respectively:

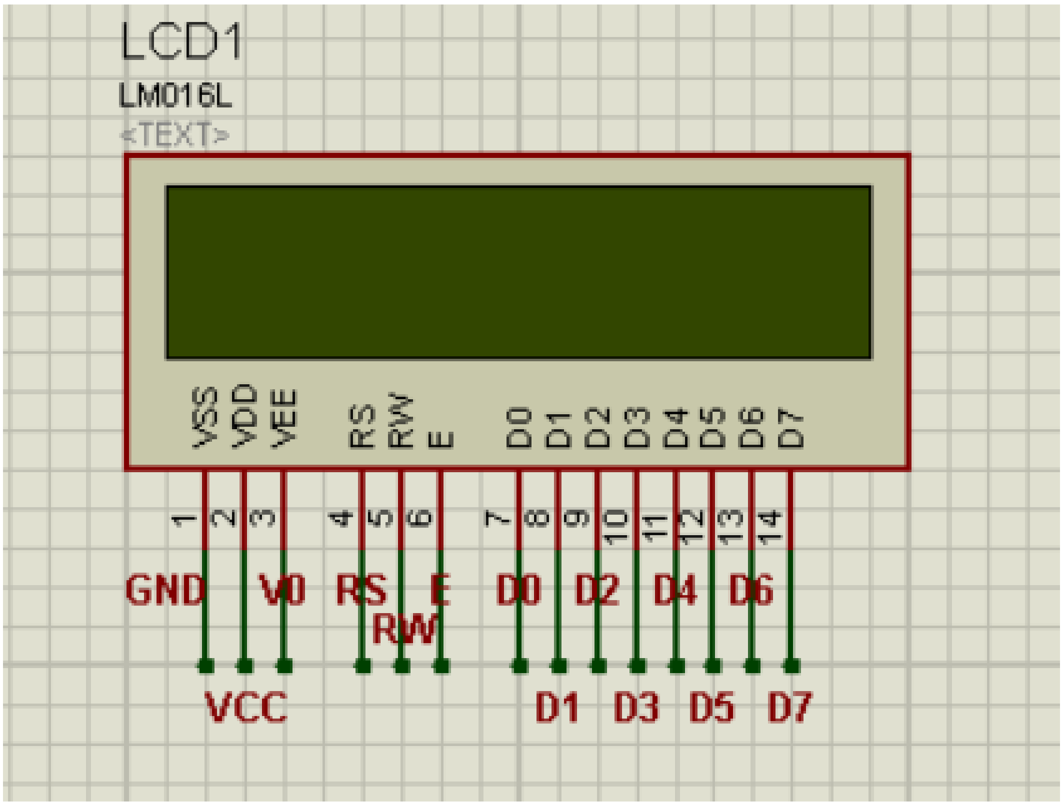


Figure 3.12 LCD1602 physical image

Figure 3.13 LCD1602 Circuit Connection Diagram

Table 3.3 Definition of each pin in LCD1602

Pin	Name	pin function
1	VSS	Power supply ground
2	VDD	power supply
3	VE	Compare and adjust voltage
4	RS	0=Input instructions 1=data in
5	R/W	0=Write instructions or data to LCD 1=Reading information from LCD
6	E	ENABLE
7	DB0	Data bus line0
8	DB1	Data bus line1
9	DB2	Data bus line2
10	DB3	Data bus line3
11	DB4	Data bus line4
12	DB5	Data bus line5
13	DB6	Data bus line6
14	DB7	Data bus line7
15	A	Positive pole of LCD backlight power supply
16	K	Negative pole of LCD backlight power supply

3.2.5 ESP8266 Circuit Design

This time, the ESP8266 module is used as the Wi Fi transmission module. I chose ESP8266 because the ESP8266 module has a low cost and strong working performance, capable of operating in ambient temperatures ranging from -40 ° C to+125 ° C. It also has the characteristic of low power consumption, which is suitable for complex application scenarios in orchards. The physical object of ESP8266 is shown in Figure 3.14, and the definitions of each pin are shown in Table 3.15:

Figure 3.14 Physical diagram of ESP8266Wi Fi module

Figure 3.15 ESP8266Wi Fi Module Circuit Connection Diagram

Table 3.3 Definition of each pin of ESP8266Wi Fi

Pin	Name	pin function
1	RX	Accept data
2	TX	send data
3	GND	Power supply ground
4	VCC	power supply

IV. System Software Design and Implementation

The upper computer of this project is written in C # language. The main function of the upper computer is to use sensors to collect data and collect and analyze the received data. Finally, the upper computer uses a line graph to express the data, allowing users to monitor the environmental data in the orchard in real time within a cycle.

