Design of Intelligent Farmland Monitoring System Based on IoT and Android Platform

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Abstract: The farmland environment is harsh and mostly unattended. According to the comprehensive monitoring problem of the growing environment of crops, the Internet of Things and Android related technologies are studied. This paper developed a farmland monitoring system based on the Internet of Things and Android platform. The remote acquisition and data storage of information on multiple sensor nodes (temperature, soil moisture, crop growth, etc.) is achieved. Real-time monitoring and observation of farmland and real-time control of the operation platform through the combination of wireless communication technology and the Internet of Things technology of mobile terminals such as mobile phones can effectively irrigate farmland and apply pesticides, thereby increasing crop yields and reducing labor force. Cost, protection of ecological and natural environment, has strong practical significance and promotion value.

1. Introduction

The environmental conditions of farmland can directly affect the quality and yield of agricultural products. Therefore, it is particularly important that information such as temperature, soil moisture, and crop growth status in farmland can be held in real time. As the primary industry and basic industry of China's national economy, agriculture faces the informatization, networking, and the development of automated science and technology.[1] Existing agriculture still falls short of standards.[2] Traditional farmland production models are mostly produced through manual management. The facilities are out of place and their reliability is poor. They only rely on the experience of agricultural workers to perform irrigation or fertilization, and cannot comprehensively monitor and regulate the environment.

With the rapid development of science and technology, the Internet of Things has become one of the strategic commanding heights of the current world economic and technological development. The Internet of Things is an automatic identification and information sensing device and system through barcodes and two-dimensional codes, RFID, Global Positioning System (GPS), infrared sensors, laser scanners, and sensor networks, in accordance with the agreed communication protocols.[3-6] Through a variety of local area networks, access networks, the Internet to connect things and things, people and things, people and people, information exchange and communication, to achieve intelligent identification, positioning, tracking, monitoring and management of an information network.[7] The development of the Internet of Things has important practical significance for promoting economic development and social progress.[8-10]

In view of the poor farmland environment and mostly unattended areas, the monitoring system adopts the Internet of Things technology. Based on the Android platform, the system has strong real-time performance. The mobile phone wireless communication method is used to monitor and track the agricultural growth environment in real time. The system is simple in operation and data. The output is fast and accurate, enabling continuous or timely monitoring of the entire crop growth process.

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2. System Design

The system is mainly divided into the bottom module (real-time monitoring of environmental parameters, control module), server remote monitoring and Android mobile client and other modules. The system architecture diagram is shown in Fig. 1.

