International Journal of Engineering Inventions
e-ISSN: 2278-7461, p-ISSN: 2319-6491
Volume 13, Issue 3 [March. 2024] PP: 113-125

Orchard irrigation system based on ZigBee technology

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ABSTRACT: *As a large agricultural country, China ranks first in the world in terms of fruit planting scale and production output. In the production management of the orchard, water has a great influence on the growth and development of fruit trees, and even the survival. At the same time, China's water resources are also scarce, so how to save water is also an important problem that China needs to solve for sustainable development. According to the survey, most of the orchard irrigation in China is still in the era of large-scale irrigation of orchards based on experience. Therefore, it is very important to develop an orchard intelligent irrigation system suitable for China's national conditions. For this reason, I conducted a survey on the intelligent irrigation system, and found that foreign countries began to study early and have obtained many research results, and the technology is relatively mature. However, the equipment is relatively expensive and not suitable for China's orchards. There are also some domestic studies, but the technology is slightly lacking, has not been promoted, and cannot meet the needs of fruit farmers. Therefore, this article combines modern electronic technology and wireless communication technology to design this orchard intelligent irrigation system.*

This article has made an overall plan for the orchard intelligent irrigation system. This system is composed of two circuit boards, one for collection and transmission, and one for reception control. Using two STC12C5A60S2 minimum systems, under the development environment of Keil uVision4, it is completed in C language, and the data collection, transmission, system control and other functions are designed. So as to realize the collection and display of soil moisture and automatic irrigation and other functions. At the same time, ZigBee is used for data transmission, and LCD1602 display and key module are used to realize the functions of displaying real-time data and modifying system parameters.

The orchard intelligent irrigation system designed in this paper has the characteristics of wireless data transmission, real-time monitoring, intelligent irrigation and low energy consumption. It is of great significance to the development of China's agriculture.

KEYWORDS: *orchard; intelligent irrigation; ZigBee; wireless transmission; single-chip microcomputer*

Date of Submission: 07-03-2024 Date of acceptance: 19-03-2024

I. INTRODUCTION

1.1 research background

Since 1993, the scale and production output of fruit cultivation in China have rapidly increased, making it a major fruit-producing country. Apples are widely grown in China and hold a prominent position among various fruits. They are one of the advantageous fruits in our country, bringing profits to many farmers. Although China has a large scale and production output, the level of production is not yet high and there is still some distance to catch up with developed countries. Currently, the agricultural industry is moving towards intensive, mechanized, standardized, and high-quality production.

In order to keep up with the pace of the times, we need to manage fruit orchards in a precise, mechanized, and standardized manner. We need to ensure that the fruit trees grow well and yield good harvests. Firstly, we need to provide an optimal environment for the growth of fruit trees. The growth of plants mainly depends on light, water, and nutrients. By meeting their needs during the growth period, we can help the fruit trees thrive, thereby improving both the yield and quality of the fruits, and indirectly benefiting the farmers.

To provide a suitable environment for fruit trees, it is necessary to monitor the surrounding environment and make necessary changes where needed. Research has shown that foreign countries have made significant progress in monitoring orchard environments and implementing automated irrigation systems. The technology is relatively mature, but the equipment is expensive and not suitable for China's national conditions. There have been some domestic research efforts, but the technology is not yet mature enough to meet the needs of fruit farmers, and thus has not been widely promoted. Therefore, it is crucial to develop an intelligent irrigation system for orchards that is suitable for the current situation in China.

1.2 The purpose and significance of the study

水 plays a vital role in the life of fruit trees. It is involved in the transportation of nutrients, photosynthesis, and other life activities of fruit trees. Moreover, in hot summers, fruit trees can utilize water transpiration to protect themselves from scorching heat. Water is not only a necessary substance for the growth and development of fruit trees but also an important link between fruit trees and the surrounding environment. When the soil moisture content is too low, fruit trees reduce their life activities, resulting in slow growth or even death. On the other hand, excessive water content in the soil reduces the oxygen level, making it difficult for the root cells of fruit trees to breathe. Prolonged exposure to excessive water can lead to root rot and ultimately the death of fruit trees. Additionally, different fruit trees have different requirements for soil moisture content at different growth stages.

China faces a severe shortage of water resources despite ranking among the top in the world. With a large population and vast territory, the per capita water availability is actually quite low and falls below the global average. Moreover, water distribution in China is imbalanced, with more water resources in the south and less in the north. Many regions still suffer from drought and water scarcity. Agricultural water use accounts for over 70% of the total water consumption in China, with low efficiency. Therefore, it is necessary to develop automated water-saving irrigation systems in China to improve water resource utilization. An intelligent irrigation system for orchards can effectively address this issue.

1.3 Development and current situation of intelligent irrigation system at home and abroad

1.3.1 current situation of overseas research

Foreign countries have already developed mature technologies in the field of automated irrigation. Research in this area began in the 1980s in countries such as the United States, Israel, and Japan. Data shows that over 40% of the irrigated areas in the United States and the former Soviet Union utilize sprinkler irrigation, while in countries like the United Kingdom, Germany, and Japan, over 90% of dryland areas use sprinkler irrigation. These systems extensively employ automation technology, transitioning from local control to centralized remote control. Well-known companies like Netafim and drip irrigation systems produced by drip irrigation companies are largely controlled by computers. This approach not only reduces the need for labor and resources but also increases crop yield and improves quality.

1.3.2 current situation of domestic research

Due to the late start in this field in our country, equipment in various industries is still in the promotion and research stage. In 1995, Beijing Agricultural Engineering University developed a system that can collect multiple channels of moisture and control it separately, but its function is very single. The WT-02 micro sprinkler timing system developed by Beijing Otesda Technology Co., Ltd. in 2010 can be timed or manually operated. In 2006, China Irrigation and Drainage Technology Development Company developed a micro automatic monitoring system, which can not only achieve detection and control, but also handle accidents. There are also irrigation systems operated by PC in China, but they are not only expensive but also very inconvenient. The above reasons have led to the lack of widespread adoption of equipment in China.