The system structure diagram of the upper computer in this system is shown in Figure 4.1:

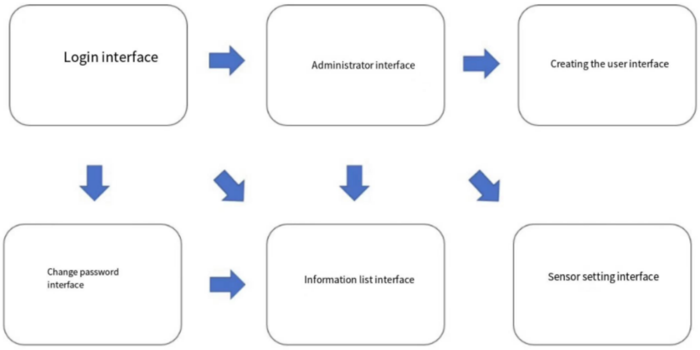


Figure 4.1 Upper computer system structure diagram

The design flowchart of the upper computer for this project is shown in Figure 4.2:

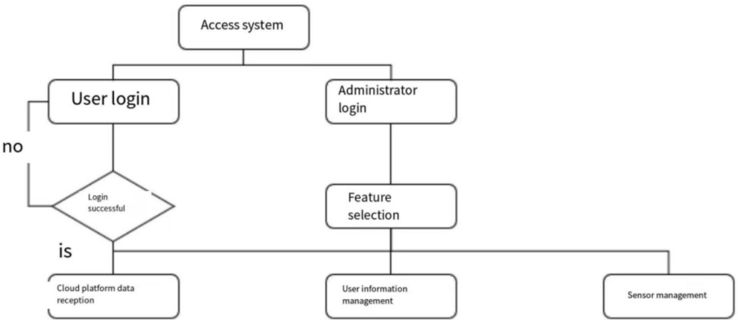
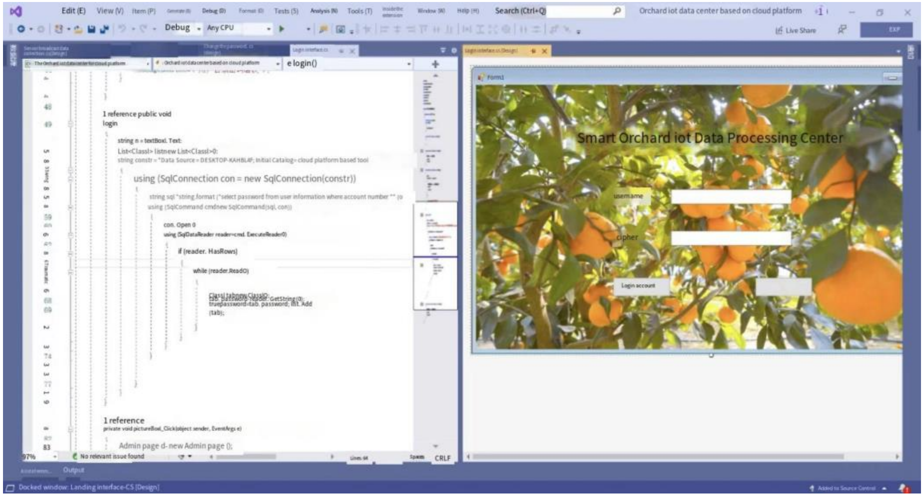


