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Design of Remote Monitoring System of Irrigation based on GSM and ZigBee Technology

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Abstract. To solve the problems of low level of irrigation and waste of water resources, a remote monitoring system for farmland irrigation based on GSM communication technology and ZigBee technology was designed. The system is composed of sensors, GSM communication module, ZigBee module, host computer, valve and so on. The system detects and closes the pump and the electromagnetic valve according to the need of the system, and transmits the monitoring information to the host computer or the user's Mobile phone through the GSM communication network. Experiments show that the system has low power consumption, friendly man-machine interface, convenient and simple. It can monitor agricultural environment remotely and control related irrigation equipment at any time and place, and can better meet the needs of remote monitoring of farmland irrigation.

1. Introduction

In the process of agricultural production, the growth, development and yield of crops are closely related to the soil moisture temperature. Suitable soil temperature and humidity can not only improve crop yield, but also improve the quality and taste of crops. At present, most agricultural irrigation in our country uses flood irrigation or artificial watering, not only wasting water resources, but also may result in the phenomenon of not timely irrigation, insufficient irrigation or over irrigation, thus affecting the growth of crops. Traditional manual measurement of soil temperature and humidity for irrigation mode, not only wasting manpower and time, it is difficult to do real-time monitoring, do not take advantage of the production of farm crops. The traditional method of measuring soil temperature and humidity for irrigation is not only wasteful of manpower and time, but also difficult to monitor in real time and not use farmland crop production.

ZigBee is a two-way wireless communication technology, with low power consumption, low cost and strong networking of devices, which can be used for a near distance wireless connection [1, 2]. GSM global mobile communication system has the characteristics of good communication quality and strong anti-interference ability. In this paper, a remote monitoring system for farmland irrigation based on GSM and ZigBee is designed. Through the real-time monitoring of soil temperature and humidity, the system can automatically obtain real-time data without going to the site, and timely and accurate understanding of soil environmental parameters, and according to the demand of crops automatically adjust the valve switch, on-demand irrigation of crops, not only greatly avoided the waste of agricultural water, reduce the cost of agricultural products, but also increased the yield of crops [3-5]. The system uses the wireless sensor network to collect soil temperature and humidity information in real time, and uses GSM network to realize remote transmission of soil data information, the staff and the host computer can analyse the data remotely to complete the real-time control of the amount of water applied to the drip irrigation or sprinkler terminal, which not only saves water but also greatly saves labor, improves work efficiency and increases farmers' income.

2. Overall plan of remote monitoring system

This irrigation remote monitoring system mainly includes data collection function, data processing function, electromagnetic valve control function, power management function, remote monitoring function. It mainly consists of sensor nodes (including soil temperature, humidity sensor, light sensor, etc.), solenoid valve node, coordinator node and monitoring center. Its structure is shown in figure 1. The monitoring part consists of temperature, humidity sensor, light sensor, etc., and it is arranged on the surrounding farmland, mainly responsible for periodically gathering information about farmland environment. The coordinator node has the instructions to send and receive the soil information and to receive a PC or cell phone. PC and mobile phones are used to display field data and to analyse and determine whether irrigation is needed. From time to time, the system collects the information of soil temperature and humidity, illumination, state of the electromagnetic valve and other information in the farmland through the sensor and collects the collected information to the coordinator node through the ZigBee network. The coordinator node collects Information uploaded to the designated phone and host computer.

When the mobile phone or the upper computer gets the definite soil parameter information, the irrigation plan can be made automatically by the program, the control instruction is sent to the coordinator node of the corresponding farmland via the GSM network. The coordinator node in the farmland transmits the control instruction through the ZigBee network to the control node, the actuator to achieve the appropriate control of the valve, for precision farmland irrigation. The manager receives the soil parameters information through the GSM network and remotely controls the irrigation equipment, so that the information of the temperature and humidity of the farmland soil can be monitored conveniently on the host computer or the administrator's mobile phone. When the soil temperature and humidity parameters exceed the set value, the system has alarm function. The upper machine USES configuration software to realize data management and human-computer interaction to achieve the purpose of user monitoring. The system is characterized by low power consumption, high performance, simple maintenance, low transmission cost and high reliability.