1.4 Main research content of the project

This project studies an orchard irrigation system based on ZigBee technology. A remote interaction system developed primarily based on microcontrollers and utilizing wireless communication technology for remote transmission. The main content is as follows:

1. Collect data through the FS200-SHT30 temperature and humidity sensor, and then transmit the collected data to the microcontroller to achieve automatic collection of soil temperature and humidity.
2. Use ZigBee to wirelessly transmit the collected soil temperature and humidity information.
3. Utilize LCD 1602 (display) to achieve real-time display of collected soil temperature and humidity and working mode, and combine with button modules to adjust the upper and lower limits of watering humidity and switch modes.
4. By comparing and judging the upper and lower limits of soil moisture, and using a microcontroller to control the relay, the control of whether the water pump needs to work can be achieved.

II. Overall system scheme design

2.1 Overall system structure design

This system uses two STC12C5A60S2 minimum systems as the core components. A soil temperature and humidity sensor FS200-SHT30 is used to collect soil temperature and humidity, and ZigBee wireless communication technology is used for transmission. The relay is used to control whether the water pump is working. The other receives data and uses LCD display screen LCD1602 and button modules to achieve real-time display of information and modification of system status and parameters. The overall structure diagram of the

orchard intelligent irrigation system is shown in Figure 2-1.

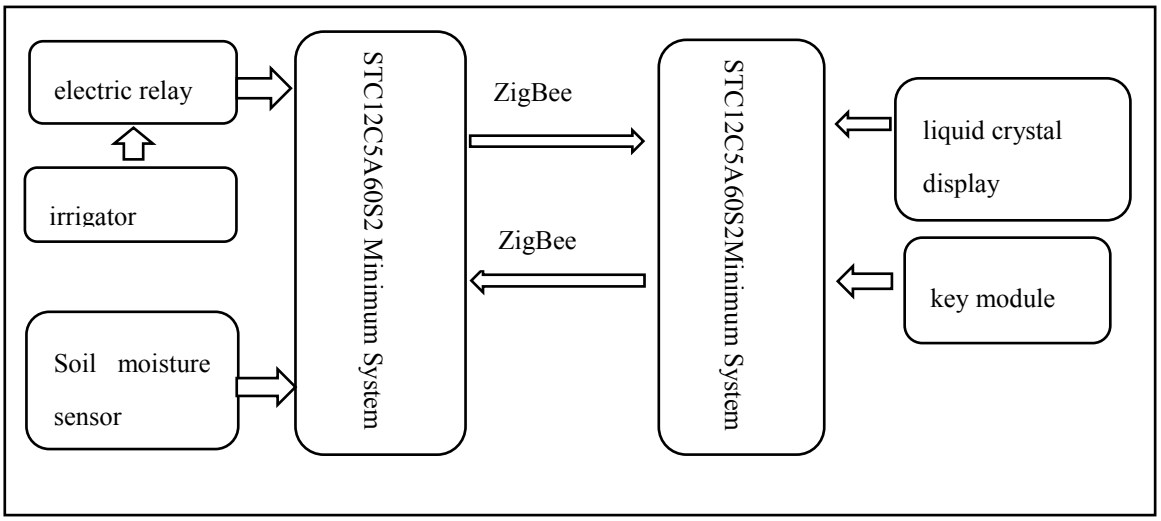

Figure 2-1 Overall structural diagram of intelligent irrigation system for orchards

2.2 Soil moisture collection plan

Soil moisture plays a crucial role in the life of fruit trees, as sufficient water is required for seed germination, growth, and fruiting. Plants typically consist of over 60% water, with the tender parts reaching over 80%. Moreover, plants cannot directly absorb nutrients from the soil and require nutrients to be dissolved in water before they can be absorbed by the plants. So plants can only grow normally when they have enough water. However, it is not sufficient. Everything has a limit, and when things reach their extreme, they will inevitably turn around. Excessive moisture content in soil can lead to a decrease in oxygen content, causing oxygen deficiency in plant roots and hindering normal life activities. Long term damage may cause waterlogging of plants, leading to plant death.

So in order for fruit trees to grow well and harvest well, watering should not be carried out until the soil is severely dehydrated. Then pour a lot of water at once. This is not conducive to the growth of fruit trees. So when will we water it? How much water should be poured at once? It becomes very important, and if judgments are made manually, accuracy cannot be achieved. So it is necessary to monitor the changes in soil moisture in real time. With the development of modern times, there has been great progress in the collection of various growth indicators of crops, including soil moisture sensors. They have developed very compact, fast, accurate, safe, low-cost, and easy to operate. After multiple considerations, this system adopts FS200-SHT30 temperature and humidity sensors. This sensor has the characteristics of precision and reliability. Can be directly buried in the soil for use.

2.3 Wireless data transmission scheme

Wireless communication is a new modern technology that utilizes radio waves for information dissemination, replacing wired communication that is inconvenient to move. After years of development, wireless communication has entered our lives and become an indispensable part of our lives, bringing convenience to our lives. Among them, wireless communication technologies mainly include WiFi, Bluetooth, ZigBee, etc., and they also have their own advantages and disadvantages in practical applications.

WiFi is currently one of the most widely used wireless communication technologies and is also very common in our daily lives. Its communication distance is usually several tens of meters, but it consumes a lot of power.

Bluetooth, Bluetooth is a wireless communication technology between devices that enables short distance data exchange between devices and personal LANs, using short baud high-frequency radio waves for transmission. But its transmission distance is small and its power consumption is also high.

ZigBee is a low-speed, low energy consumption, and low-cost wireless communication technology that can effectively transmit within 100m. And it can form a self-organizing network.