Figure 4.2 Upper computer flowchart

4.1 System upper computer program design

4.1.1 Login interface



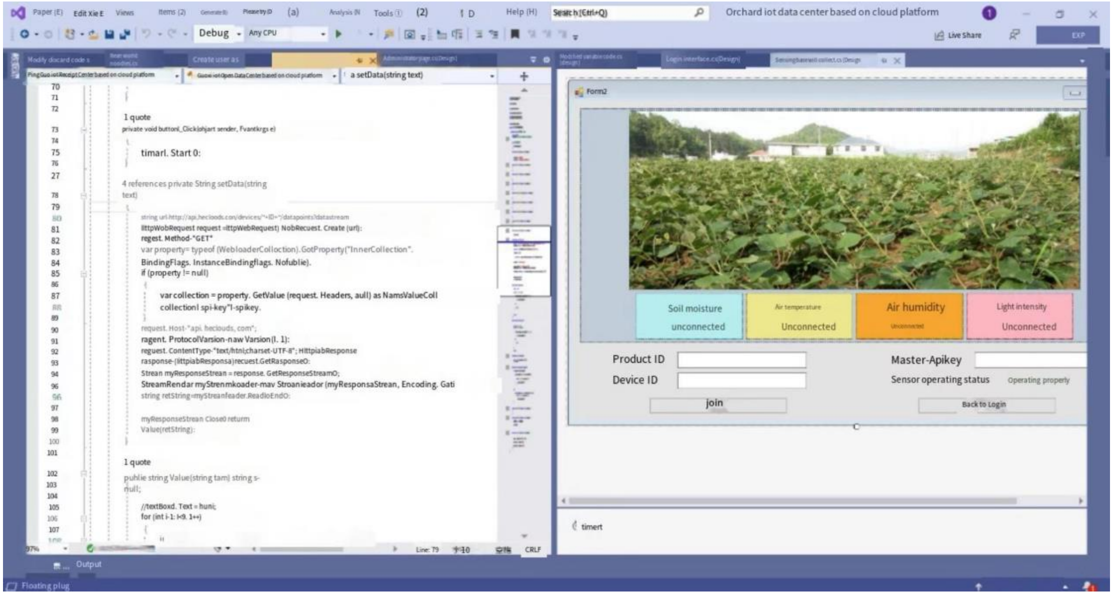
```
1 reference public void
login
{
    string n = textBox. Text:
    List<Class1> listnew List<Class1>0:
    string constr = "Data Source = DESKTOP-KAHBL4F; Initial Catalog= cloud platform based tool
    {
        using (SqlConnection con = new SqlConnection(constr))
        {
            string sql "string.format ("select password from user information where account number "" (o
            using (SqlCommand cmdnew SqlCommand(sql, con))
            {
                con. Open 0
                using (SqlDataReader reader=cmd. ExecuteReader0)
                {
                    if (reader. HasRows)
                    {
                        while (reader.ReadO)
                        {
                            Class1 tabnew Class1()
                            tab. password- reader. GetString(0);
                            truepassword-tab. password; list. Add
                            (tab);
                        }
                    }
                }
            }
        }
    }
}

1 reference
private void pictureBox_Click(object sender, EventArgs e)
{
    Admin page d- new Admin page ();
```

Figure 4.3 Login Interface

The login interface is the homepage when the system is turned on. Ordinary users can enter their personal account and password to log in and go to the information list to view information. If you forget your password, you can enter the password modification interface from the button below. The login interface effect is shown in Figure 4.3:

4.1.2 Information List Interface

The information list interface is the main monitoring window of this system. The data collected from the sensor end of the lower computer will be read through the cloud platform to this interface. The information list summarizes all temperature, humidity, soil moisture, light intensity and other data. Users can remotely monitor orchard information here. When a certain data exceeds the threshold, an alarm will be automatically triggered. The information overview interface is shown in Figure 4.4:

