Design of Ranch Fire Monitoring System Based on ZigBee Technology

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Abstract This paper designs a way to introduce ZigBee technology into the ranch fire monitoring system, and builds a real-time ranch fire monitoring system based on ZigBee wireless sensor network. The system can monitor the parameters related to ranch in real time, such as air moisture, temperature and smoke density, so as to provide information support for ranch fire prevention and extinguishment. This paper researches the circuit design of ZigBee wireless sensor network node, node information collection, data fusion, transmission and effective topological structure of sensor network.

Key words ZigBee, Fire monitoring, Ranch

1 Introduction

The annual springs and falls are the fire-prone dry weather periods for ranch, and the frequent fires have caused huge casualties and economic losses to herders. The traditional fire prediction is mainly based on the monitoring according to the satellite remote sensing, but it does not reflect the fire danger rating of the monitored regions in real time. This design uses the sensor technology to carry out the automated real-time collection of critical information related to ranch fire, and thus perform the timely treatment, to bring the ranch fire accident rate to a minimum. Given the current domestic technology level, this design realizes the real-time monitoring of ranch fire based on ZigBee. It has the advantages of low power consumption, and low cost. ZigBee is a wireless network communication technology[1], without the need for cable laying, so laying fixed nodes in a designated place can achieve the collection and processing of data, significantly saving the construction costs.

2 System framework

The system monitoring substations collect various sensor data and transmit the data to the monitoring center through ZigBee wireless network, which can be used as router or RFID in ZigBee network. The hardware part of network node of Zigbee wireless data transmission system mainly consists of microprocessor module, wireless communication module, and data acquisition module, as shown in Fig. 1.

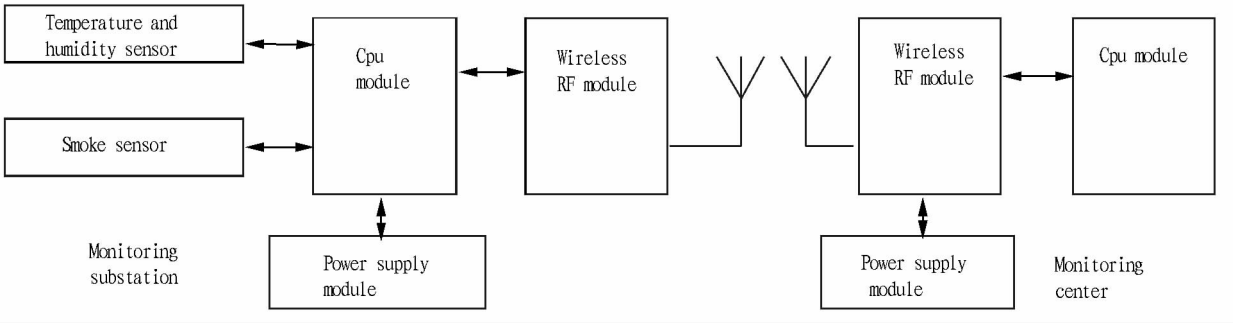

Fig. 1 Hardware structure

2.1 CC2430 RF module design CC2430[2] integrates the microcontroller, ZigBee RF front-end and memory on the single chip. It uses 8-bit MCU (8051), 8KB RAM and 128KB programmable flash memory, and it also includes analog to digital converter (ADC), timer, AES128 co-processor, and 21 programmable I/O pins. CC2430 is produced using 0.18μm CMOS production process; in the transmission and reception mode, the current consumption is less than 27 mA and 25 mA, respectively. The features of CC2430's sleep mode and short time of switching to active mode are especially suitable for those applications requiring long battery life.

2.2 Sensor module The DHT11 digital temperature and humidity sensor is used to measure temperature and humidity. This sensor can measure the temperature and humidity at the same time, and output the digitized signal to the processor module, with simple interface, small size and low power consumption. MQ-2 smoke sensor module is used to measure the smoke. This sensor has the features of low cost, long life and high sensitivity.

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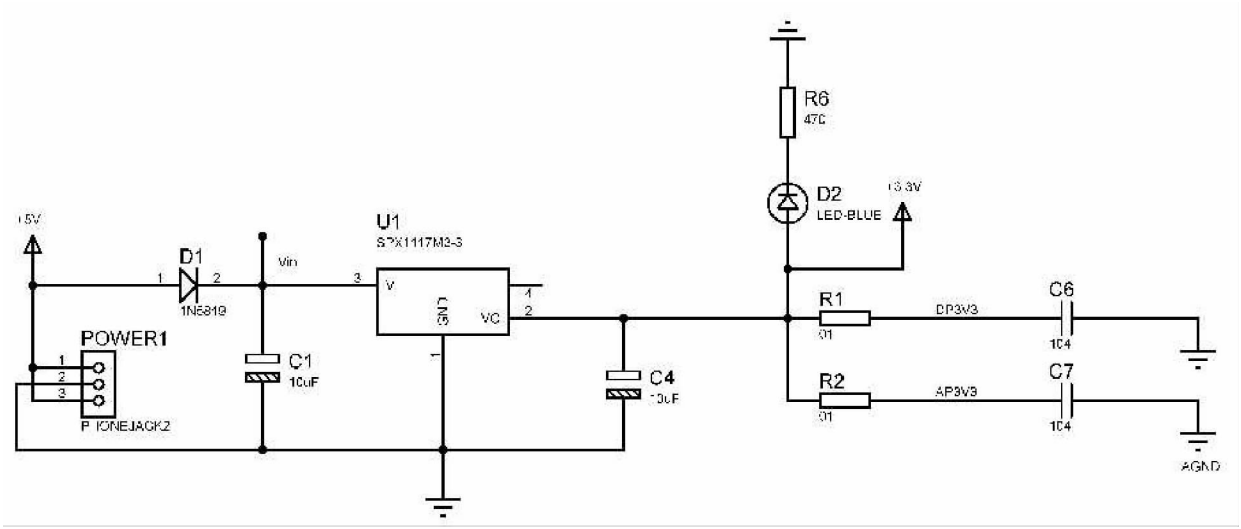