In summary, based on the actual situation of the orchard, this system adopts ZigBee as the wireless communication technology, and the selected module is the DL-20 wireless serial port module.

III. hardware design

3.1 ZigBee wireless communication

ZigBee is a wireless network protocol that features simplicity, speed, reliability, and low energy consumption. It can be applied in fields such as wireless communication control and automation, indirectly saving the cost of computers and wired cables. ZigBee is similar to Bluetooth, but it has greater advantages in power and transmission distance. Compared to traditional networks, ZigBee performs more efficiently. Moreover, ZigBee is a bidirectional wireless network technology that can simultaneously receive or send information. Moreover, because ZigBee can establish many branches, its information capacity is very large. In order to prevent collisions with other signals during transmission, ZigBee has adopted efficient collision measures, which gives ZigBee another characteristic of strong compatibility. The ZigBee technology used in this article mainly has the following characteristics:

(1) Low power consumption, ZigBee has very low power consumption. It can be used for 6 to 24 months with two No. 5 batteries, while Bluetooth and WiFi can only be used for a few hours.

(2) High capacity, ZigBee can adopt multiple network structures, and a node can manage up to 254 nodes. This node also has a superior, so there can be up to 65000 layers nested together, which results in ZigBee having a very high capacity.

(3) Strong compatibility, ZigBee adopts an efficient anti-collision mechanism to prevent collisions with other signals during propagation, and it does not cause collisions when using home networks, but is well integrated with it.

(4) The cost is low because ZigBee only uses an eight bit microcontroller for calculation and a small amount of code, and ZigBee is free of protocol patent fees, which leads to its low cost.

(5) Short latency, ZigBee only takes 15 milliseconds to transition from standby mode to working mode, and connecting to network nodes only takes 30 milliseconds, while Bluetooth and WIFI both require three seconds to start.

3.1.1 DL-20 module

The DL-20 wireless serial port module is a 2.4G wireless communication module that can connect two or more serial ports. And it supports serial port continuous transmission and simultaneous transmission and reception, and can transmit up to 3300B of data per second. The DL-20 also has two working modes. The first is point-to-point mode, where two nodes send data to each other, ensuring a data loss rate of 0.00%. The second is broadcast mode, where data sent by one node can be received by multiple nodes with the same channel at a distance. This mode may result in packet loss and a bit error rate of about 1%. The interface diagram of the DL-20 module is shown in Figure 3-1, and the parameter table of the DL-20 module is shown in Table 3.1.

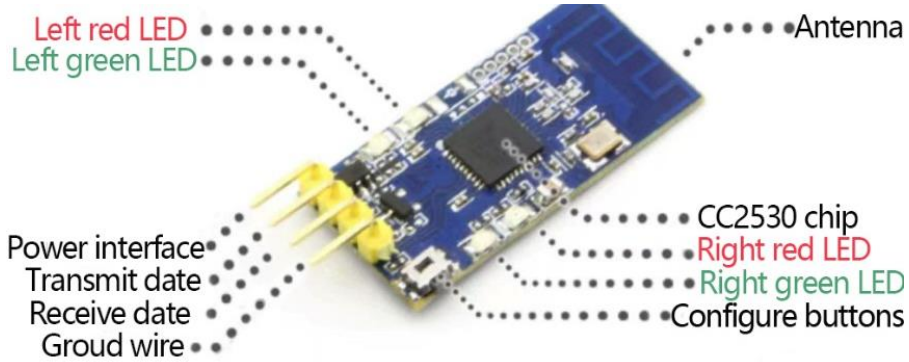

Figure 3-1 DL-20 Module Interface Diagram

Table 3.1 DL-20 Module parameter table

parameter	value	explanation
Input voltage	3.0-5.5V	supply voltage
Working current	<30mA	Receive and send current
Peer-to-peer transmission rate	Up to 3300Bps	Measured at a distance of 1m
Distance	250m	Measured in open areas
wireless spectrum	2400-2450MHz	
Transmission power	4.5dBm	

Accept sensitivity	-97dBm	
Point to point bit error rate	0.00%	No packet loss when the transmission power is below the maximum
Broadcast bit error rate	0.5%	Unidirectional transmission measurement at a distance of 1m
size	15.5*31.5mm^2	Size does not include needle arrangement

3.1.2 On-chip system CC 2530

CC 2530 is a SOC (System on Chip) solution developed by T1 company to solve applications such as ZigBee and RFCE at 2.4 GHz. CC2530 adopts a single cycle 8051 processor. It can edit flash memory and has four types of flash blocks. The external device of the system is powered by a 1.8V low-voltage regulator, which can effectively judge the different power supply of different systems, operate different working modes, and adapt to different low energy consuming systems. And it also provides many other peripherals for easy development. CC 2530 can be divided into two communication methods based on different connection methods. One is parallel communication, which means that each data is sent and received using a single line with fast speed. At the same time, it also leads to the use of many data lines, resulting in increased costs. The second type is data sent through parallel communication, where data is sent or received in sequence one after another on a data line. This can result in slow speed, low efficiency, and cost savings.

3.2 Core control chip selection

A good control system can make the system work more efficiently and reduce the complexity of the circuit. A microcontroller is a great choice. A microcontroller is a computer device that integrates processors, memory, and other computer components onto a single chip, much like a microcomputer. There are only fewer IO devices than computers. So microcontrollers have powerful functions. And the microcontroller is of good quality and affordable price, with a compact size. It is suitable for making core chips.

At present, many companies in the world manufacture microcontrollers, so microcontrollers are also different and each has its own unique characteristics. So it is very necessary to choose a microcontroller that is suitable for this system. After comparing several microcontrollers, STC's STC12C5A60S2 microcontroller was ultimately chosen.

