A SELF-ADAPTIVE GREENHOUSE CO2 CONCENTRATION MONITORING SYSTEM BASED ON ZIGBEE

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Abstract: CO2 is one of the main raw materials, which is used for plant photosynthesis and synthetic organics. Because the content of CO2 affects crop yield and quality directly, this paper designs the monitoring and controlling system of greenhouse CO2's concentration based on ZigBee wireless network. This system, taking the microprocessor CC2530 as core, is mainly made up of data acquisition module, control module, executive module, power supply module and user interactive module. The real-time monitoring on the greenhouse concentration of CO2 is completed by each module's coordination work. This system uses ZigBee wireless network system to achieve data collection.

Keywords: Greenhouse canopy; ZigBee; CC2530; CO2 concentration; Real-time monitoring

1 Introduction

Nowadays the research of wireless sensor network which is used in the field of agriculture has already attracted the researchers' attention at home and abroad due to the shortcomings of the agricultural monitoring equipment [1]. The internal design of the greenhouse has reached a relatively perfect degree and formed some standards.

At present, the cultivation of greenhouse crop has gradually developed into a commercial production system [2], given that the growth of corps needs an appropriate environment. The development of intelligent monitoring environmental technology [3] is very important. Depending on the wide application of ZigBee technology [4] in agricultural areas and the influence of air temperature and humidity on the greenhouse, this paper proposed a system, based on the ZigBee wireless network, to monitor the concentration of CO2 in the greenhouse.

2 Overall structure design of the system

2.1 System technology index and requirements

1) Detection range: CO2 concentration's measurement range: 0ppm-10000ppm.

2) Showing way: Real-time display greenhouse CO2 density.

3) Warning processing: judging whether the collecting parameters overrun, if overrun, giving sound and light alarm.

4) Automatic control: according to setting threshold, driving the corresponding executive action, such as opening CO2 generator, driving warning processing.

5) Timing control: set opening time depending on threshold which has been set.

2.2 System solutions and function

The system put to use the modular design including the main data acquisition module, control module, executive module, power supply module and user interactive module. The whole system structure is shown in Figure 1. The data acquisition module achieves greenhouse CO2 concentration real-timely through the ZigBee wireless network system [5] and conveys detected data to the control module. The control module receives data and controls the module of control through different I/O entrances. The executive module which includes CO2 generator and alarm system realizes supply the concentration of CO2 and warms when the concentration of CO2 is higher than threshold [6]. The power modules provide power for the entire system. The user interactive module is used to complete setting up different threshold for the different crops in their different growth stage, which is better to adapt the needs of the CO2 concentration of crop [7].

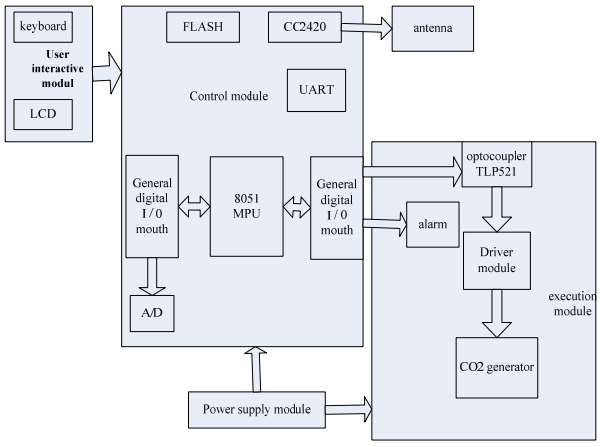

Figure 1 The system structure

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3 System hardware design

3.1 Data acquisition module

Data acquisition module includes three panel points: sensor node, route node, coordinator node. After collecting data, the sensor node disposes and conveys data by ZigBee wireless to the coordinator node.The coordinator node will receive and summary all of data which is transferred from the sensor node.In this system, the sensor which is used in data acquisition module is CO2 sensor B530. The specific sensor module's circuit and system function diagram are shown in Figure 2 and Figure 3 respectively.