Fig. 2 The power supply circuit

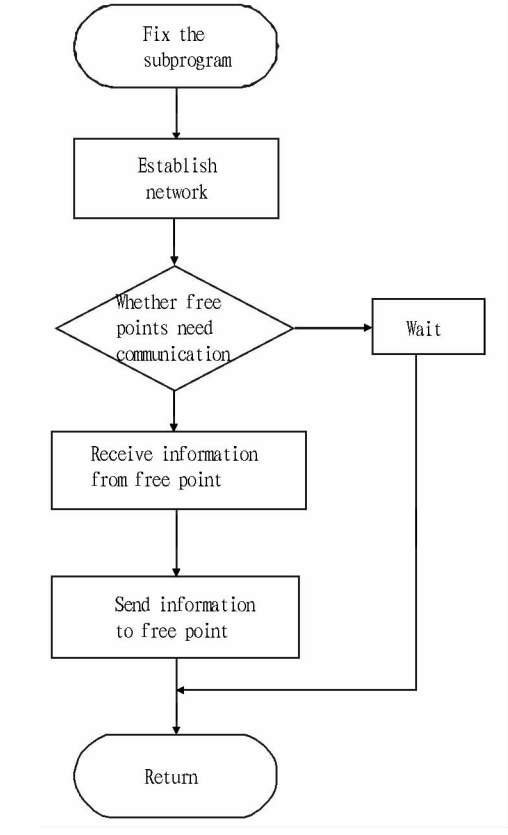

Fig. 3 Program flow chart of wireless gateway

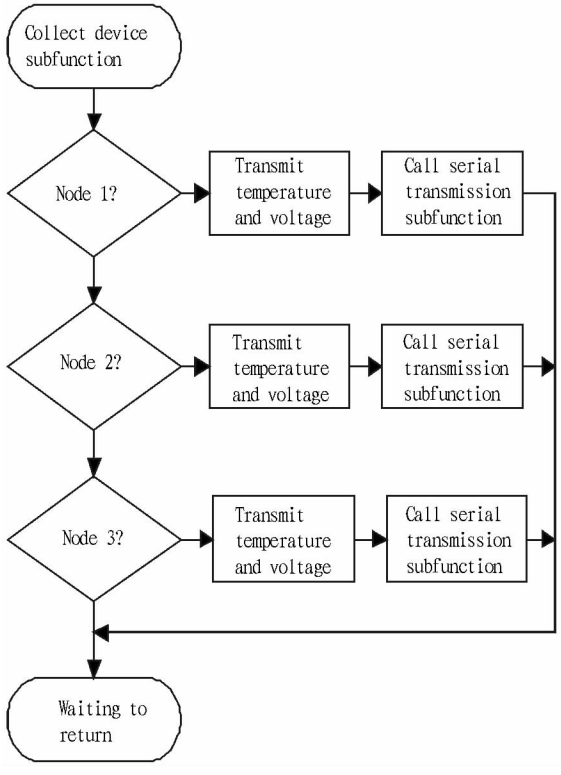

Fig. 4 Program flow chart of data collection

2.3 Power circuit design The power supply circuit designs two modes in order to meet the power demand of a variety of ZigBee nodes, and the main power supply modes include battery-powered mode and direct current (DC) power supply mode. The switching between the two power supply modes can be realized using the SPDT switch. The direct current (DC) power modules use 5V power supply, and use the voltage converter chip AMSl 117 – 3.3 to get 3.3V voltage. This chip can better achieve voltage conversion, and provide 500mA of current output. The circuit is simple, and only two 10uF tantalum capacitors can maintain constant voltage output of 3.3V. The battery power supply depends on two ordinary AA batteries. The power supply circuit is shown in Fig. 2.

2.4 Serial converter circuit The serial converter circuit uses CP2103 chip, and the working voltage range is 3V – 5.5V. This circuit is mainly used for the serial voltage conversion between the coordinator and the PC.

3 Software design

3.1 Wireless gateway The data exchange between the network based on TCP protocol and the protocol stack based on ZigBee is completed mainly via ZigBee wireless gateway[3]. The Zigbee wireless gateway can send the data in common Ethernet to Zigbee network, and it can also send the data in Zigbee network to the Ethernet based on TCP protocol, in order to achieve network interconnection. After the ZigBee wireless gateway is opened, other RFD nodes will automatically contact it, and quickly enter the wireless network. Thus, all nodes are dominated by ZigBee wireless network. The program flow chart is shown in Fig. 3.

3.2 Data collection The reference nodes and wireless gateway in the ZigBee network act as the coordinator or router device. The sensor device records the temperature and battery energy readings and sends them to the wireless gateway. After the wireless gateway is started or joins a network, it must be placed under the mode of allowing binding in response to the binding request sent from the sensor device. The program flow chart is shown in Fig. 4.

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