The STC12C5A60S2 microcontroller is equivalent to an upgraded version of the 8051 microcontroller. It is not only compatible with the traditional 8051, but also 8 to 12 times faster in speed. And it also has a large amount of editing memory. The system can operate normally at a voltage of+5V, so using USB can provide power to the entire system. Moreover, the chip is equipped with a 500mA self recovery fuse, which can effectively protect the circuit from damage caused by short circuits. And this microcontroller also supports serial port burning programs, and realizes USB to serial port conversion through CH340T, so that the system can directly burn programs through the USB port. The schematic diagram of STC12C5A60S2 is shown in Figure 3-2.

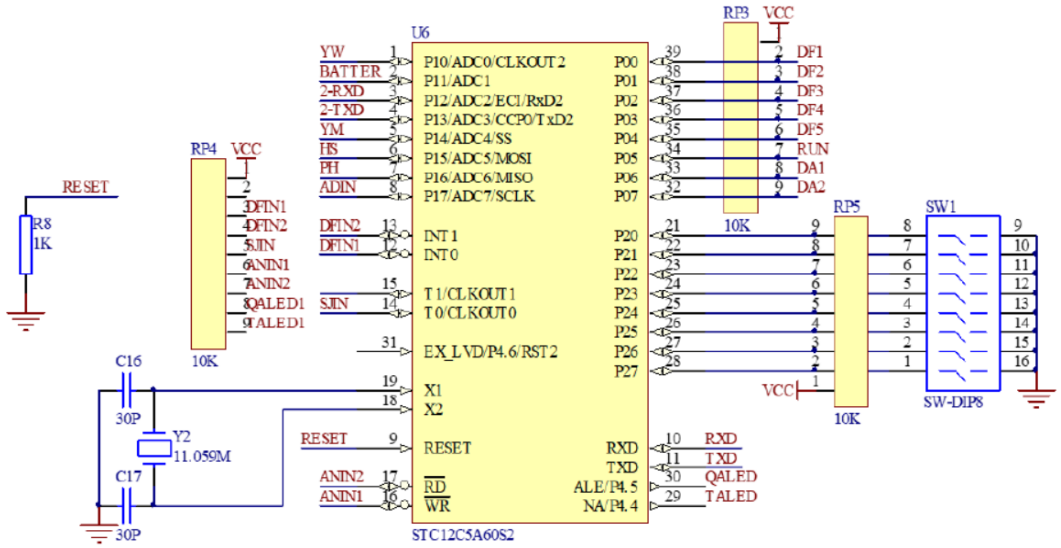

Figure 3-2 schematic diagram of STC12C5A60S2

3.2.1 STC12C5A60S2 reset circuit

The reset circuit in a microcontroller is a circuit that restores the microcontroller to its initial state, which initializes the values of the memory and various registers in the microcontroller. This can avoid errors during program execution. The reset circuit is mainly composed of resistors and capacitors. Its working mode is as follows: when the power is turned on, the capacitor is empty and begins to charge, causing current to pass through the resistor and generate voltage. The generated voltage is equivalent to a high level applied to the RST terminal of the microcontroller. When the RST terminal of the microcontroller reaches a high level, it will reset the microcontroller. When the capacitor is fully charged, there is no current, and there is no voltage at both ends of the resistor. The RST terminal of the microcontroller also has no voltage and becomes low, and the microcontroller starts to operate normally. The reset circuit diagram used in this system chip is shown in Figure 3-3. Because STC12C5A60S2 has a dedicated reset circuit inside, when the external crystal oscillator is below 12MHz, the RST end can be directly connected to a 1000 ohm resistor without the need for a capacitor to function properly。

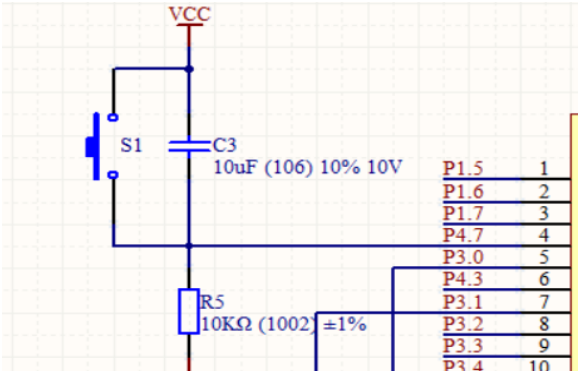

Figure 3-3 STC12C5A60S2 Using a reset circuit diagram

3.3 FS200- SHT30 Soil temperature and humidity sensor

This system uses FS200 SHT30 digital temperature and humidity sensor, which is composed of Swiss imported SHT30 sensor and copper sintered protective shell. It can effectively withstand high temperature, high pressure, and corrosion. Its core adopts world-class sensors, which have high reliability and stability, and can be seamlessly connected with AD conversion circuits or serial port circuits. The soil temperature and humidity sensor is shown in Figure 3-4.

Figure 3-4 Soil temperature and humidity sensor

3.3.1 SHT30 sensor

The SHT30 sensor is a precise and stable temperature and humidity sensor. Its transmission speed can reach up to 1M/s. The temperature is collected using the method of thermocouples, which weld one end of two conductors with different materials together and connect the other end to the instrument to form a closed loop. When there is a temperature difference between the two ends of the conductor, thermoelectric electromotive force will appear in the circuit, and this electromotive force will be converted. The measurement of humidity is done using thin film capacitors. The principle is that after the polyammonium salt or acetate fiber polymer film on the electrode absorbs or loses water, it causes a change in the dielectric constant between the electrodes. This causes a

change in capacitance and capacity. By capturing and converting this capacity change, the output temperature and humidity need to be converted before they can be used. The conversion formula is as follows:

Relative humidity conversion formula：

$$RH = 100 * \frac{SRH}{2^{\wedge}16\text{-}1} \qquad (1)$$

Temperature conversion formula:

$$T[℃] = -45 + 175 * \frac{ST}{2^{\wedge}16\text{-}1} \qquad (2)$$

$$T[°F] = -49 + 35 * \frac{ST}{2^{\wedge}16\text{-}1} \qquad (3)$$

SRH represents the humidity output by the original sensor, and ST represents the temperature output by the original sensor.

