The Design of on Line Thermo-humidity Monitoring System Based on ZigBee Technology

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Abstract. The traditional wired soil thermo-humidity monitor is inconvenient to wire the monitoring equipment and unable to automatically monitor in real time. In response to these shortcomings, the soil thermo-humidity real time online monitoring system basing on Zigbee technology is developed. The system takes CC2530 as Zigbee terminal node and coordinator. The terminal node takes soil thermo-humidity sensor SHT10 to collect the soil thermo-humidity in node monitoring area, and wirelessly transmit the data to coordinator. The coordinator will transmit the data after processing to host computer for record. The terminal node is powered by combining solar energy and lithium battery, which achieves continuous and stable working of terminal node. The experimental results show that the system with simple installation and arrangement may monitor soil thermo-humidity in long time and real time, achieve accurate monitoring data, and have certain application value in promoting the benign growth of crops.

Introduction

Soil thermo-humidity is a key factor influencing the growth of crops. The traditional wired soil thermo-humidity monitor has such disadvantages of inconvenient wiring monitoring equipment, high manual monitoring cost, failure in real-time monitoring and lagging control mode. Therefore, it is required to design a kind of thermo-humidity monitoring equipment with low cost and based on wireless network. The design uses ZigBee technology to construct thermo-humidity monitoring system in start network shape based on ZigBee. The convenient and real-time thermo-humidity monitoring through the flexible networking technology has important guidance significances to agricultural production [1].

System Design Scheme

The system consists of terminal node and coordinator. The system structure is as shown in Fig. 1. The terminal node mainly is composed by solenoid valve consisting of cc2530 and thermo-humidity sensor. Collect the soil thermo-humidity and other environment information in real time through each terminal node. The coordinator mainly consists of cc2530 and serial port communication interface. The coordinator is responsible for configurating channel, establishing ZigBee wireless network, managing distribution network address, sending signal, receiving thermo-humidity data transmitted from terminal node, processing thermo-humidity data and sending to control solenoid valve according to the processing results for irrigation control command. The thermo-humidity data after processing will be transmitted to the upper computer through serial port for real-time display and record.

Data Collection Part. The function of data collection part is to collect the data collected by each sensor to ZigBee coordinator and receives the control signal from coordinator to open or close solenoid valve. The system uses CC2530 to establish terminal network code for Zigbee node. This part mainly includes soil thermo-humidity information collection, and electromagnetic water valve opening/cloding.

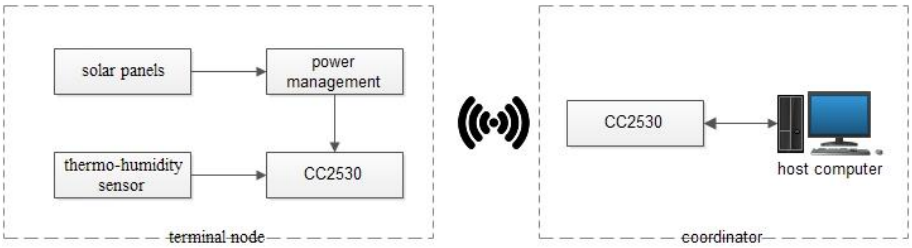


Figure 1. System structure diagram

Collection of Soil Thermo-Humidity. Soil thermo-humidity probe uses thermo-humidity sensor SHT10 [2]. SHT10 is a kind of thermo-humidity composite sensor including calibrated data signal output. The sensor includes one NTC temperature measurer and one capacitive somatosensory humidity element. The power supply scope of sensor is 3.3V ─ 5 V. The sensor is four-pin single row pin package. The pin is respectively VDD, DATA, SCK and GND. The humidity precision is ±4.5%RH. The thermo-humidity output value is 14-bit effective figures. The supply voltage of sensor is 2.4～5.5 V[3]. The working current is not more than 15mA. Collect at regular time and further reduce power consumption. The collection circuit is as shown in Fig. 2.

SHT10 data out uses serial output. SCK is serial clock input and DATA is serial data output. During the data transmission period, when SCK is in high level, DATA line shall keep stable. To prevent data conflict, CC2530 drives DATA to keep low-level. One pull-up resistor shall be connected outside to pull up to high level. 100nF capacitance between VCC and GND is used to decouple filter.