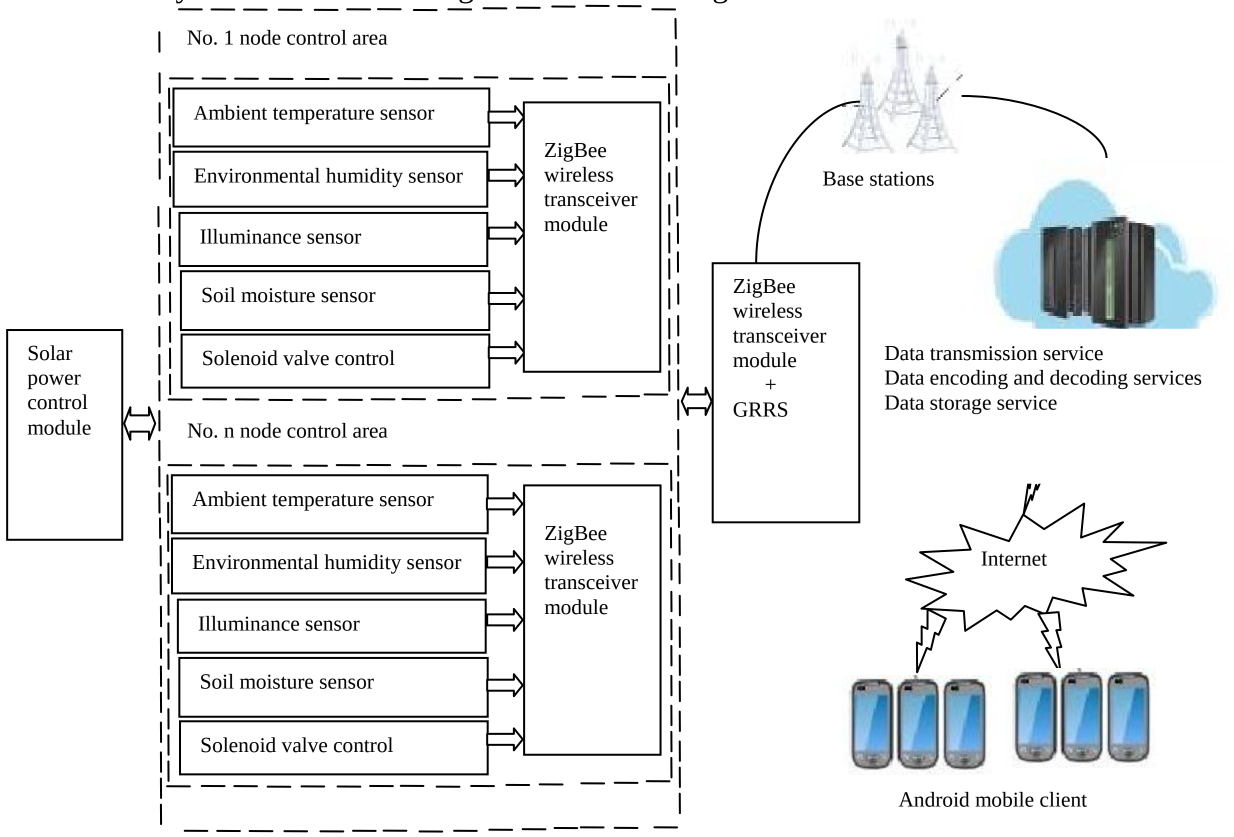

Fig. 1 Overall System Design

In order to solve the power supply technical problems of the intelligent farmland environment system, the system uses solar power to supply power to the environmental sensor nodes and the solenoid valve control nodes. The wireless sensor module uses the new generation SOC chip CC2530 of ZigBee technology. The module is mainly responsible for the real-time collection of environmental parameters such as air temperature, air humidity, light and soil moisture. The ZigBee protocol is used to send the collected data to the controller node ZigBee module and receive the control commands from the controller node ZigBee module. [11] The controller node is mainly used to send and receive ZigBee module data and perform network communication with the remote monitoring center through the Internet and mobile internet.

Server remote control is the basic support platform for application systems. On the one hand, it is necessary to connect various sources and channels, collect, extract, and aggregate various sources of geographic, meteorological, and other data information, and establish a comprehensive system database; on the other hand, the platform needs to be in the form of a standard Web Service interface to the business. The application system provides various data service interfaces to support the normal operation of the business application systems. It mainly includes three service modules, namely data transmission service, data encoding and decoding service, and data storage service. At the same time, through the communication with the farmland GPRS/GSM/3G/4G wireless network, the front-end sensors (air temperature and humidity sensors, soil temperature and humidity sensors, light sensors, etc.) can be collected and processed, and the data can be recorded and analyzed.

Android mobile phone system, including map positioning, map operations, site real-time data charts, site daily statistical data charts, historical data viewing (including real-time data and statistical data), complete the data exchange with remote monitoring center and network communications and other functions . At the same time, the threshold of each function sensor can also be set on the mobile terminal. When the collected data in the field exceeds the threshold, the system will remind, or send a message.

3. Android Client Design

3.1 Android Client Functional Architecture

Android is an open source embedded operating system based on the Linux platform developed by Google. It includes operating systems, user interfaces, and applications. The system adopts the client/server model, the service part adopts WebService and Socket programming technology, Java technology development, the client part is implemented using Android Java development technology, and the Socket completes communication. The compilation is finally generated in the APK file and can be used directly on Android mobile devices after installation. Compared with the traditional farmland monitoring system, this design is not limited by time, location, external environment, distance and other factors. The control interface is designed on the user's mobile terminal. The operation is simple and easy to use.

3.2 Client Interface Design

The Android system uses a scripting language to complete the interface design. The client app provides map location modality. This function is implemented by calling the API of the Map SDK Development Kit provided by Reed Maps. This system mainly includes login interface, main function interface, and main control interface. In the main function interface, you can click to enter the main control interface at all levels. The control interface of node 1 is shown in Fig.2. In this control interface, the air temperature, humidity, light, soil moisture and other environmental parameters of No. 1 node can be received and displayed in real time. Automatic irrigation and manual irrigation modes can also be set.