3.4 l iquid crystal displayLCD1602

In a system, we need to visually observe some data, status, etc. The most convenient way is to watch through the monitor. The monitor can convert electrical signals into characters that we can recognize, such as numbers and text. It allows us to directly and conveniently obtain the information we want to know.

This system uses an LCD 1602 liquid crystal display. The LCD 1602 monitor can display characters such as symbols and numbers. This monitor mainly consists of a display controller, driver, and bias generation circuit. It can achieve functions such as reading and writing, display, and cursor movement, but these functions need to be programmed through instructions. The circuit diagram of LCD1602 LCD display is shown in Figure 3-5.

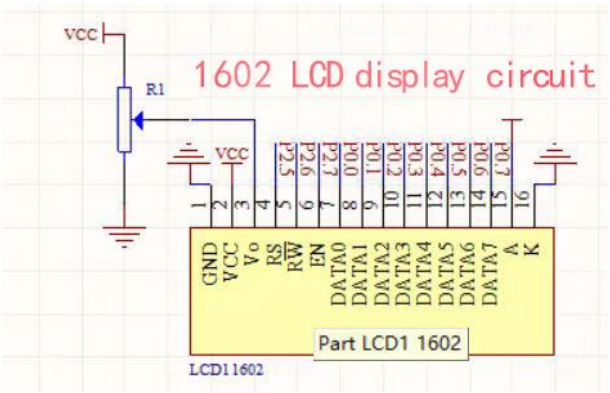

图3-5 LCD1602 circuit diagram

3.5 Water pump control device

A relay is an electrical control component, equivalent to an automatic switch. This system uses relays to control the operation of the water pump. A relay typically consists of two circuits, controlled through two contacts, one normally open and one normally closed. A relay controls the circuit by connecting the coil controlled armature to the contact point. The electromagnetic effect acts on the armature to connect different circuits. By connecting the water pump to the normally open circuit, its operation can be controlled. The high-level trigger circuit diagram of the relay is shown in Figure 3-6。

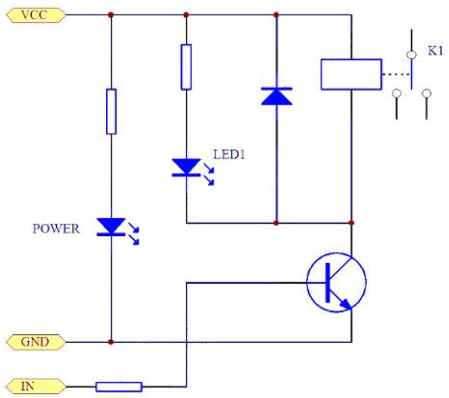

图3-6 Relay high-level trigger circuit diagram

3.6 Irrigation equipment

Irrigation equipment, also known as watering equipment. There are many irrigation methods nowadays, such as sprinkler irrigation, drip irrigation, subsurface irrigation, infiltration irrigation, etc. So there are also many corresponding devices that can adapt to different terrains and environments. So choosing a suitable device can save a lot of trouble and improve water utilization. This system uses a water pump here, and in reality, suitable irrigation equipment can be selected according to the actual situation. The parameters of the water pump are as follows：

- Voltage：DC3-5V
- Electric current：100-200mA
- Traffic：1.2-1.6L/分钟
- weight：28克

IV. software design

4.1 SYSTEM DEVELOPING ENVIRONMENT

4.1.1 Keil uVision

Because the control chip used in this article is a 51 series microcontroller. Generally, the development of 51 microcontrollers adopts Keil uVision developed by American company KeilSoftware, and this software is also used in this article.

1. Keil uVision overview

Keil uVision is a 51 series compatible microcontroller C language software development system with rich library functions and many powerful features. Provides development solutions such as C compiler, macro assembly, linker, and simulation debugger. Moreover, Keil uVsion4, released in 2009, also introduced a flexible window management system that can be displayed on multiple screens. There is also a new user interface that can make development neat and efficient. The Keil uVision 4 software diagram is shown in Figure 4-1.