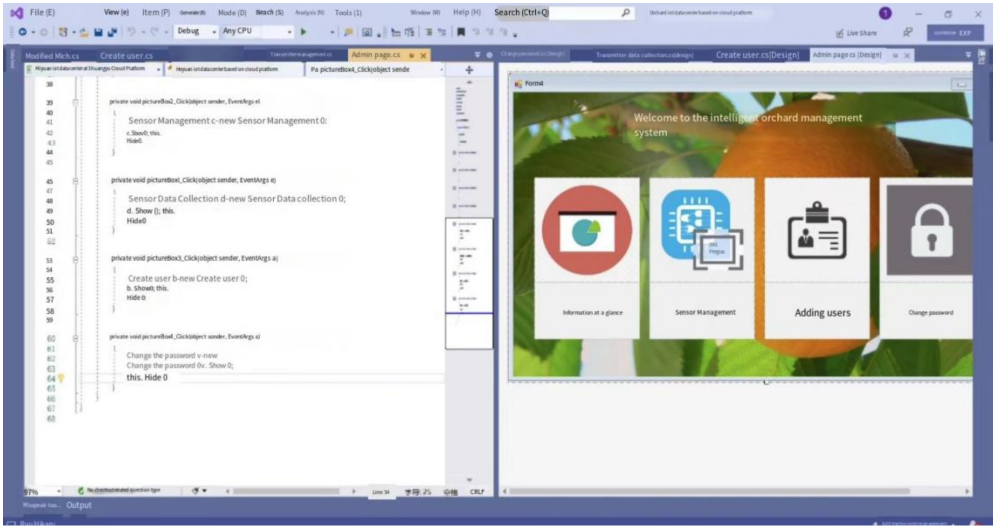


```
}

1 quote
private void buttonl_Click(ohjart sender, Fvantkrgs e)
{
    timarl. Start 0:
}

4 references private String setData(string
text)
{
    string url-http://api.heclouds.con/devices/"+ID+"/datapoints?datastream
    IittpWobRequest request =IttpWebRequest) NobRecuest. Create (url):
    regest. Method-"GET"
    var property= typeof (WebloaderColloction).GotProperty("InnerCollection".
    BindingFlags. InstanceBindingflags. Nofublie).
    if (property != null)
    {
        var collection = property. GetValue (request. Headers, aull) as NamsValueColl
        collectionl spi-key"l-spikey.
    }
    request. Host-"api. heclouds, com";
    ragent. ProtocolVarsion-naw Varsion(l. 1):
    reguest. ContentType-"text/htnl;charset-UTF-8"; HittpiabResponse
    rasponse-(IittpiabResponsa)recuest.GetRasponseO:
    Strean myResponseStrean = response. GetResponseStreamO;
    StreamRendar myStrenmkoader-mav Stroanieador (myResponsaStrean, Encoding. Gati
    string retString-myStreanfeader.ReadloEndO:

    myResponseStrean Closed return
    Value(retString):
}

1 quote
puhlie string Value(string tam) string s-
null;

    //textBoxd. Text = huni;
    for (int i-1: I<9. 1++)
    {
```

Figure 4.4 Information Overview Interface

4.1.3 Administrator interface

The administrator page is created for the convenience of device administrators to adjust and modify sensors and user information. The administrator page is accessed by the administrator button in the lower right corner of the login interface and provides unified control over the system. Administrators can modify user account passwords and access the sensor management interface to manage individual sensor interfaces. The administrator interface is shown in Figure 4.5:

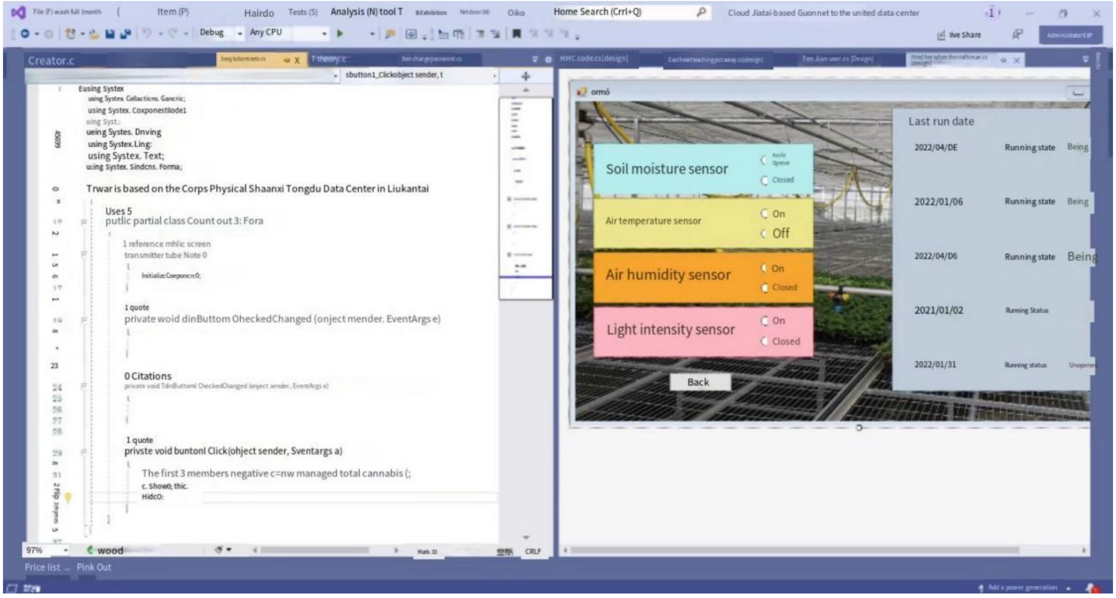


```
private void pictureBox2_Click(object sender, EventArgs el
{
    Sensor Management c-new Sensor Management 0:
    c.Shov0; this.
    Hide0.
}

private void pictureBoxl_Click(object sender, EventArgs e)
{
    Sensor Data Collection d-new Sensor Data collection 0;
    d. Show (); this.
    Hide0
}

private void pictureBox3_Click(object sender, EventArgs a)
{
    Create user b-new Create user 0;
    b. Show0; this.
    Hide 0:
}

private void pictureBox4_Click(object sonder, EvontArgs a)
{
    Change the password v-new
    Change the password 0v.. Show 0;
    this. Hide 0
}
}
}
```

Figure 4.5 Administrator Interface

4.1.4 Sensor settings interface

In actual production and life, not all sensors can be used in every situation. To prevent idle sensors from wasting energy, sensor management functions are specially set up. The sensor settings interface collects real-time information about sensors and provides options for turning them on and off. Administrators can turn off and turn on the corresponding sensors based on actual situations. The sensor settings interface is shown in Figure 4.6:



```
Eusing Systex
  using Systex. Collacticns. Gancric;
  using Systex. Coxponestllode1