3.3 Client Main FlowDesign

The Android mobile client system test uses Huawei glory 6X phone, Android7.0 version, kernel android4.1.18. The development environment is AndroidSDK+jdk8+gradle. The server can communicate with multiple Android mobile clients at the same time. At the same time, each client is assigned a port number. After the user legally logs into the system, it first enters the main function interface. The interface selects a control node and enters the control node interface. The main control flow is shown in Fig. 4.

This system mainly contains 7 activities, 16 XML script files, and communication between Activity and Activity through Intent and variable data transmission. The attributes and permissions of each file are defined in the global configuration file manifest.xml.

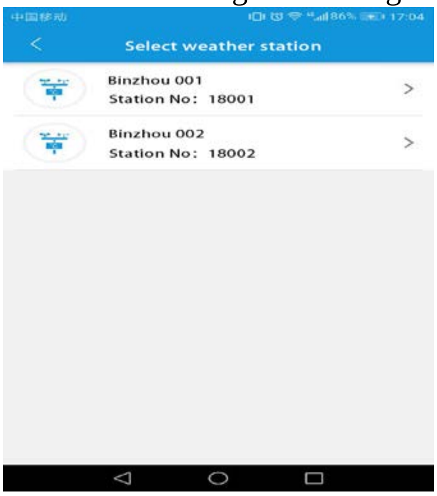

Fig.2 Site Selection Interface

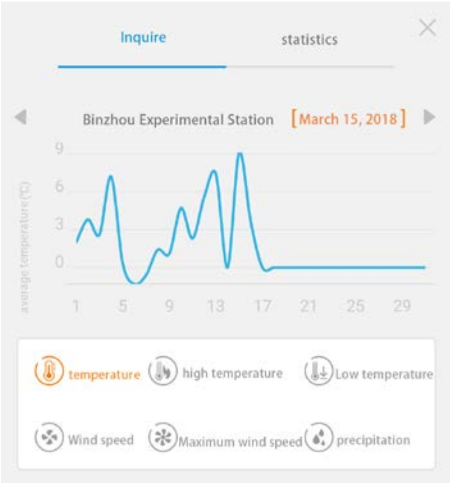

Fig. 3 Environment Data Query Interface

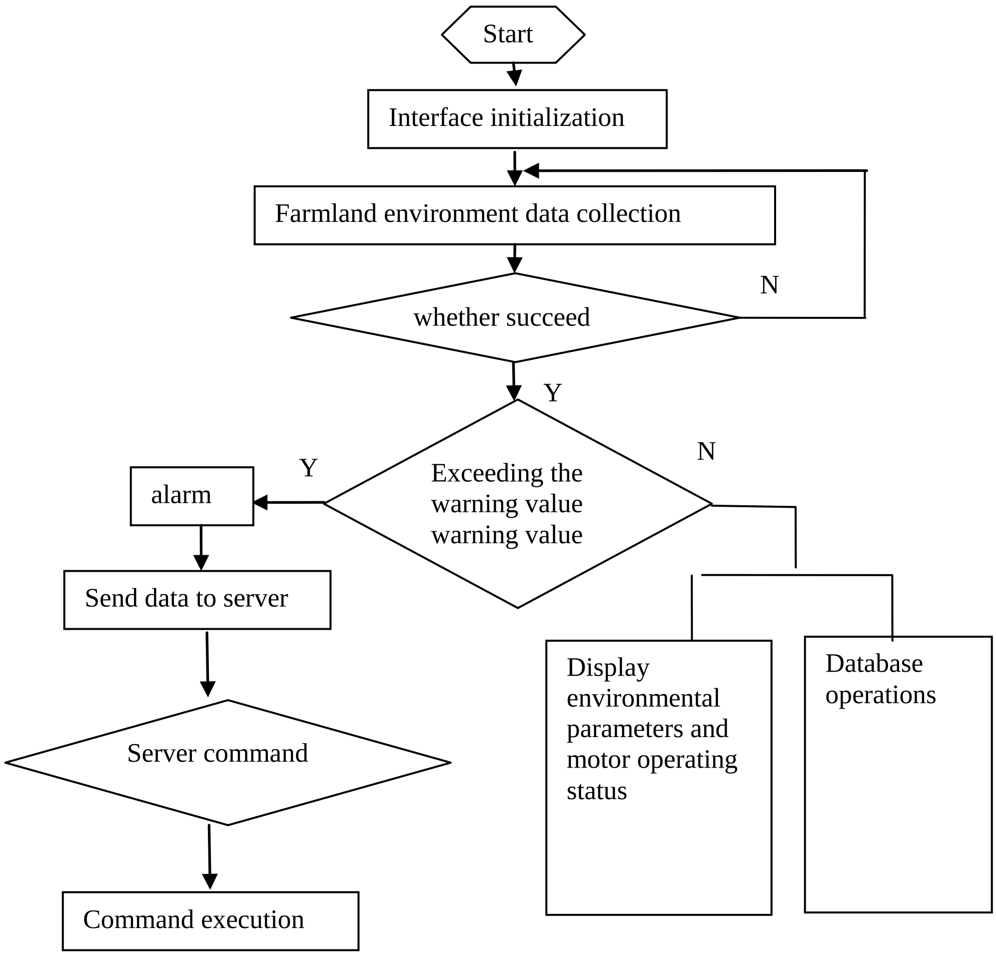

Fig. 4 Main Control Flow Chart

3.4 Communication Module Design

The communication module mainly adopts the SOCKET communication method, and the SOCKET (Socket) is an abstraction layer, and the application program sends and receives data through it. Use SOCKET to add applications to your network and communicate with other applications that are on the same network.

Socket, commonly used communication protocols are TCP and UDP. The TCP protocol is a reliable, connection-oriented protocol; the UDP datagram protocol is an unreliable, connectionless protocol. The system selects the TCP communication protocol, and the communication terminal sends heartbeat packet data to the server periodically to maintain a long connection state. When the server needs to obtain data, it sends an instruction for acquiring data to the terminal. After receiving the instruction, the terminal returns the data collected by the device to the server. The original data is a hexadecimal code, and the original data is stored in the database.

3.5 Data Processing Module

Android's different activities can't use global variable sharing directly. Use the Bundle's putParcelable and getParcelable functions to transfer data between activities, which are divided into two kinds: transferring data to the source Activity and acquiring data from the target Activity. The specific implementation is as follows:

```
  Pass the object to the target Activity
bundle.putParcelable("mode", mode);
Get the object passed by the source Activity
  mode = bundle.getParcelable("mode");
// Resolve json data returned by the server
public BaseRet<List<AddressMode>> jsonToMode(String jsonStr) {
```

```
        return new Gson().fromJson(jsonStr, new
TypeToken<BaseRet<List<AddressMode>>>() {
        }.getType());
}
```