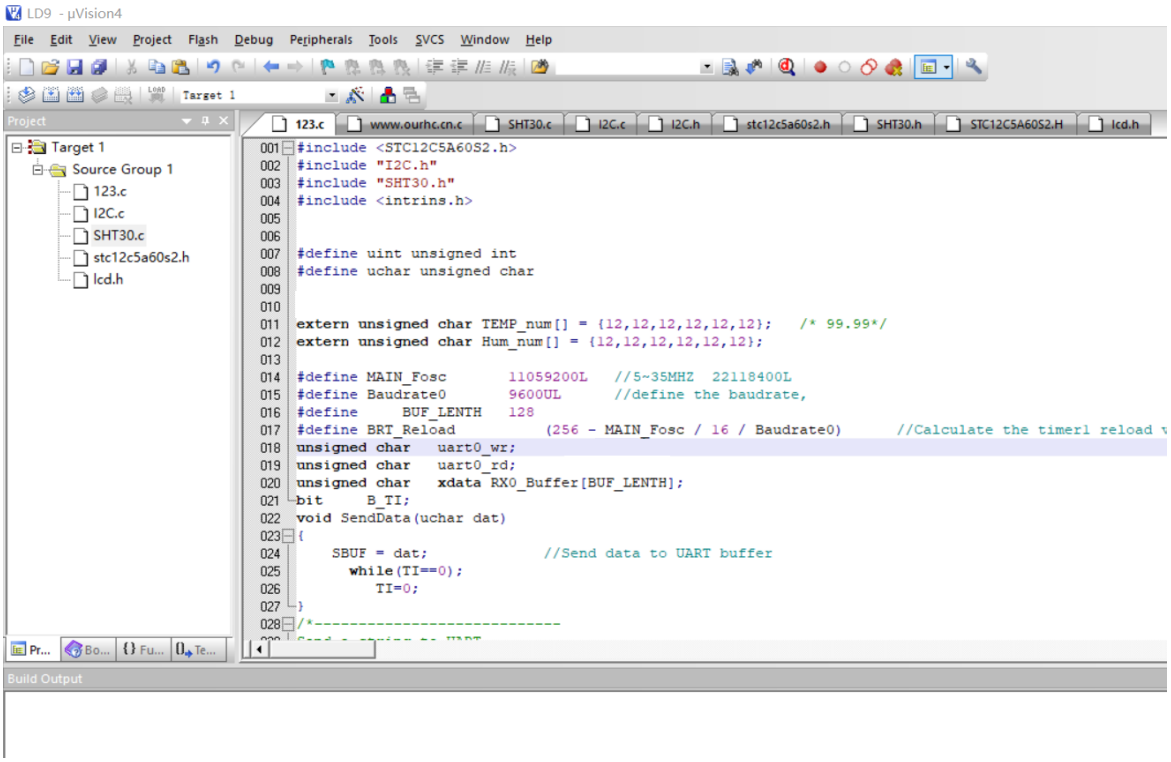

Figure 4-1 Keil uVision 4 software diagram

4.1.2 Development language selection

Keil uVision 4 supports programming in multiple languages, including C language, assembly language, and more. Assembly language is a machine oriented language that is highly targeted and resource intensive. But it is difficult to understand and write. C language is a high-level language with strong performance and processing capabilities, and supports structured programming, which can be ported to different microcomputer platforms. And it is easy to maintain and modify. Moreover, Keil uVision 4 has excellent support for C language compilation, so this system uses C language for programming.

4.2 system programming

4.2.1 Data Acquisition Module

The system used in this article is an FS200-SHT30 temperature and humidity sensor with a copper sintered protective shell on the outside. It can effectively resist high temperature, high pressure, and corrosion, so it can be used to measure soil. This sensor can collect both temperature and humidity data simultaneously. Temperature measurement is done using a thermocouple method, while humidity is captured and converted through changes in capacitor capacity caused by changes in the dielectric constant between electrodes. And this sensor integrates signal processing, outputting digital signals without the need for AD conversion. The soil temperature and humidity collection process is shown in Figure 4-2.