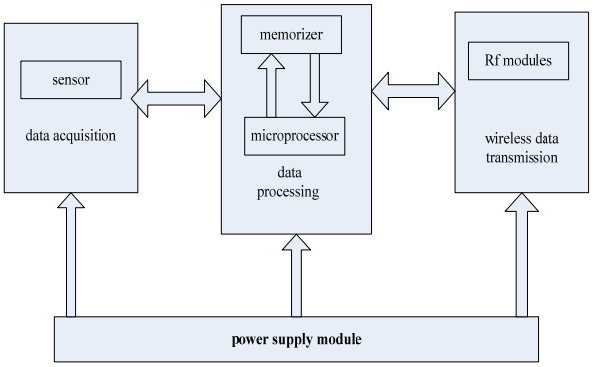

Figure 2 System function diagram

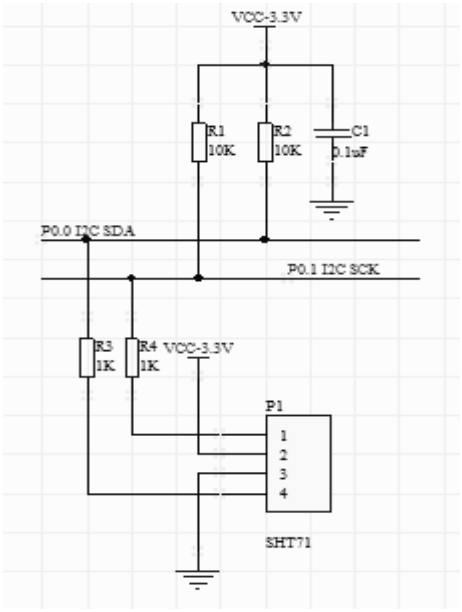

Figure 3 Sensor module's circuit

3.2 Control module

Control module is consisting of the core processor CC2430 and peripheral circuit. The circuit is shown in Figure 4. CC2430 has 128KB programmable flash memory and 8KB RAM integrates the enhance performance of 8051 MCU memory and micro controller. It can realize to deal with data in the system.

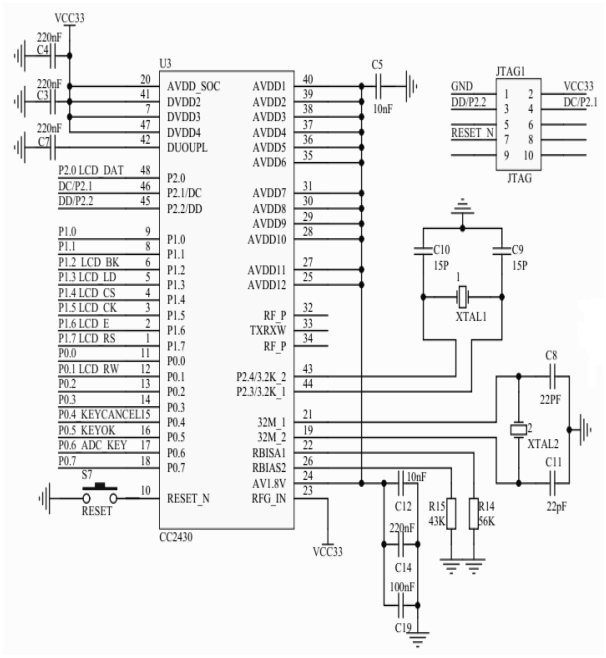

Figure 4 Expansion circuit of control module

3.3 Execution module

The execution module includes controllable equipment of CO2 generator and alarm which is used to regulate and warn about CO2 concentration of greenhouse.Its driving circuit is shown in Figure 5.