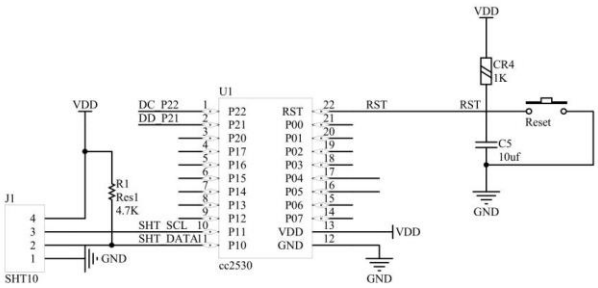


Figure 2. Temperature and humidity sensor module circuit diagram

ZigBee Data Collection Child Node. ZigBee data collection child node uses CC2530F256 chip manufactured in TI company as the core element. CC2530F256 has excellent RF receiver and transmitter performance [4]. The core uses enhanced 8051CPU carrying 8KB RAM and A/D conversion, which may establish the strong network node and achieve low power consumption with minimum cost.

Design of ZigBee Coordinator and ZigBee Child Node Software. ZigBee stake is established on the basis of IEEE 802.15.4 standard, which defines MAC and PHY layer of the protocol. ZigBee equipment should include PHY and MAC layer of IEEE802.15.4 (the standard defines RF and communication between equipment), and ZigBee stack layer: network layer (NWK), application layer and safety service provision layer [5].

The wireless control sub-system in the design uses wireless sensor network protocol based on ZigBee. The star-type network topology structure is used. In the system, the main tasks of coordinator are establishing network, accessing node, receiving node data, sending command to controller; the main tasks of wireless sensor are collecting environment information (Thermo-humidity, illuminance, etc.) and transmitting the data to coordinator. It is used to display the environment parameters and make control decision. The controller node may receive the command transmitted from central controller, control switch electromagnetic valve and complete irrigation tasks.

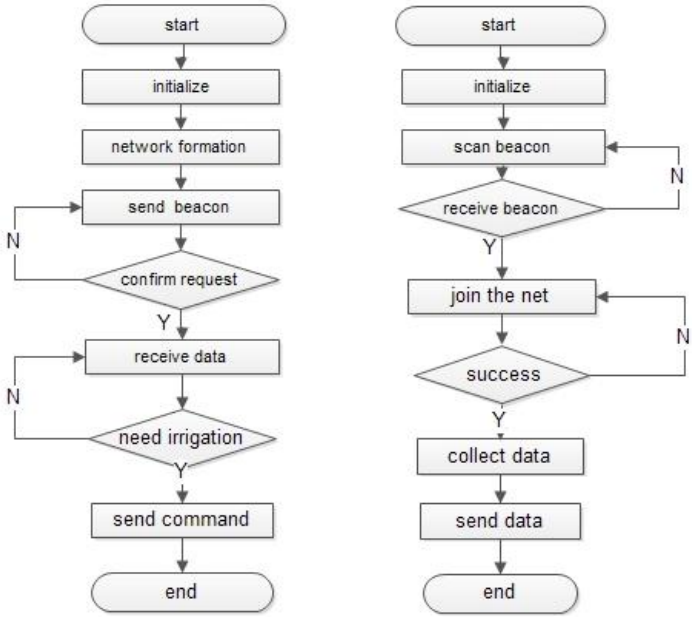
The work of the coordinator is mainly divided into three parts, as shown in Fig. 3A:

(1)Define itself to the coordinator node of ZigBee network and establish network, send signal and wait for node [6];

(2)Enter into the main cycle after networking with the child node, receive the data sent by wireless sensor node and make a decision of irrigation according to the data, transmit control command to controller node;

(3) When the software or hardwire interrupts, jump to the interruption service program. After implementing the service, it will return to the main program for continuous cycle.

Wireless sensor node belongs to the “terminal node” in star topography structure. The main task is adding into the network established by the coordinator, and then transmitting the environmental parameters collected by the sensor to the coordinator. After sending the collection data, it will enter into dormancy until receiving the irrigation command sent by the coordinator, and jump into irrigation interrupt service. The process is as shown in Fig. 3B.