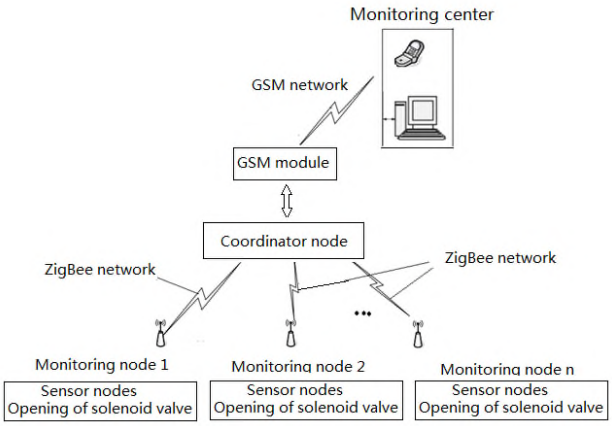

Figure 1. Structure of remote irrigation system.

3. System detection circuit design

3.1. The choice of ZigBee module

The ZigBee module of the system uses TI chip CC2530 as the core module, the module supports the IEEE802.15.4/ZigBee protocol, the working frequency range is 2.4GHz. This chip integrates a high performance direct sequence 2.4GHz RF transceiver core, the enhanced 8051 controller with low power consumption, temperature sensing function and battery monitor function; There are 2 USART, 8 timer and 16 timer each. It supports 2 ~ 3.6V power supply; Working temperature is minus 40 ~ 125 °C; It supports the working mode of hibernation, sending, receiving and so on, with short conversion time and low current power consumption, which can meet the requirements of low power

consumption of the system. The CC2530 minimum system circuit connection diagram is shown in figure 2.

The minimum system of CC2530 can be realized only by a few components. The crystal oscillator 1 is 32.768KHz, the crystal oscillator 2 is 32MHz, and the RF transceiver needs 32KHz crystal oscillator when transmitting and receiving functions; The digital power interface 40 pipe joints with a 1uF decoupling capacitor to improve the stability of the power supply; RF-N and RF-P adopt inductance and discrete capacitance realize the connection with RF matching network part (including matching capacitor, antenna, etc.); The purpose of crystal vibration-load capacitance C2, C3, C4 and C5 is to ensure that the crystal vibration has precise and stable oscillation frequency.

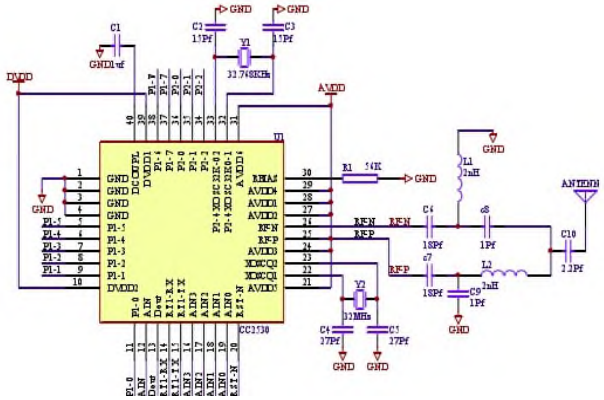

Figure 2. CC2530 peripheral hardware circuit diagram.

3.2. GSM module design

The function of the GSM module is to send the collected data to a remote host or mobile phone [6]. Because ZigBee network can only realize short distance data transmission, and GSM network has signal stability, can realize global roaming and networking, high coverage, so the system uses GSM network to send data to the remote. The GSM module of the system adopts the TC35i module of Siemens, which is a GSM debug demodulator, and the supply voltage is 3.3 ~ 5.5V, which supports the 900MHz/1800MHz dual frequency [7]. Providing RS232 serial port in PC communication, using AT format instructions.