The server data is in json format, using the GSON framework serial number to the object, and then the program manipulates the resulting object.

4. Monitoring Platform

Remote monitoring consists of a PC that can be directly accessed by a mobile terminal. It establishes a connection through the Internet and mobile Internet and modules in the field controller node to communicate. The ZigBee wireless communication module receives the data information of each sensor node and the state information of the motor work (irrigation, fertilization, etc.) of each control node, and transmits it to the PC server using the RS232 serial port. The remote monitoring center stores the information collected in the field into the database for later analysis and processing. At the same time, the electromagnetic valve in the field can also be controlled as needed to enable the automatic irrigation mode. The automatic irrigation control is based on the soil moisture and automatically starts the irrigation system when the soil moisture reaches the humidity and goes offline.

System Test and Application

The system was tested on farmland monitoring at the Huimin Experimental Base in Binzhou, Shandong Province. During the period of stable operation, the wireless sensor network transmission is stable and reliable, the farmland environment data collection is accurate and normal, the response is rapid, the data upload synchronization delay is within 1s, the control command is issued accurately and quickly, the delay is within 10s, and the control status is normal. The cloud web service running is stable and normal, the interface responds quickly, and the data is returned completely and accurately. The monitoring center is working properly and no query exception has occurred.

Fig. 5 System Monitoring Data Interface

5. Summary

This article developed an intelligent farmland monitoring system based on the Internet Things (IoT) Android platform to implement remote wireless monitoring of farmland environment information in large areas on mobile phones. A mobile phone can manage mult of iple sites at the same time, and the results can be in the client computer software. Display, low hardware cost, high cost performance, intelligence, and other characteristics, effectively solve the traditional monitoring system, the existence of energy, limited transmission distance and other issues. The 24-hour continuous monitoring of the farmland was conducted at the Huimin Experimental Base in Binzhou City, Shandong Province. The test results showed that: The system is running well, the interface is user-friendly, the operation is convenient, the real-time performance is good, and the remote control output is responsive and has a certain Promotion value.

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