A. The coordinator B. The terminal node

Figure 3. Wireless transmission flow char

The equipment will automatically form or add into network after powering on. If you want to process other events when powering on the equipment rather than adding into network, you may achieve through defining HOLD_AUTO_START [7]. Add into network after manual definition after deploying ZD App_ Start Up From App ( ) [8].

If the equipment connects the network successfully, the network information will be stored in NVM (NV flash). The information will still be stored after powering off. After powering on again, the equipment will automatically read network information [9]. The equipment may remember the network. The action of NV flash is implemented through NV_RESTORE () and NV_ITNT () function.

Power Module. Power module is supplied by micro-type solar energy battery, which mainly consists of solar PV plate, accumulator and output adjustment circuit. When the line is enough, PV plate will convert optical energy to electric energy and store the energy in the accumulator to supply power. When the light is weak, the accumulator storing energy may supply power. The output adjustment circuit is used to convert suitable voltage input to node. After voltage conversion, input 3.3V voltage to provide stable working pressure for wireless sensor node, guarantee the data

collection and transmission of wireless sensor node, and facilitate understanding the environment conditions and make the correct decisions. Micro-type solar energy battery is used to supply power, which is clean and environmental and may achieve the effective utilization of solar energy resources.

Actual Test and Analysis

The system selects lawn for system test (collection time: May 25, 2016; collection site: XX institute artificial lake lawn). The physical drawing of ZigBee child node is as shown in Fig. 4.

Data collection test uses is conducted on the spot for long time. Select the equivalent lawn with or without facilities to collect the data from 6:00am to 10: pm, in order to compare the analysis data and obtain reliable result analysis. Because the data collection time is in summer, it is hard to achieve temperature regulation after noon. The soil humidity is the humidity at 10cm. according to the data transmitted from the humidity sensor, judge whether the plant may be irrigated. The measured data are as shown in Fig. 5.

Figure 4. Physical map of child node

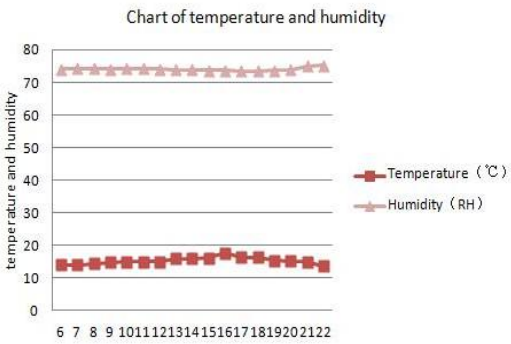


Figure 5. Test results line chart

The precision of system temperature collection is ±0.1℃ and the temperature collection precision is ±0.1%. The actual transmission accuracy rate of data is 99.8%. as shown in Fig. 5, the temperature scope is 13.6℃—17.6℃ and the humidity scope is 73.5—75.2RH. The data analysis results and judgment are accurate and effective. The system may achieve automatic irrigation in short reaction time, and improve the real-time temperature conditions of vegetation and guarantee the plants in a external environment suitable for growth. When the environment temperature is higher, it may effectively control the humidity and guarantee the relative humidity environment of plant (60%-80%), and make the plant grow better. It has positive improvement effect on the growth conditions of the plant. It is more convenient and accurate relative to the existing equipment node.

Conclusions

The design uses CC2530 to conduct wireless soil temperature and humidity monitoring system based on ZigBee. The system may record the real-time temperature and humidity through upper computer software. When the soil humidity is lower than the setting threshold value, the system may automatically implement irrigation, improve the soil humidity and promote good growth of crops. The design core may achieve flexible network construction between nodes through TI-Zstack, solve automatic networking between ach node and coordinator, and transmit the data in bottom sensor. The terminal node supplies power combining micro solar energy battery plate and lithium battery, which may collect humidity and temperature data stably. Through the actual test, the whole system operates reliably and the collection of soil temperature and humidity is correct. It provides decision basis for agricultural production and irrigation and has practical value on fine agricultural production.

Acknowledgements

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