Design of Intelligent Agricultural Greenhouse Monitoring System Based on 5G Network Cloud Platform

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Abstract. At present, the control of greenhouse environment of agricultural greenhouses in China mainly depends on artificial and simple equipment. This situation shows that our agricultural management lacks scientific technology. Production management lacks scientific equipment. With the continuous development of information technology of logistics network, the monitoring system of intelligent shed has been invented. The emergence of intelligent monitoring system has also been widely concerned by people. This paper studies the design of the monitoring system of intelligent agricultural greenhouse based on the cloud platform of 5G network technology, and finally draws the corresponding conclusion.

Keywords: 5G Technology, Cloud Platform, Agricultural Greenhouse, Monitoring System

1. Introduction

As we all know, 5G network technology shocked the world. Compared with the previous wireless network technology, 5G technology has higher transmission speed and lower time delay. These two characteristics ensure the reliability and stability of 5G technology. With the gradual progress of our society and times, 5G network has been gradually applied to all aspects of life.

At present, the facilities used in our country's agricultural greenhouses are very simple. We know that the influence of environment on the growth of crops is very important. To a great extent, the environment determines the growth form of crops. Without scientific monitoring equipment, vegetable farmers can not get the information of environmental parameters inside the greenhouse. This phenomenon is harmful to the growth of crops in the greenhouse. If we use 5G network cloud platform technology to build the corresponding greenhouse monitoring system, it will greatly improve the efficiency and quality of agricultural production.
2. Design idea of monitoring system based on 5G Technology

In the face of the phenomenon that the traditional agricultural greenhouse is not easy to manage and the environmental parameters are not easy to control, we will use the 5G network cloud platform technology to optimize the design of the traditional greenhouse monitoring equipment. By collecting the environmental parameters in the agricultural greenhouse, we need to complete the development of the collection system of humidity, illumination and carbon dioxide concentration unit.

We can upload these information to the cloud controller of the cloud platform to realize the communication monitoring between the cloud platform and 5G network\(^1\). The environmental parameters inside the shed can be displayed in the app or computer terminal in real time. Generally speaking, the design of monitoring system can effectively solve the problem that the environmental variables of greenhouse cultivation are not easy to control.

3. Overall structure framework of monitoring system

The monitoring system of the greenhouse based on 5G cloud platform is divided into four application layers. They are application layer, 5G network layer, middle control layer and sensor layer. The role of cloud application layer is the development and control of cloud platform and mobile app. 5G network layer is responsible for the supervision of network technology. The function of middle control layer is the design of single chip microcomputer\(^2\). The function of the sensor layer is to measure the environmental parameters inside the shed. The sensor technology of 5G network adopts special networking mode to improve the accuracy of parameter acquisition\(^3\). The function of the receiving end of the data is that the environmental parameters are transmitted to the computer terminal and mobile phone software through 5G network after the measurement of the sensor.

4. The software and hardware design of the monitoring system of the shed based on 5G network cloud platform

4.1. Design of power circuit and module circuit

The main system adopts switch power supply to provide system 24V voltage. The power supply of the node collecting the environmental parameters is powered by two dry batteries. The design of the module circuit adopts ZigBee's module circuit design mode. Therefore, this circuit needs two chips CC2530 and cc2591.

4.2. Circuit design of environmental parameter sensor

The communication format of digital signal sensor and MODBUS is planned for the sensor of this system. SHT10 chip is used for air humidity sensor, illumination sensor and carbon dioxide sensor. In order to transmit data stably, we need to connect 10nf capacitance and corresponding pull-up resistance between power supply and low section\(^4\). The wires used in the circuit need to use anti-interference wires with shielding function.

4.3. Software design of industrial touch screen

The programming software of touch screen is planned to adopt the terminal design of HMI. When the
timer overflows, the system will start to collect environment data and wake up the terminal device. The data will be transmitted to the computer terminal through the serial port. ZigBee software design is also included in the process of touch screen software design. The location of ZigBee's equipment in a protocol stack is the most important. The corresponding address assignment can be:

\[ R = 1, C_{\text{skip}}(d) = 1 + C \times (L - d - 1); \]
\[ R \neq 1, C_{\text{skip}}(d) = (1 + C - R - C \times R^{(L-d-1)}) (1 - R); \]

The allocation of the short address of the device of the nth child route of the parent device is as follows:

\[ n = 1, A_{\text{child}} = A_{\text{parent}} + (n - 1) \times C_{\text{skip}}(d) + 1; \]
\[ n > 1, A_{\text{child}} = A_{\text{parent}} + (n - 1) \times C_{\text{skip}}(d); \]

The allocation of the short address of the device of the nth child terminal of the parent device is:

\[ A_{\text{child}} = A_{\text{parent}} + R \times C_{\text{skip}}(d) + n; \]

Users can't know the details of the protocol stack when they develop a specific project. The protocol stack is executed by the main function, whose task is to initialize the system and execute the query operating system\[^5\]. The corresponding event handling functions are designed at each level of the protocol stack. Each level has its own tasks. The perfect completion of tasks at each level can ensure the stable operation of the program (see Table 1).

| Table 1. Application level and main functions of greenhouse monitoring system based on cloud platform |
|---------------------------------------------------------------|
| Module level                                      | Module function                   |
| Cloud application layer                             | Web of things open platform       |
| Network layer                                      | 5G network                       |
| Mesosphere                                        | Control module                   |
| Bottom                                            | Sensor measurement module        |

5. Test of the monitoring system of the shed based on 5G network cloud platform

5.1. Test of system stability

We can choose 30 environment variable acquisition boards, 2 temperature sensors, 1 light sensor, 1 carbon dioxide sensor and 1 main controller as test equipment. They are randomly distributed in the range of 1.5km in the shed. We found that all the equipment was working properly. Moreover, the deviation of the sensor is small.

5.2. Function consumption test of acquisition board

The purpose of function consumption test is to test the power supply time of two dry batteries. It is
assumed that the automatic discharge capacity of dry cell in half a year is 30%. According to the rate of power consumption of the monitoring device[6]. We can estimate that the power supply time of two dry batteries can be more than half a year.

5.3. Evaluation of comprehensive performance of the system

After several days of testing, we found that the system runs stably with the help of 5G network. During this period of time, the system did not break the network. The system will not lose data during the transition of sleep state and wake-up state. Therefore, the comprehensive performance of the monitoring system designed in this paper is good.

6. Conclusion

In fact, the 5G network cloud platform technology designed in this paper is similar to ZigBee technology. They all use the sensor network connection technology to monitor different positions in the shed. In the process of data transmission, ZigBee technology adopts 4G network. However, the system in this paper uses 5G technology in the process of data transmission. This feature is also the advantage of this system.

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