# Intelligent Agriculture Greenhouse Environment Monitoring System Based on IOT Technology

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*Abstract*—In recent years, greenhouse technology in agriculture is to automation, information technology direction with the IOT (Internet of Things) technology rapid development and wide application. This paper takes CC2530 chip as the core, presents the design and implementation of agriculture Greenhouse Environment monitoring system based on ZigBee technology, the wireless sensor and control nodes takes CC2530F256 as core to control the environment data. This system is made up of front-end data acquisition, data processing, data transmission and data reception. The ambient temperature is real-time processed by the temperature sensor of data terminal node. Processed data is send to the intermediate node through a wireless network. Intermediate node aggregates all data, and then sends the data to the PC through a serial port, at the same time, staff may view, analysis and storage the data by the PC that provide real-time data for agricultural greenhouse, fans and other temperature control equipment, and achieve automatic temperature control.

Keywords-Agriculture Greenhouse, Internet of things, CC2530, ZigBee

## Introduction

With the development of society, traditional forms of agriculture can't satisfy people's needs, so agriculture must be change to satisfy people's needs. The development of Internet technology has brought light to the development of agricultural modernization, agricultural Internet of things has become the inevitable trend of agricultural informatization. Through the remote monitoring and control of greenhouse, the greenhouse monitoring system realized the precise measurement and real time control of the greenhouse. Also the greenhouse monitoring system can implement the scientific management methods, improve crop disaster prevention ability and increase production [1].

This paper introduces a kind of agriculture greenhouse monitor system which is low cost, low power consumption and constructed based on the short distance wireless communication technology ZigBee. The main objective of the system is to control the climatic condition as per the crop data sheet. The sensors are designed for collecting information about the climate of the green house like Temp, Pressure, Light, Humidity and CO2. With the help of this, system will decide the action about the controls like, fan control, curtain control (protect the direct sunlight and sun heat) and sprinkler (to maintain the humidity and temp).

## I. Structure and Function of Agriculture Greenhouse Monitoring System

The greenhouse monitoring system is designed to satisfy the need of the remote monitoring and control of greenhouse, the aim of the system is to realize Greenhouse Environment system, the system can improve the efficiency of environment room management and reduce the human resources investment and save energy. It is a typical IOT system based on B/S structure; it includes perception layer, network layer and application layer. In this system, CC2530 is used as the processing chip of the wireless sensor nodes and the coordinator, ZigBee technology is adopted in wireless communication, the gateway uses the Coretex-A8 processor and Linux operating system as the core [2].

The structure of this system is shown in Figure 1. In this system, the network topology model of ZigBee is satellite. The ZigBee coordinator is the organizer of Zigbee network; it receives the wireless sensor nodes information and sends the information to the room gateway through the serial port. The server transplanted in the gateway receives the user's request and disposes the information by the CGI program, and feeds back the processing information to control and display terminal.

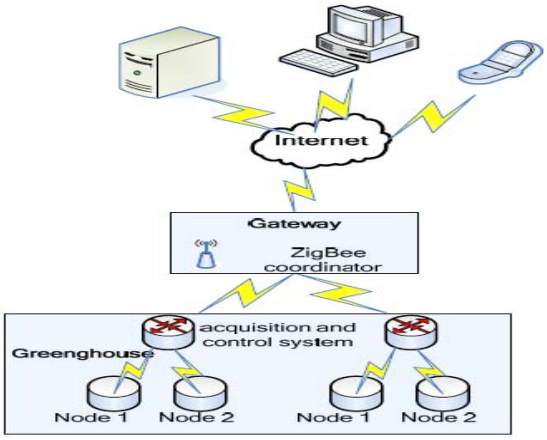


Figure1. Structure of the System

## II. Hardware Design

The hardware design of the system includes room gateway design and ZigBee wireless sensor node design. The IOT gateway is a join point of public network and wireless sensor network in greenhouse monitoring and control system. And the function of the gateway is realized data gathering, upload and processing remote user control information. The gateway is based on modularization method and the using of the method improved the

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compatibility and better meets the needs of complex agricultural environment. All wireless nodes data and camera data must be transmitted to the room gateway. The gateway receives the data, transforms the data, and sends the data to the display and control terminal by Internet or sends to smart phone by GPRS. At the same time, the display and control terminal sends the controlling command to the wireless nodes by Internet or GPRS [3].

The system adopts CC2530 produced by TI corporation as the main chip in the ZigBee communication module. A 2.4GHz DSSS RF transceiver based on IEEE802.15.4 and an industrial level low power, enhanced 8051 microprocessor core is integrated into a CC2530 single chip mainly[4]. CC2530 chip is power-saving, low-cost. Using CC2530 as ZigBee wireless communication module has a certain economic benefits in the smart room system.

CC2530 provides a complete ZigBee solution with combination of the Z-Stack. Wireless sensing and control nodes of the system uses the CC2530F256 as the core, includes wireless transceiver circuit, power module, debugging module, crystal oscillator circuit, reset circuit, information collection or control module. The information collection module sensor uses the STM8S103F3 chip as the micro processor. The sensing information converted by the AD is sent to CC2530 through the serial port. Hardware Structure of Gateway and Sensor Nodes is shown in figure 2.

