Smart Agriculture Information System Based on Cloud Computing and NB-IoT

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ABSTRACT

The typical projects of NB-IoT technology in the agricultural Internet of Things are being planned, which has broad application prospects and development space. NB-IoT and cloud computing promotes the development of the agricultural Internet of Things and improves the development model. Smart Agriculture Information System Based on Cloud Computing and NB-IoT designed in this paper monitors crops or farmland through information transmission equipment in real time, and records the growth status of crops, so as to adjust the planting technology and planting methods.

KEYWORDS

Smart agriculture, Information system, NB-IoT, Cloud computing.

INTRODUCTION

With the advancement of science and technology and industrial upgrading in various fields, the combination of information technology and agriculture such as the Internet of Things has produced the application of smart agriculture. Its connotation is mainly through the intelligent implementation of collecting agricultural production environment and controlling the production environment. Production is standardized production, efficient agricultural production is carried out, agricultural intensification is realized, and information services are provided to agricultural producers through a smart agricultural system.

Traditional Internet of Things technologies include WiFi, Bluetooth, and ZigBee. They need to be built and applied in the form of self-organizing networks. The power consumption is large and the cost is high and the limitations are high. In recent years, the emergence of low-power WAN has gradually replaced the traditional Internet of Things technologies, such as LoRa and SigFox. Although it solves the problem of high cost and high cost, it is still a self-organizing technology. And it belongs to the non-authorized IoT technology without relevant international standards. The prospect of unlicensed low-power WANs is less clear and will also limit user demand. However, the importance of NB-IOT is that it is a whole city-wide network established by operators. The whole country shares a low-power WAN. The cost is low and the data security is high. The participation of operators is reduced, which is conducive to the scale of modern agriculture.

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NB-IoT technology is the latest cellular-based narrowband IoT technology with wide-area transmission, ultra-low power consumption, large access, and low cost. NB-IoT utilizes the base station service of telecom operators to timely collect and transmit data. It is a new Internet of Things technology in modern agriculture. The application of the NB-IoT node can not only greatly reduce the unnecessary traditional routing node setting and networking design, but also can be based on the telecom company base station for large-scale networking, which is simple and reliable in form, adapts to various complex environments, and can reduce the external environment to some extent. Interference with the signal, appropriate amount of field data collection, provide a basis for irrigation, drainage, to achieve real-time adjustment of crop growth environment, while improving the modern agricultural science management level.

The smart agricultural information collection system based on cloud computing and NB-IoT mainly uses the latest Internet of Things technology to construct an IOT sensor monitoring network system for crop irrigation, growth environment and state, and meteorological parameters in the modern agricultural demonstration park. Nowadays, agriculture is gradually moving towards an era of unmanned, regionalized, highly specialized and high-efficiency. It relies on modern science and technology to develop agriculture, so that no one is required to be on duty in the field, realize digital irrigation, and fully utilize computer automatic control and software data systems to ensure reliable production. It can improve efficiency while steadily increasing revenue.

**SYSTEM STRUCTURE DESIGN**

The main framework of the intelligent agriculture information collection system consists of the perception layer, the network transmission layer, the platform layer and the application layer. The sensing layer is composed of various sensor monitoring nodes. Through the sensing technology, the information parameters that affect the agricultural production, such as weather conditions, soil fertility, crop growth situation and other information parameters are collected to achieve refined agriculture. The network transport layer transmits the information collected by the sensor layer sensor through wired or wireless means to the local area network and the wide area network in various communication protocols. The platform layer will collect the data transfer platform center server end, and analyze and summarize the data, and display the real-time data in the database in the form of graphs. In the application layer, managers make scientific decisions after understanding the real-time growth of crops, and realize remote control of agricultural production processes.