  uing Syst.:
 ueing Systes. Dnving
  using Systex.Ling:
  using Systex. Text;
 using Systex. Sindcns. Forma;

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        }

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            HidcO:
        }
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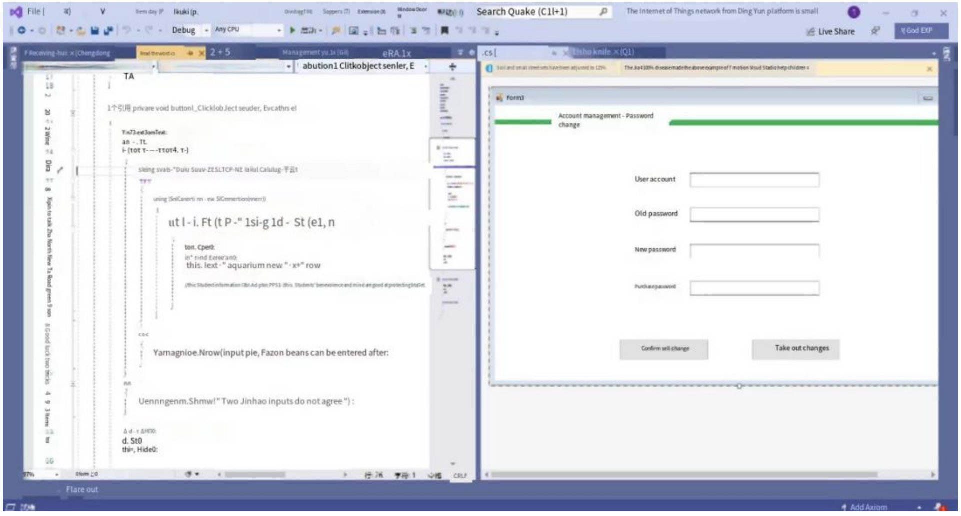
Figure 4.6 Sensor Setting Interface

4.1.5 Password modification interface

The password modification interface is a predetermined interface for users to modify their passwords, which allows users to change their passwords and synchronize the changes in the database. The password modification interface is shown in Figure 4.7:



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    }
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    d. St0
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```
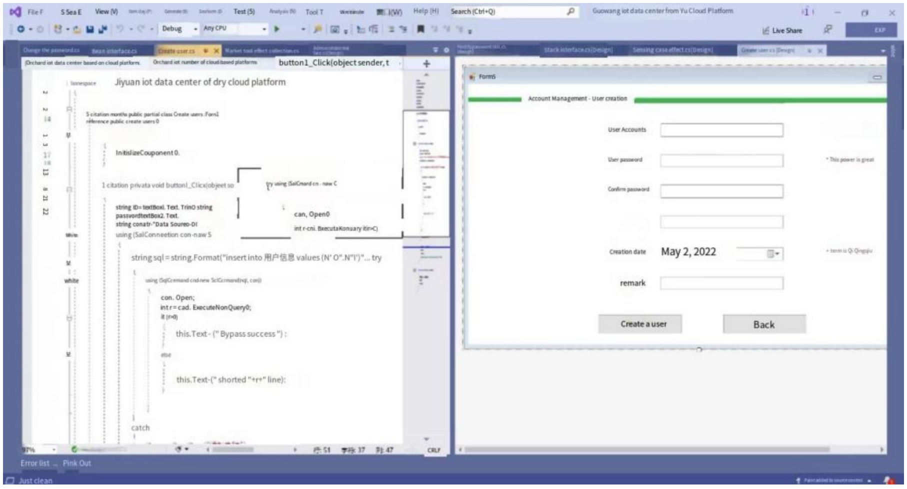

Figure 4.7 Password Change Interface

4.1.6 Create user interface

Creating a user interface is a page where only administrators can log in and perform operations. Administrators can add new accounts for use on this page and synchronize them in the database. Create a user interface as shown in Figure 4.8:



```
Jiyuan iot data center of dry cloud platform
5 citation months public partial class Create users :Form1
reference public create users 0
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1 citation privata void buttonl_Clicx(objeet so
    string ID=textBoxl. Text. TrinO string
    passvordtextBox2. Text.
    string conatr-"Data Soureo-Di
    using (SalConneetion con-naw S
        string sql = string.Format("insert into 用户信息 values (N' O".N"I')"... try
            using (SqlCcemand cnd-new SclCcrmand(sql, con))
                con. Open;
                int r = cad. ExecuteNonQuery0;
                it (r>0)
                    this.Text - (" Bypass success ") :
                else
                    this.Text-(" shorted "+r+" line):
        catch
try using (SalCmard cn - naw C
    can, Open0
    int r-cni. BxecutaKonuary itir>C)
```

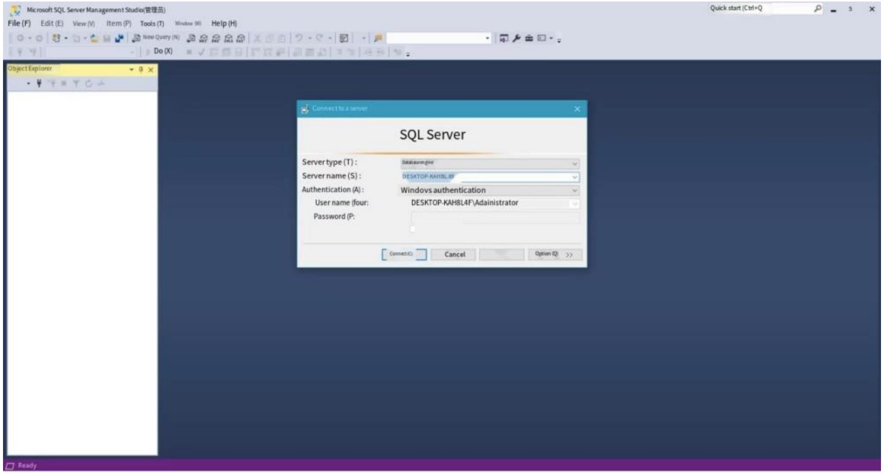
Creation date May 2, 2022

Figure 4.8 Creating User Interface

4.2 Database design

4.2.1 Database Analysis

The database conceptual model is independent of any specific database management system, therefore, it needs to be transformed according to the characteristics of the specific database management system used. This project uses a database to save account passwords, as well as to save and display sensor data downloaded from the OneNet cloud platform, making it more convenient for users to analyze the growth environment in the orchard. The SQL Servr soft volume was selected this time, and the SQL Servr login interface is shown in Figure 4.9:



Server type (T) :
Server name (S) : DESKTOP-KAH8L4F
Authentication (A) : Windovs authentication
User name (four: DESKTOP-KAH8L4F\Adainistrator
Password (P:

Figure 4.9 Database Server Login Interface

4.2.2 Data Table Design

According to the relevant design specifications of the database, it is necessary to design a corresponding database for specific requirements. Establishing necessary indexes can improve the query speed of data tables, and tables with large amounts of data can be managed by partitioning them. For database operations, try to make each field indivisible and independent of other fields.

The primary data table of this system is the user information table, which mainly carries the function of saving user accounts and passwords, facilitating user login, and protecting the security of user personal information. The main attributes are shown in Table 4.1. The main attributes are shown in Table 4.2:

Table 4.1 User Information Table - Details

attribute	types of	Is it empty	length	describe
account number	nvarchar(50)	NOT NULL	50	Primary key user account
password	nvarchar(50)	NOT NULL	50	User defined password

Table 4.2 Sensor Data Table - Detail

attribute	Type of	Is it empty	length	describe
temperature	nchar(10)	NOT NULL	10	Temperature inside the orchard
humidity	nchar(10)	NOT NULL	10	Humidity inside the orchard
Soil moisture	nchar(10)	NOT NULL	10	Soil moisture inside the orchard
Light intensity	nchar(10)	NOT NULL	10	Light intensity

4.2.3 Obtain cloud platform data

This system uses the Data method to obtain cloud platform data, as OneNet supports devices to access the platform using the HTTP protocol principle. The protocol has functions such as access authentication, control command issuance, and alarm departure, making it suitable for data docking between platforms. Its features and functions include short connection protocol and terminal data point reporting. So in the process of obtaining data in the program, a request object is established to apply for reading the data flow of the OneNet cloud platform using HTTP messages as the sending method.

The read data is of JSON type, and then the precise numerical values detected by sensors in the JSON type data are extracted using the string truncation method. The core code is as follows:

Listening to the cloud platform to obtain data core code：