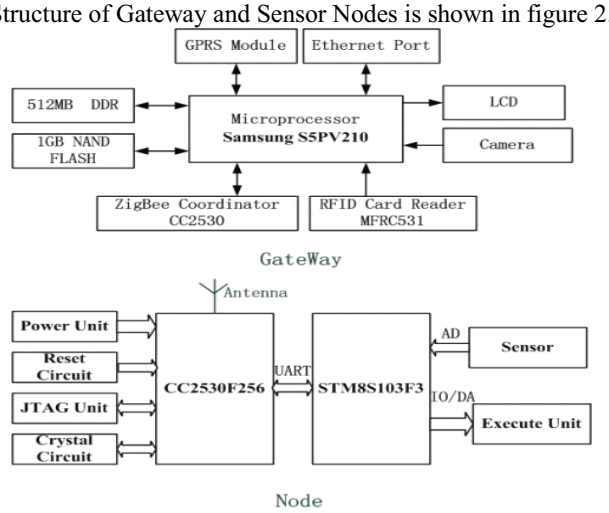


Figure 2.Hardware Structure of Gateway and Sensor Nodes

## III. Sensor Nodes Design

### A. *Numbers of Sensor Nodes and Input parameters*

The total number of sensor nodes and actuators are depends on the size of greenhouse. About 200 nodes are sufficient if the size of green house is 35m × 200m. This is the physical size of the targeted area. It is under the range of sensing capacity of the hardware. The sensor nodes can be classified as 'A', 'B' Where type 'A' is climate sensor for outside, and type 'B' is climate sensor for the inside of the greenhouse. Type 'B' sensors can be placed at a distance of 10 to 15 meters of diameter, to capture precise environmental condition. The different controlling parameter ranges in various modes for some typical crop is as shown in Table 1. This information collected from the data sheet about the crop.

| Crop | Temp °C | $CO_2$ PPM | Light K Lux |
|---|---|---|---|
| Carnation | 16-22 | 1000 | 45-50 |
| Gerberas | 27-30 | 1000 | 35-40 |
| Anthurium | 24-26 | 1000 | 18-35 |
| Tomato | 16-35 | 1500 | 45-50 |
| Roses | 15-30 | 1000 | 30-40 |

Table1. Input parameter for the system

### B. Sensor Parameters and its use in System

The main objective of WSN system for Agriculture Greenhouse is to control the climatic condition as per the crop data sheet. The sensor is designed for collecting information about the climate of the green house like Temp, Pressure, Light, Humidity, CO2,Wind speed and wind direction. All these parameters gives the outside world information about the climate. With the help of this, system will decide the action about the controls like, in out air flow control, screen control (protect the direct sunlight and sun heat) and sprinkler (to ma (to maintain the humidity and temp). A typical greenhouse with sensor nodes is as shown in figure 3.

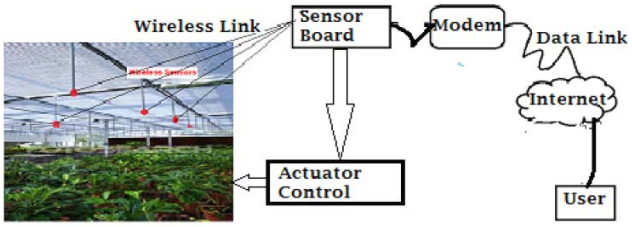


Figure 3.Typical Greenhouse and Remote Control

## IV. Software Design

### A. Gateway Software

The development process of the gateway is: firstly loading boot program; secondly transplanting the embedded operating system; thirdly transplanting the root file system; fourthly transplanting the embedded Web server; and running program; finally running the local GUI control application. Hardware design of the IOT gateway is shown in figure 4.

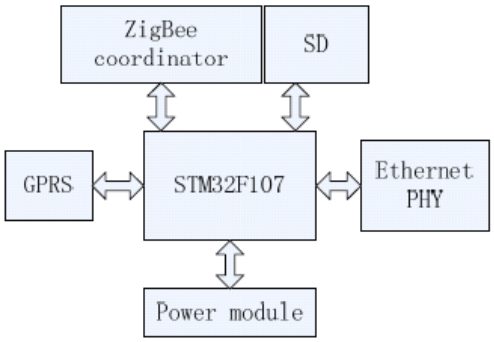


Figure 4. Hardware Design of the IOT Gateway.

As is shown on the Figure. 4 the hardware design of the IOT gateway is made up of Ethernet PHY, ZigBee module, GPRS module (replaceable). And the MCU using STM32F107, which based on Cortex-M3 [4], DP83848 is using as the Ethernet PHY and connected the Ethernet MAC of the MCU through MII.

### *B.* Coordinator Software Design

The ZigBee coordinator is connected to the room gateway through the serial port. It's tasks are: initialing CC2530F256 and protocol stack; building the ZigBee network with the temperature nodes and light intensity nodes; monitoring the ZigBee wireless signal and so on. If some routers or terminal nodes join the network, the coordinator distributes network address to them; receives data from terminal nodes, and transmits data to the room gateway through the serial port; receives the control information from the gateway, analyses and recombines the control data, sends it to ZigBee terminal control nodes, such as controlling the room lamps and curtains [6]. The coordinator software flow chart is shown in figure 5.