The system mainly uses the parameters such as temperature and humidity, light intensity, soil moisture content and pH value of irrigation water in the crop growth environment as the collection target for research and design. With NB-IoT wireless transmission communication method, the base station is used as the carrier for fast and efficient wireless transmission. The COAP protocol reduces the data packet loss rate during transmission. NB-IoT chip adopts BC95, a well-known module supplier from China. The chip has small size, ultra-low power consumption, wide operating temperature and is compatible with GSM/GPRS mode of remote communication. The module has the advantages of easy upgrade and reliability. High in nature, it can meet the application needs in complex
environments such as agricultural field. The system mainly consists of information acquisition sensors, transmission terminals and supporting software monitoring platforms. In the design, the actual use environment conditions, transmission distance, maintenance difficulty and power consumption should be considered to ensure the monitoring data collection and transmission stability, and the server side realizes synchronous storage and real-time query and command control. System structure is shown in Figure 1.

Figure 1. System Structure.

**HARDWARE DESIGN**

System design ultimately realizes data collection, transmission and platform database collection of modern agricultural IoT monitoring nodes based on NB-IOT technology. The core of the hardware design is the data acquisition and data collection and storage part. The main part is to transfer, process and save the data collected by the sensor in the server. The terminal node collects data, and the server platform is responsible for parsing and collecting management. The entire design consists of three major parts:

- **Control part:** CPU, RS232/485, power supply, charging circuit and serial port;
- **Communication part:** NB-IoT chip, voltage conversion circuit, etc.;
- **Collection part:** plug-ins required for the Internet of Things platform, preparation of profile files, and registration and installation of IoT terminal devices.

![Hardware Structure](image)
The hardware design of the node is mainly around the control circuit, expansion circuit and peripheral circuit of the single chip microcomputer, and the other part is the circuit design of the NB-IoT communication part. According to the basic requirements of the monitoring node, the control board mainly includes a control module, a power circuit module, a lithium battery charging and discharging module, an external power supply step-down and power selection circuit module, and an RS232/485 interface. The communication board is designed in the overall circuit of the communication module, which mainly includes the BC95 connected to the SIM module, the step-down circuit and some peripheral circuits.

![Node Structure](image)

**SOFTWARE DESIGN**

The main work of terminal node software design is IoT network connection, sensor work collection and packet transmission and acceptance control. The software working steps are mainly as follows: First, configure the initialization of the microcontroller, turn off the watchdog configuration SMLK as the clock source, and ensure that the UART serial port can be woken up in the LPM3 mode. It also initializes the other interfaces and initializes variables such as clearing the serial port buffer area, message buffer initialization, threshold variable initialization, and status flag initialization. After the initialization process is completed, it is judged whether the communication between the MCU and the NB-IoT module is normal, including whether the test serial port communicates normally, whether the network mode is automatic, and confirms the mobile operator. The next step is to determine whether the BC95 module enters the full working mode, whether the SIM information is read normally, whether there is a signal, whether it is registered to the network, whether it enters the link state, etc., and finally confirms whether it enters the connect state, or enters IDLE low-power sleep mode. Next, the MCU collects the sensor data for packaging and then sends the data to the designated server through the NB-IoT network. After the transmission is completed, the data is received through
the NB-IoT network, and the number of receptions is reset. Finally enter the sleep power-saving mode, and enable the interrupt, waiting for the next attempt to open the network, and data acquisition and transmission. The main software flow is shown in Figure 4.

![Software flow diagram](image)

**Figure 4. Software flow.**

**CONCLUSION**

Smart agriculture information system based on cloud computing and NB-IoT mainly uses the parameters such as temperature and humidity, light intensity, soil moisture content and pH value of irrigation water in the crop growth environment as the collection target for research and design. With NB-IoT wireless transmission communication method, the base station is used as the carrier for fast and efficient wireless transmission. The COAP protocol reduces the data packet loss rate during transmission. NB-IoT chip adopts BC95, a well-known module supplier from China. The chip has small size, ultra-low power
consumption, wide operating temperature and is compatible with GSM/GPRS mode of remote communication. The module has the advantages of easy upgrade and reliability. It can meet the application needs in complex environments such as agricultural field.

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