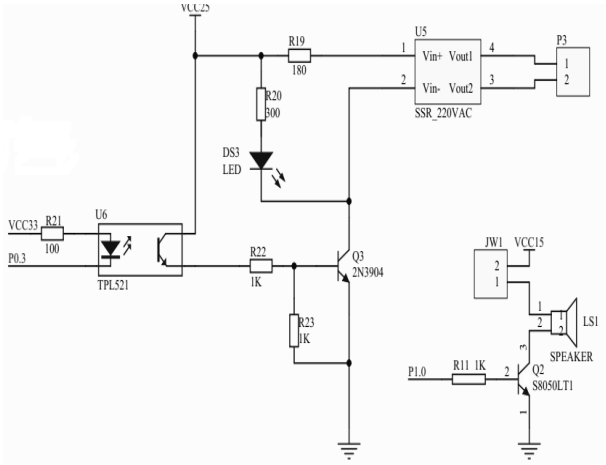

Figure 5 Driving circuit of execution module

3.4 Power supply module

The power modules provide energy for the entire system. The CO2 sensor module B530 works from 9 V to 18 V. Since single-chip microcomputer CC2430 of control module works in voltage of 3.3 V and executive module need 5 V voltage driver, this module must provide 12 V, 5 V and 3.3 V three working voltage. 5 V-5 V power supply module of isolation type is shown in Figure 6.

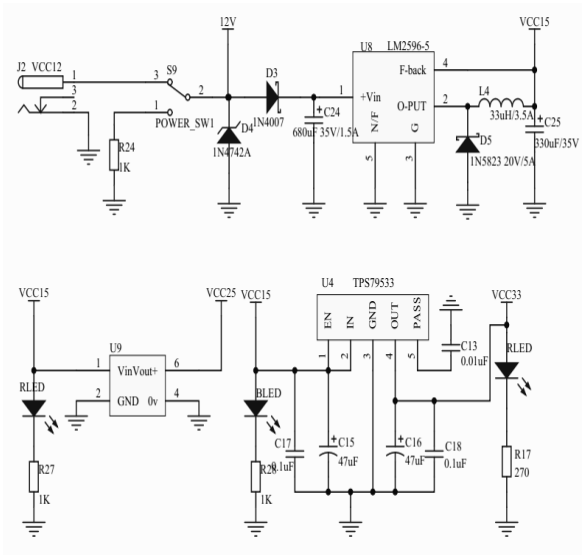

Figure 6 Power supply module's circuit

3.5 User interactive module

User interactive module includes keyboard input submodule and LCD display submodule. Schematic diagram is shown in Figure 7.The LCD displaying submodule uses OCM12864-3 to display relevant information with CO2 concentration.The keyboard input submodule is made up of some functional buttons like enter, cancel, up, down, left and down.After detecting analog voltage from P0.6 and A/D transforming through inside of MCU, these keys like up, down, left, right could be identified by software. In addition, other keys would be identified through independent keys which are respectively connected to P0.5, P0.4 and the user could set the bound of CO2 concentration and some other operation like working model selecting.

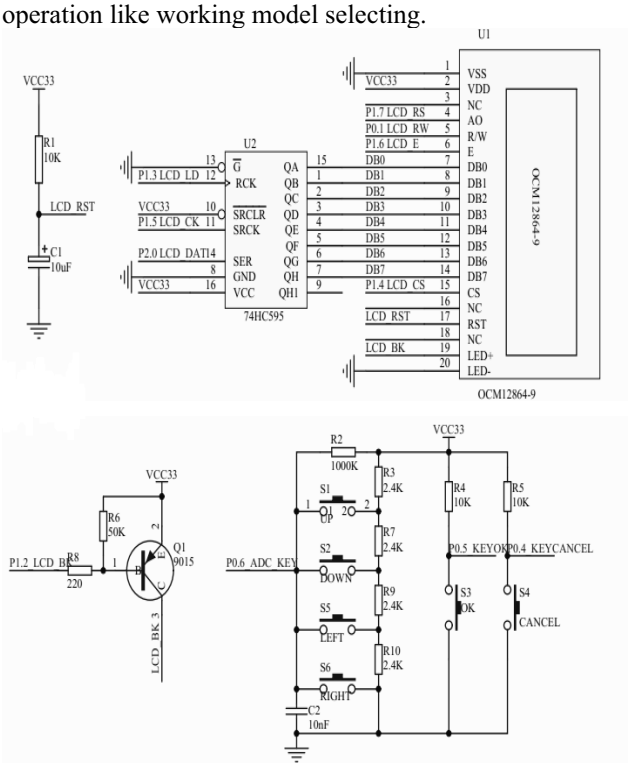

Figure 7 Schematic diagram of user interactive module

4 Software design

The compiling of system software uses C Language, which is designed modularly. It concludes six parts such as main program, communication subprogram process, collection subprogram, data processing subprogram, display subprogram as well as button subprogram. The main program and timing interrupt flow chart are shown in Figure 8.