```
private String setData(string text)
    {
        string url = "http://api.heclouds.com/devices/" + ID + "/datapoints?datastream_id=" + text;
        HttpWebRequest request = (HttpWebRequest)WebRequest.Create(url);
        request.Method = "GET";
        var property = typeof(WebHeaderCollection).GetProperty("InnerCollection",
        BindingFlags.Instance | BindingFlags.NonPublic);
        if (property != null)
        {
            var collection = property.GetValue(request.Headers, null) as NameValueCollection;
            collection["api-key"] = apikey;
        }
        request.Host = "api.heclouds.com";
        request.ProtocolVersion = new Version(1, 1);
        request.ContentType = "text/html;charset=UTF-8";
        HttpWebResponse response = (HttpWebResponse)request.GetResponse();
        Stream myResponseStream = response.GetResponseStream();
        StreamReader myStreamReader = new StreamReader(myResponseStream, Encoding.GetEncoding("utf-8"));
        string retString = myStreamReader.ReadToEnd();
        myStreamReader.Close();
        myResponseStream.Close();
        textBox3.Text = retString;
        return Value(retString) + "      " + DateTime.Now.ToString("MM-dd hh:mm:ss");
    }
```

Extract the core code of the string part

```
public string Value(string temp)
{
```

```
    string s = null;
    //textBox4.Text = humi;
    for (int i = 1; i < 9; i++)
    {
        if (checkstring(temp.Substring(99, i)) == true)
        {
            s = temp.Substring(99, i);
        }
        else
        {
            break;
        }
    }
    return s;
}
private bool checkstring(string a)
{
    bool isnum = Regex.IsMatch(a,    @"^\d+$");
    return isnum;
}
```

Final result core code

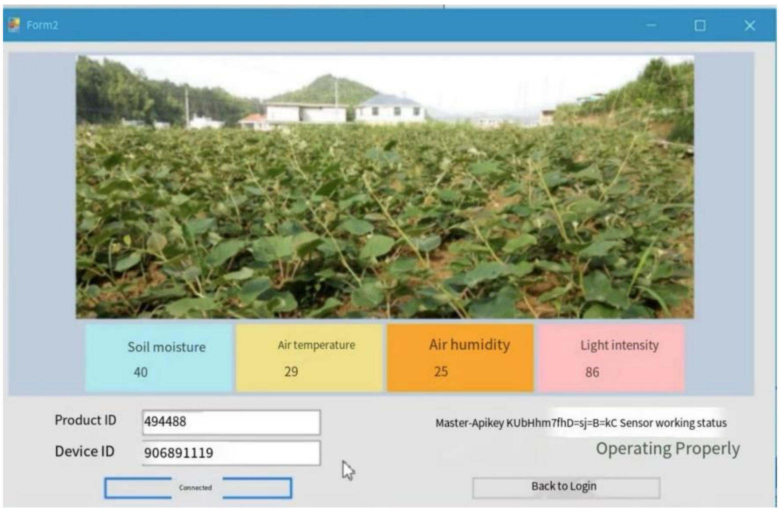
```
public void writer(string path, string[] arr)
{
    if (!File.Exists(path))
    {
        using (StreamWriter sw = File.CreateText(path))
        {
            for (int i = 0; i < arr.Length; i++)
            {
                sw.WriteLine(arr[i]);
            }
        }
    }
    else
    {
        using (StreamWriter sw = new StreamWriter(@"d:\a.txt"))
            for (int i = 0; i < arr.Length; i++)
            {
                sw.WriteLine(arr[i]);
```

```
                        }
                }
            }
```

5 Integration and effectiveness of the system

5.1 Actual effect

In this system, the underlying hardware and the upper computer respectively display the data of crop growth environment in the orchard, as shown in Figures 5.1 and 5.2:



Soil moisture 40
Air temperature 29
Air humidity 25
Light intensity 86

Product ID 494488
Device ID 906891119
Master-Apikey KUbHhm7fhD=sj=B=kC Sensor working status
Operating Properly

Figure 5.1 System Upper Computer Display Effect

Figure 5.2 System Hardware Display Effect

By collecting sensor data, orchard environment data is first displayed on LCD1602 through a microcontroller, and then uploaded to the OneNet cloud platform through the microcontroller's Wi Fi module ESP8266. Subsequently, the upper computer on the computer obtains the collected data through the Internet on OneNet and displays it on the upper computer.

5.2 Result and Analysis

Users can set up hardware nodes on the PC and inside the orchard to observe various environmental data such as temperature and humidity, light intensity, and soil moisture of crops in the orchard more clearly and scientifically. Compared with previous human perception, using sensors to obtain data is also relatively objective. To observe the growth environment of crops in the orchard, And subsequently provide basic physical equipment for analyzing the periodic growth environment of crops in orchards.

The orchard system has completed most of its functions, but there are still some issues in certain aspects. For example, when using MQTT communication to transmit data, instability and data interruption may occur.

V. conclusion

This article introduces a design method for a low-cost remote monitoring system for orchard growth environment. In order to achieve remote monitoring, the data of the system is initially collected through various sensors on the microcontroller. The data is initially processed within the microcontroller and connected to the cloud using Wi Fi modules. The monitoring data is transmitted using the OneNet cloud platform. Finally, the upper computer downloads the data from the OneNet cloud platform and allows users to see the corresponding results on the upper computer. The entire system has been assembled and debugged, and can achieve remote detection of orchard growth rings. It can also be controlled by a separate sensor switch on the upper computer, and the corresponding sensors can be turned on and off according to the specific usage environment. Non essential sensors can also be turned off to avoid resource waste. After verification, the system runs stably, can effectively complete the remote monitoring function of orchard environmental data, and has a certain degree of progressiveness.

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