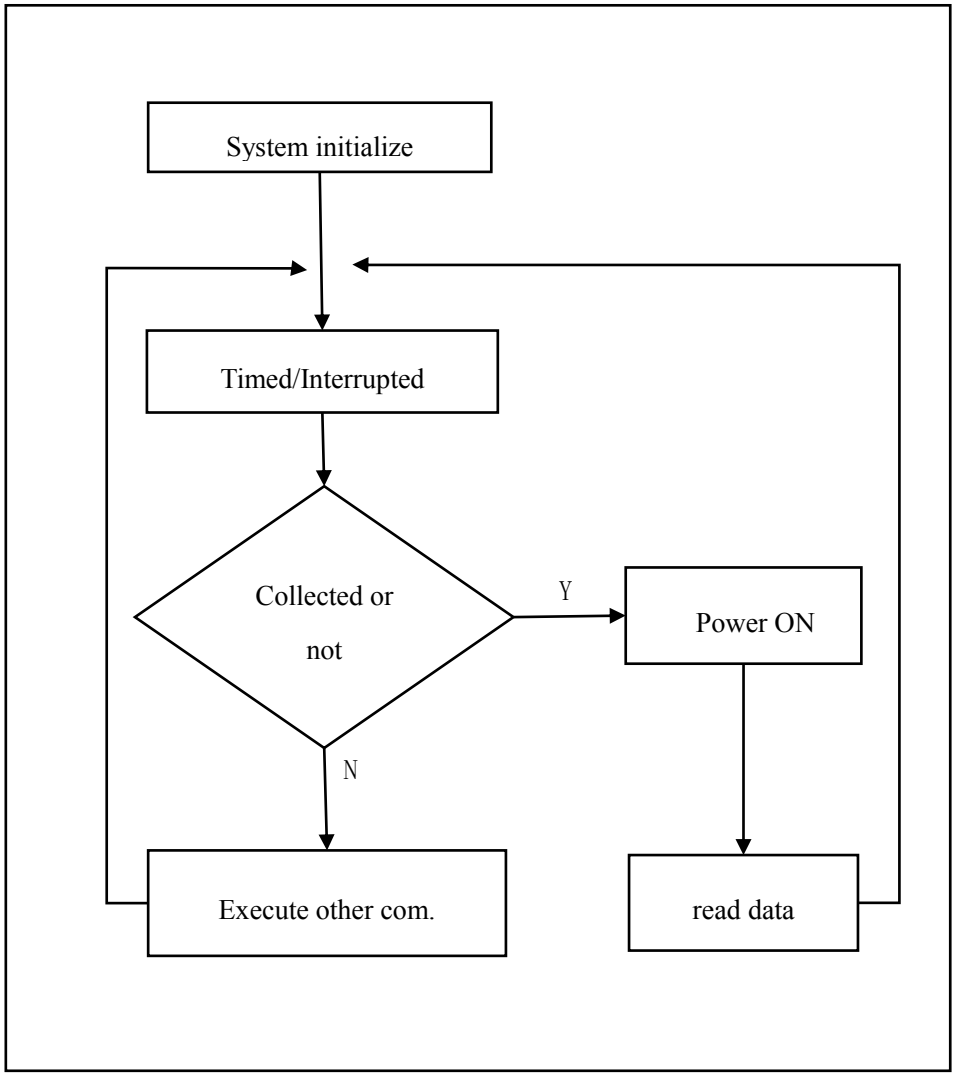

图4-2 Flow chart of soil temperature and humidity collection

4.2.2 Irrigation module

The irrigation module in this system consists of a microcontroller, a relay, and a water pump. By controlling the relay through a microcontroller, the operation of the water pump is controlled. Because this system has two working modes, manual and automatic. When the system is in manual mode, the relay can be operated directly through buttons to control the working circuit of the relay and thus control the operation of the water pump. When in automatic mode, the system will judge the collected humidity information. When the humidity is below the lower limit, it will power on the relay to make its normally open circuit work. If the water pump is on this line, the water pump will work. When the collected humidity exceeds the upper limit, the relay will be in a normally closed circuit and the water pump will not work. The relay of this system is controlled through the p1.0 port. When output 0 indicates that the water pump is turned on and output 1 indicates that it is turned off. The workflow diagram of the irrigation system is shown in Figure 4-3.

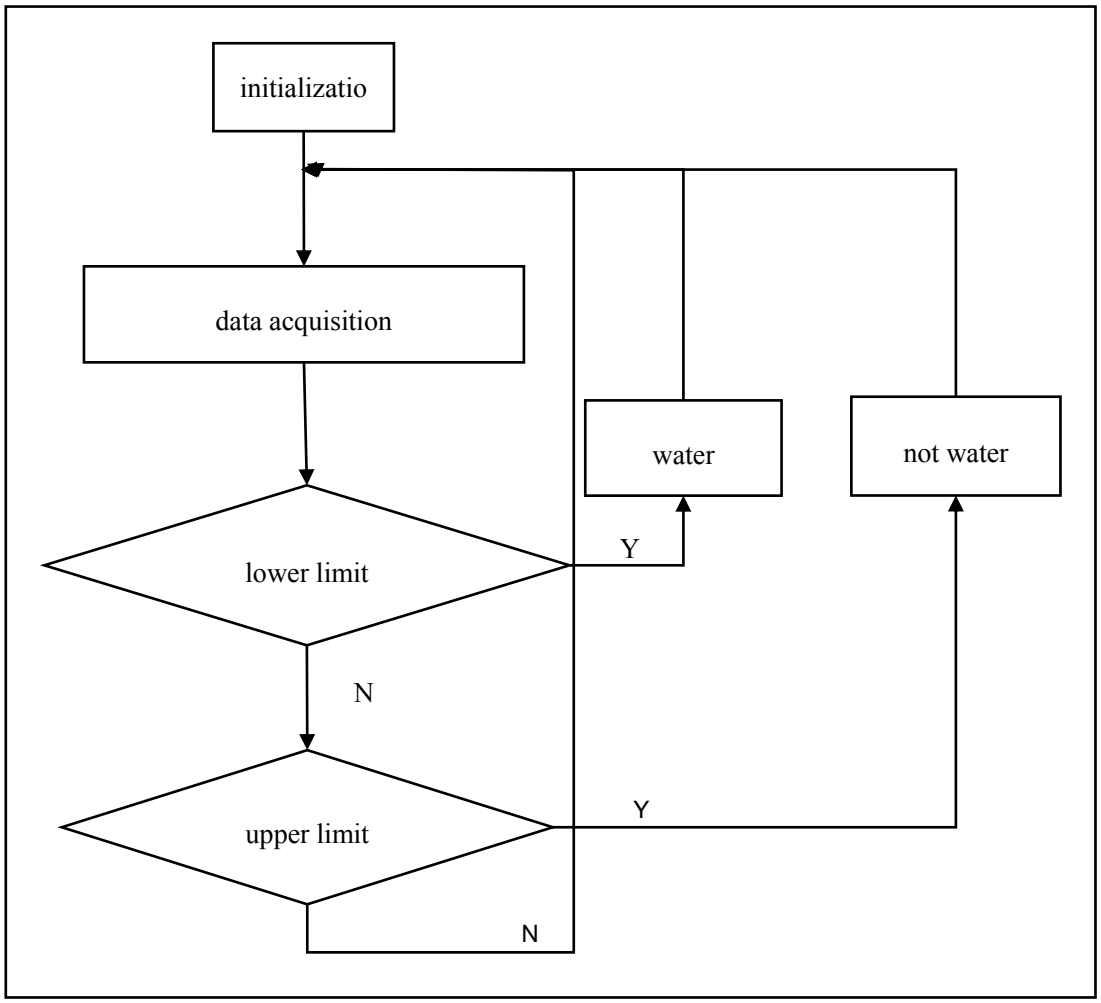

图4-3 Irrigation system workflow diagram

4.2.3 key module

The design of the button module is mainly to allow users to control the system working mode and set and modify system parameters. This module uses three buttons to switch between manual mode and automatic mode, as well as adjust the upper and lower limits of humidity to determine whether to water. The button adopts an interrupt scanning method. When the button is pressed, an interrupt signal is generated and the corresponding program is executed. When the left button is pressed, the upper and lower limits of humidity will be selected. The middle and right buttons can be used to adjust the upper and lower limits of watering humidity. When pressing the middle button, the system working mode can be adjusted. When in manual mode, the relay circuit can be controlled by the right button to switch, thereby achieving manual irrigation.

4.2.4 Display module

The display module of this article uses an LCD 1602 display screen, which can display 16 words x 2 lines, and can be used to display the temperature and humidity data collected by the system, as well as the upper and lower limits of soil moisture. The LCD display screen has a low-level driver written in C language, which can directly call functions to control the display and read/write functions of the LCD. The LCD display flowchart is shown in Figure 4-4.