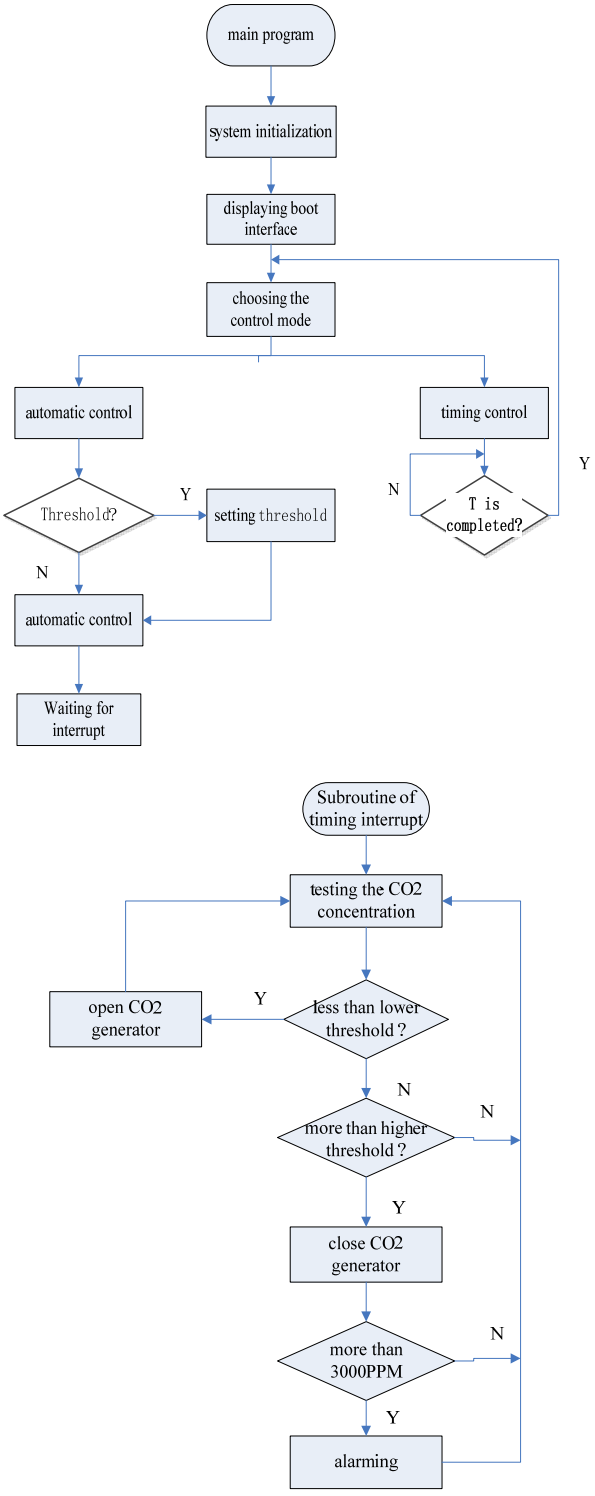

Figure 8 Main program and timing interrupt flow chart

4 System experiments

This equipment had been tested and run stably, and the data of which is reliable.

System operation interface is shown in Figure 9.

Parameter setting interface is shown in Figure 10.

Time setting interface is shown in Figure 11.

Display interface is shown in Figure 12.

Figure 9 System operation interface

Figure10 Parameter setting interface

Figure11 Time setting interface

Figure 12 Display interface

5 Conclusions

This paper introduces the design of Greenhouse CO2's concentration monitoring system based on ZigBee. The system can complete real-time monitor CO2 concentrations of greenhouses. Experiment results show that the system can work with a stable performance and low cost.

Acknowledgements

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