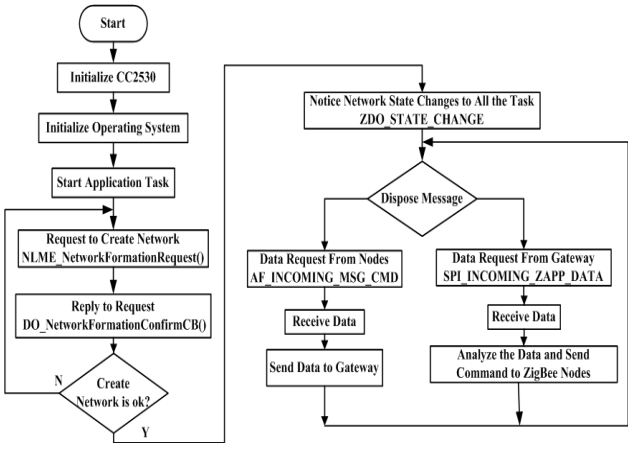


Figure 5. Coordinator Software Flow Chart

### *C.* End Device Software Design

The ZigBee end devices main work is applying to join ZigBee network and communicating with ZigBee coordinator. Temperature and humidity, light intensity end devices are responsible for sending information to the coordinator. Lamps and curtains, projection switch controlling end devices are responsible for receiving the control command from the coordinator and feeding back switch state to the coordinator. The end devices software flow chart is shown in figure 6.

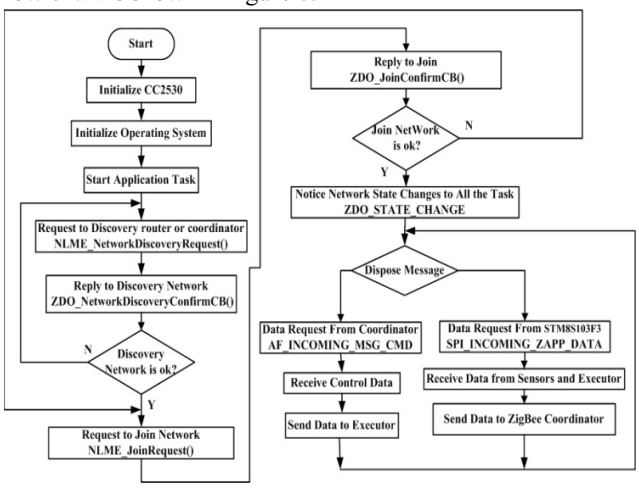


Figure 6.End Device Software Flow Chart

## V. Application Results

The software of the upper computer is designed by LabVIEW. LabVIEW is a virtual instrument platform developed by NI Company, which adopts powerful graphic language instead of procedure code.The program behavior of LabVIEW is described by graphic symbols, and eliminates the complicated grammar rules, so the development circle is short just need Interactive graphics front panel to show the control and result of the system [4]. And for LabVIEW it is easy to solve the problem of data collection, data analyze, file processing, waveform processing and arithmetic operations [5].The upper computer works as is shown on Figure 7.

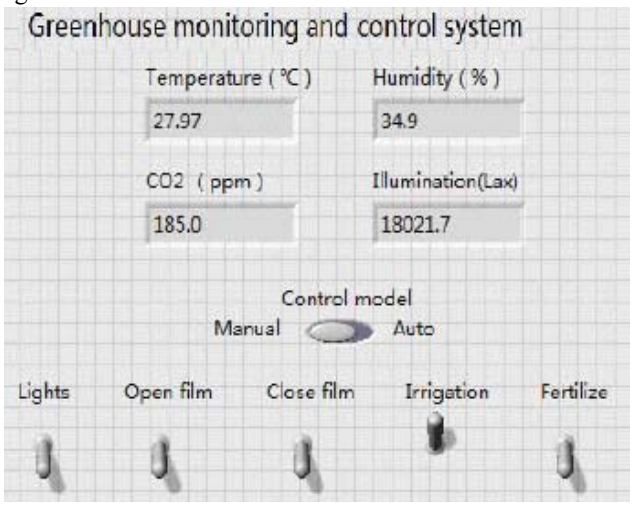


Figure7.The interface of upper computer

## VI. CONCLUSION

In this paper, the low cost, low power wireless ZigBee technology applies in greenhouse monitoring system. The system realizes the remote intelligent control to the room equipment through Internet. It improves the operational efficiency and system application flexibility by using the wireless sensor network instead of the traditional wired network, and at the same time reduces the manpower cost. The practical application approved that the gateway run fine in the greenhouse monitoring system, the environment data of the greenhouse can transfer reliably, and the control instruction sent timely. This design realizes remote intelligent monitoring and control of greenhouse, and is helpful to farms to scientific and rational planting crops. So this design has certain of value to popularize.

## VII. ACKNOWLEDGEMENT

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