Intelligent Agricultural Monitoring System Based on Big Data

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Abstract. As a major agricultural country in the world, agricultural modernization has always been one of the most important problems to solve. With the development of science and technology, China’s agriculture has evolved from traditional agriculture to smart agriculture [1]. In order to improve the level of agricultural modernization, an intelligent agricultural detection system is designed, which combines embedded real-time processor with various sensors to realize the collection of underlying agricultural information, data transmission through local area network and monitoring of real-time environmental data information to monitor crops growth. The results of the system show that the system can greatly improve the agricultural production efficiency [2].

Keywords: Embedded, Microprocessor, Sensor, Local area network

Introduction
Combining sensors, embedded real-time processors, local area networks and agriculture to compare and analyze historical data and real-time monitoring data of agricultural production by collecting data from the growing environment in which crops are growing, and then transferring the collected data through a local server or data processing center [3]. Combining electronic components with traditional agriculture to form a smart agricultural monitoring system, which detects the growing environment and growth status of crops, analyzes the growing environment in which the crops are located through mathematical models, and regulates the growth environment through closed-loop systems, so that agricultural production can be safer, higher and more efficient and make the field of agriculture intelligent.

1. Overall Structure of Intelligent Agriculture Monitoring System

1.1 Overall Requirements of the System
The overall demand for intelligent agricultural monitoring systems is mainly reflected in two aspects: data collection, data transmission and monitoring. Data collection mainly collects data such as temperature, light, moisture, air quality, and humidity; data transmission and monitoring mainly transmit data to the terminal processor through the local area network and the purpose is to allow
monitors to more intuitively understand various parameters such as crop growth environment.

1.2 Overall Design of the System
According to the analysis of the overall needs of the system, the intelligent agricultural monitoring system is mainly composed of modules such as a wireless data acquisition module, a wireless data transmission module and an LCD display processing module.

2. Hardware Design of Intelligent Agriculture Monitoring System
The hardware of the intelligent agricultural monitoring system is mainly composed of three parts: data acquisition module, data transmission module and network coordination module. The overall design of the system hardware is shown in Figure 1.

![Figure 1. Overall design of the system hardware](image)

1) Overall design of the system data acquisition module. The overall design of the system data acquisition module. The system uses the CC2530 as the control center for the data acquisition module for reasons such as stability, durability and practicality, and consists of power supply, sensor, control circuit, ZigBee wireless data transmission terminal.

2) Overall design of the sensor module. Integrated sensor application environment and cost-effective factors, the selection of DS18B20 sensor for temperature detection module, HDC1080 sensor for air humidity detection module, MG811 sensor for carbon dioxide detection module, RMD LC sensor for soil PH value detection module, BH1750 the type sensor is the light intensity detection module and the RS485 sensor is the soil moisture detection module.

3) Overall design of the wireless transmission system. Considering the comprehensive application environment of the wireless transmission module of the monitoring system and the comprehensive cost-effectiveness of the module, the ZigBee wireless transceiver module produced by Shenzhen Zhida Company was selected. The module has multi-node, no network, low power consumption, wireless chip packaging and pins and other advantages.

4) Workflow of the intelligent agricultural monitoring system. The system is centered with CC2530 as a control center, sensors monitor ingress crops in real time and collect data on the environment in which the crops are located, and the digital module of the ZigBee terminal converts digital information into analog electrical signals, which are then used by ZigBee. The data processing module of the terminal stores the data, and the RF module of the ZigBee terminal passes through an internal amplifier circuit to transmit the analog signal through the antenna. At this time, the coordinator in the star self-group network consisting of the ZigBee network coordinator, ZigBee interrupter, ZigBee terminal device receives the request from the terminal node and responds to the request to the network and the endpoint receives the coordinator's response and sends the data request. At the same time, the coordinator is requested to assign the network address to the coordinator to send 64-bit...
IEEE0-00124B75E3E80 as the identification identity, and then the coordinator to the endpoint to answer and assign 16-bit 0-5B6C network address, so that the endpoint uses this network address for network communication. This enables the function of data transmission. Then through the computer terminal or mobile phone terminal display received analog signal, so the crop growth data to the farmers. The system compares the environment in which the crops are located with the mathematical model, and if there is a risk in the growing environment of the crops, it can be warned to farmers in time, so as to achieve the goal of real-time monitoring of crops.