GSM module circuit includes TC35i module, power module, SIM interface circuit and RS232 serial communication circuit with CC2530 to realize GSM communication function. The interface circuit of the TC35i module is shown in figure 3.

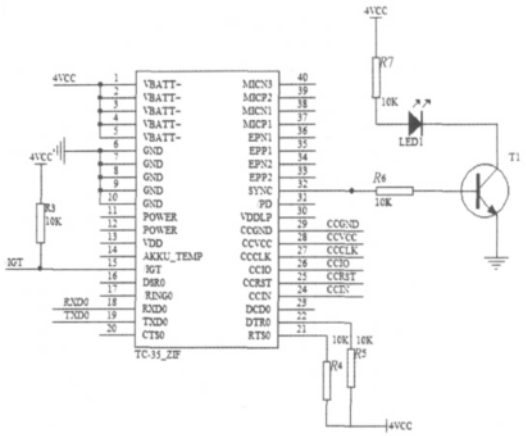

Figure 3. TC35i module interface circuit.

1 ~ 5 pin is the power pin in parallel. The 6-10 pin is a parallel grounding pin; In order to ensure the stability of TC35, the parallel capacitance between the earth and the power supply is decoupled.

The 15 pin is the boot foot, then the work state of TC35i is controlled by the P2-0 of CC2530. 16 ~ 23 pin is the data input/output function pin, which conforms to itu-trs232 interface standard, and is connected with the 16/17 foot of CC2530. The 32 pin controls LED lights, and the TC35i work state can be determined by displaying the light.

Access to the GSM network must have a SIM card, The SIM card is connected to the TC35 module from 24 ~ 29.The circuit diagram is shown in figure 4.

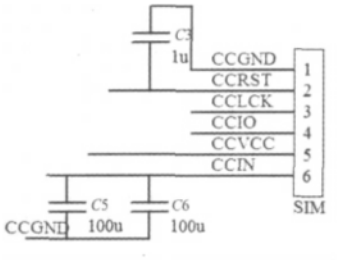

Figure 4. Interface circuit between TC35i and SIM card.

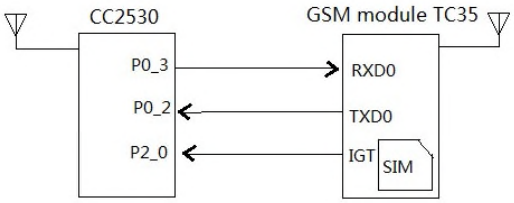

Figure 5. Connection between coordinator and GSM module.

CC2530 and GSM module use the RS232 protocol for serial communication. The connection between CC2530 and GSM module is shown in figure 5.

3.3. CC2530 charging circuit

Because the ZigBee coordinator requires uninterrupted work and consumes a lot of power, the ZigBee coordinator recharges the battery using a solar panel. The solar charging circuit is shown in figure 6.

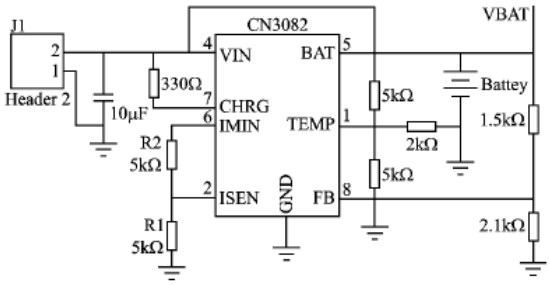

Figure 6. Solar charging circuit.

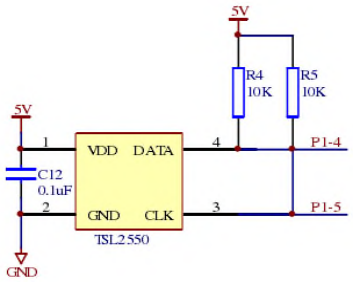

Figure 7. Interface circuit of illumination sensor TSL2550.

3.4. Sensor selection

The selection of sensors in this system should be determined according to the actual farmland.