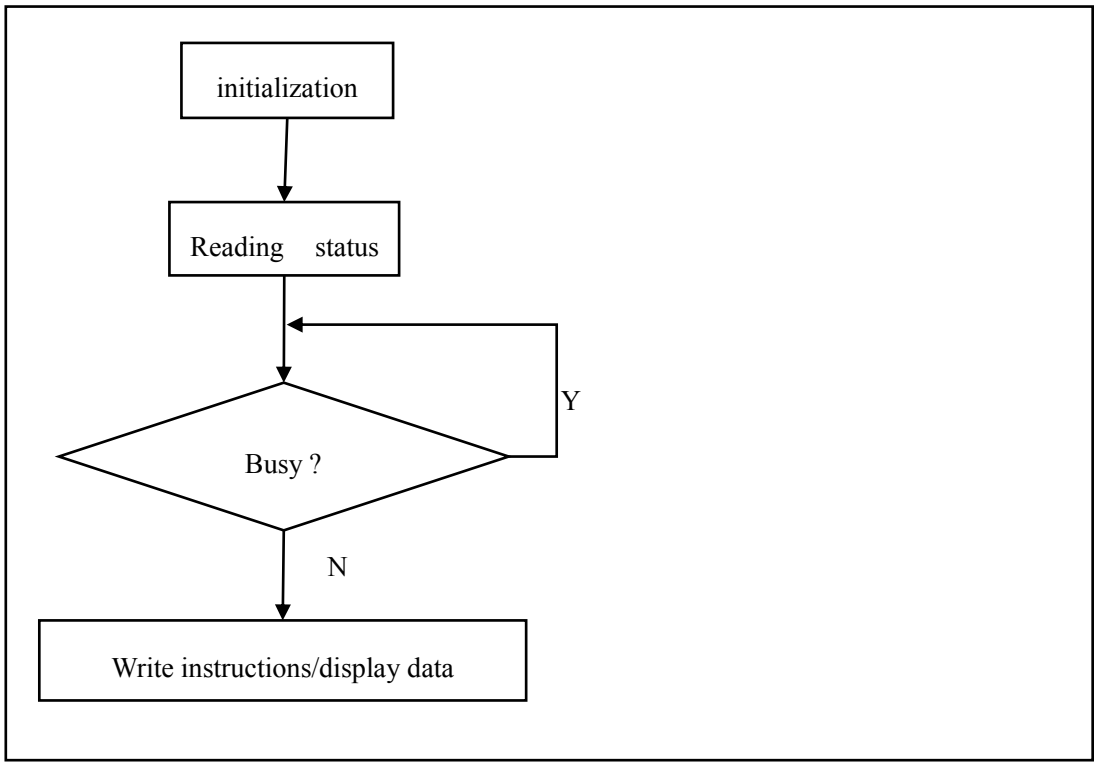

图4-4 LCD1602 Display flowchart

V. System testing

The intelligent irrigation system for orchards designed in this article mainly involves overall design of the system, selecting appropriate components and designing circuits, as well as writing and debugging software programs. Next, we will test the system, mainly focusing on the hardware and overall operation of the system. The test content is to check whether the components are intact, whether the circuit design is reasonable, and whether it can work normally. Also, whether the software program can run normally and achieve the design functions.

According to the final detection results, the software and hardware parts of the system designed in this project are all problem free and running well, and the functions have been implemented and can achieve the expected results.

5.1 System hardware testing

Hardware testing is mainly to ensure the normal operation of the circuit board. After the circuit board is soldered and before charging, a multimeter should be used to test the power supply and circuit. Check for any short or open circuits. If there is, the cause should be carefully investigated, identified, and the problem resolved. And it is also necessary to observe the welding situation of the components, whether there is any false soldering, missing soldering, reverse soldering, etc., to avoid damage to the components after power on. After confirming that there are no issues with the above tests, power on the circuit board. After testing, the hardware of this system has been tested to be within the normal range of voltage, and both the components and circuits are functioning properly.

5.2 System operation testing

The system operation test is mainly a comprehensive test of the system. After all hardware tests are successful, the system is powered on for functional testing. Mainly includes the collection of soil temperature and humidity, wireless data transmission,

Testing of real-time display and automatic irrigation functions. Test whether the system software is running normally and whether the functions are implemented and achieve the expected results.

The test data shows that this system can correctly collect data, transmit and display it without errors by ZigBee, and can achieve irrigation in both manual and automatic modes. All designed functions can operate normally and achieve the expected results. The system operation status table is shown in Table 5.1.

Table 5.1 System Health Status Table

Soil temperature (℃)	soil moisture (%)	Water pump status	Upper limit of watering (%)	Lower limit of watering (%)	test result
18.5	31.5	Not working	50	20	normal
18.4	32.3	working	50	35	normal
15.4	68.6	Not working	60	40	normal
15.2	84.5	Not working	80	70	normal

VI. CONCLUSION

This article addresses the issues of poor efficiency, imprecision, and wastage of water resources in orchard irrigation. Using modern computer and IoT technologies, a orchard irrigation system based on ZigBee technology is designed. The system can monitor soil moisture content in real-time and display the data in the display module through wireless transmission. It also has two modes: automatic and manual. After final testing, the following conclusions were obtained:

(1) The orchard intelligent irrigation system designed in this article can complete automatic irrigation tasks after testing and meets the design requirements.

(2) This system adopts ZigBee technology for wireless transmission, which ensures secure and stable data transmission, low power consumption, and accurate and fast delivery of issued instructions.

(3) This system has a button module that allows for switching between system operating modes and setting system parameters. Combined with the display module, it achieves human-computer interaction.

Acknowledgement: This work was funded by the Science and Technology Department of Henan Province [222102210116]; Ministry of Education Industry-University Cooperation Collaborative Education Projects (Granted Number: [221001221014436], [230800506114441] and [230800922021132].

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