3. Software Design of Intelligent Agriculture Monitoring System
The software part of the system is mainly composed of sensor data acquisition and wireless data transmission. The software part mainly uses the embedded real-time processor, which is programmed in C language and translated in the IAR Embedded Workbench IDE environment.

1) Software design of the sensor module. The data module acquisition parameters are collected through the sensor terminal, with the single-chip microcomputer as the core, and the data transmission is performed through the wireless transmission module.

2) Software design of wireless transmission module. The wireless data transmission system is mainly composed of a short-distance, low-power ZigBee network structure.

3) Program preparation. Here are some of the procedures for monitoring ambient temperature and humidity:

```c
#include <ioCC2530.h>

typedef unsigned char uchar;
typedef unsigned int uint;

#define DATA_PIN P0_7

// Definition of temperature and humidity
ucharucharFLAG, uhartemp;
uchar shidu_shi, shidu_ge, wendu_shi, wendu_ge = 4;
ucharucharT_data_H, ucharT_data_L, ucharRH_data_H, ucharRH_data_L, ucharcheckdata;
ucharucharT_data_H_temp, ucharT_data_L_temp, ucharRH_data_H_temp, ucharRH_data_L_temp, ucharcheckdata_temp;
ucharucharcomdata;

// Delay function
void Delay_us () // 1 us delay
{
    asm ("nop");
    asm ("nop");
    asm ("nop");
    asm ("nop");
    asm ("nop");
    asm ("nop");
    asm ("nop");
    asm ("nop");
    asm ("nop");
    asm ("nop");
}
```

4. Commissioning of Intelligent Agriculture Monitoring System
The Intelligent agricultural industry monitoring system uses an embedded microprocessor as the core to collect data such as temperature, humidity, carbon dioxide concentration, soil pH value, light
intensity, soil nutrients and other data during plant growth and transmits data through the ZigBee network. After the signal is displayed directly through the LCD display module, the crop growth status is known\(^4\). Thus real-time monitoring of crop growth environment is formed. The physical connection diagram is shown in Figure 2.

![ZigBee physical connection diagram](image)

**Figure 2.** ZigBee physical connection diagram

After repeated tests and debugging, the system can work stably and efficiently. As shown in Figure 3, this figure is real-time data in the greenhouse monitored under stable operating conditions of the system. The specific data are: temperature 21 degrees Celsius, light intensity 90%, humidity 40%, and automatic watering mode is turned on.

![Real-time data in the greenhouse](image)

**Figure 3.** Data results

5. Conclusion
The intelligent agricultural monitoring system designed in this time is built by using CC2530 as the core, DS18B20 as the temperature detection module, HDC1080 humidity detection module, MG811 carbon dioxide detection module and other sensing modules. The system realizes the monitoring of crop growth environment so that farmers can intuitively monitor the indicators of crop growth through the terminal lcdscreen. It has greatly improved the efficiency of agricultural production and further promoted the intelligent development of agriculture. Although this study has achieved the expected goal, it still needs to be further studied in the aspect of closed-loop system control. For example, when
the ambient temperature in the process of crop growth is too high, we can control the stability of the system by controlling the rotation of the motor, putting down the shade curtain and open the vents, so as to provide the most suitable growth environment for the crops[^5].

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**References**

[1] Development experience of foreign smart agriculture and its enlightenment to China [J]. Liu Jianbo et al. World Agriculture. 2018 (11)

[2] Improved artificial bee colony algorithm with adaptive stochastic optimization strategy [J]. Liu Xin, Yang Xiaopeng, Yao Kun, Su Zixuan, Zhang Hengyang. Small Microcomputer System. 2018 (02)

[3] Research and application of network public opinion management system based on MVC model [J]. Liu Yunhua. Modern Electronics Technology. 2017 (24)

[4] Research on Precision Agriculture Corn Growth Monitoring and Analysis System Based on Internet of Things [J]. Fan Yanying. Agricultural Mechanization Research. 2018 (08)

[5] Design of Precision Intelligent Greenhouse System Based on Internet of Things [J]. Zhou Xinchun, Zhang Tong, Lu Hongqiang. Foreign Electronic Measurement Technology. 2016 (12)