3.4.1 Selection of soil moisture sensor

Soil moisture is the main factor determining whether crops are irrigated or not. Soil moisture is too high, affecting soil aeration, prone to lodging and other phenomena; soil moisture is too low, so that crop water shortage, drought affect crop growth, serious water shortage may lead to crop wilt or even death. The FDS-100 sensor is used to collect the soil moisture of the system, the FDS-100 sensor outputs analogue signals, the working current is 25mA, the working voltage is 5 ~ 12V, the measuring accuracy range is about 3%, and the probe length is 5.3cm.

3.4.2 Selection of soil temperature sensor

DSl8B20 temperature sensor is used in soil temperature measurement. The sensor has the characteristics of fast transmission speed, small volume and low power consumption. It can directly convert the measured temperature into serial digital signal and transmit it to the host computer, which has unique wire interface mode. The range of temperature measurement is -55 ~ +125°C, and the

precision is 0.5 C at -10 ~ +85°C. It can realize high precision temperature measurement, and is suitable for field temperature measurement in harsh environment.

3.4.3. Selection of light sensor

The lighting of farmland also affects the amount of irrigation for cropland crops. This system adopts the TSL2550 module as a light sensor, and the light intensity is detected by the potentiometer on the module, which converts the light signal collected to the digital signal and sends it to the connected node. The working power of TSL2550 is 2.7 ~ 5.5 V, and the working current is 0.35 mA, small volume and low power consumption. Light sensor TSL2550 1 pin to connect power; The number 2 pin is grounded, the 4 pin is the output of the signal, and the signal is transmitted to the I/O port of the CC2530 module. The specific interface circuit is shown in figure 7.

4. System software design

According to the system monitoring requirements, the system software design is mainly to solve the collection and processing of soil environmental information in farmland, and the shutdown and opening of the field solenoid valve; Control monitoring nodes to transmit real-time data through intermediate nodes to GSM communication module, and sent to the control center through GSM network administrator mobile phone, When the soil information of the collected farmland exceeds the set value, the control center's upper computer and the administrator's mobile phone send control instructions to the terminal equipment to complete the control operation. The software of monitoring center mainly has functions of remote setting soil temperature and humidity, displaying soil temperature and humidity information, inquiring temperature and humidity function, temperature abnormal prompt, alarm record and historical data inquiry, printing, etc. The design of the system software enables the staff to realize the automatic or manual control without needing to go to the farm site. It not only saves human resources, but also improves the reliability of operation. The system software design flow is shown in figure 8.

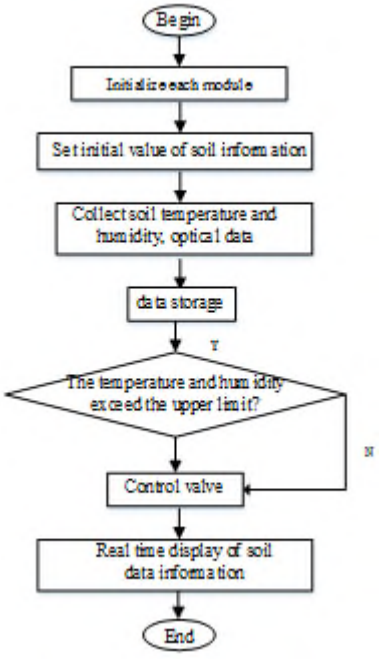

Figure 8. Flow chart of system software design.

5. Conclusion

This system uses GSM technology and ZigBee technology to realize accurate irrigation and remote monitoring of farmland irrigation system, and low power consumption. The monitoring nodes in the farmland regularly collect the status information of temperature and humidity and light intensity in farmland, and transmitted to the intermediate node, intermediate nodes to transmit data through the GSM network to the remote control center or mobile phone users, After data analysis, the control

center sends instructions through GSM network to realize irrigation of farmland. Through testing, the system can realize precise irrigation, save resources, and have certain practicability and applicability.

References

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