Design and Implementation of Agricultural Internet of Things System Based on Aliyun IoT Platform and STM32

Tianli Zhou* and Jian Zhang
Wuhan Universtity of Technology, Wuhan430070, China

*Corresponding author: zhoutianli@whut.edu.cn

Abstract. Based on the research of Internet of things, agricultural intelligent management system was proposed based on Aliyun IoT platform and STM32. Through the ZigBee wireless sensor technology to complete the data transmission function of each sensor by ESP8266 and the MQTT protocol complete STM32 access connection function of Aliyun IoT platform, through the cloud database RDS complete data storage function, and implements the Web visual development and system supporting Android APP development. A set of agricultural automation intelligent management system, which is portable, small and suitable for farmers' consumption demand, has been developed.

Keywords: Agricultural Internet of Things System, Aliyun IoT Platform, STM32

1 Introduction
With the development of the automation of agriculture and the popularity of the Internet technology [1-5], in the process of agriculture irrigation water will produce a large amount of historical data, such as temperature, light intensity, irrigation water and fertilizer, etc., but only by the level of agricultural workers own intellectual can't effective use of these valuable data, and agriculture experts in the absence of a large amount of data, also can only rely on their own experience and theoretical knowledge to make a decision.

From the above two aspects, each side greatly increases the difficulty of intelligent agriculture development due to its own limitations. Therefore, building the Internet of things for agriculture to collect, store and mine the growth information of various crops and make scientific decisions will become a bridge between agriculture, agricultural workers and agricultural experts, and a key step to improve agricultural production efficiency. STM32 has a good foundation in the original industrial market, and there is a large market growth space to add more services connected to the cloud. And MQTT [6-8] of Aliyun has become the preferred cloud communication protocol for the domestic industrial Internet of things.

Therefore, based on STM32 series chips and Aliyun Internet of things cloud platform, combined with ESP8266 and ZigBee[9-10] network communication chip, this paper designed the agricultural Internet of things and completed the collection and storage of relevant agricultural data.

2 Architecture Design of Agricultural System
The whole system is composed of sensor layer, feedback layer, network layer and application layer. The sensor layer is mainly composed of environment variable sensor group, soil variable sensor group and Openmv4 camera. The feedback layer is mainly composed of fan, water and fertilizer mixer and water valve. The network layer is mainly composed of ESP8266 network module, router, serial communication and ZigBee network. The application layer is mainly composed of aliyun IoT platform, Web services, cloud database RDS and mobile App. The summary composition is shown in figure 1.

![Fig 1. Agricultural Internet of things summary composition](image)

3 The Design of Sensor Layer

The sensor layer is composed of a main control chip STM32F407, various sensors and ZigBee network, as shown in figure 2 below. The main function is to receive and transmit real-time information of environment variables and soil variables in the field, which is transmitted to STM407 via ZigBee network and to the cloud platform via WIFI router via ESP8266.

4 The Design of Feedback Layer and Network Layer

4.1 Feedback Layer

The feedback layer consists of a core control board and functional modules. The main function of the control board card is to complete the corresponding functions such as mixing water and fertilizer by receiving instructions from mobile terminals or cloud platforms.

Feedback layer hardware design: In addition to the core control board card, the feedback layer also includes three kinds of data acquisition extension board cards: analog input board card, digital input board card and digital output board card. The main function of these three boards is to extend acquisition and control channels.

Feedback layer hardware design: The device of the feedback layer consists of water filtration, fertilizer feeding, water and fertilizer mixing, drip irrigation, cleaning device and PE pipe. After
receiving the instruction from the mobile terminal or cloud platform, the inlet water filter device and the fertilizer feed device start to work at the same time. After taking the appropriate water and fertilizer ratio, it enters the water and fertilizer mixing device. After the mixing, it is transported to the pipeline for drip irrigation.

The device design of feedback layer: The device of the feedback layer consists of water filtration, fertilizer feeding, water and fertilizer mixing, drip irrigation, cleaning device and PE pipe. After receiving the instruction from the mobile terminal or cloud platform, the inlet water filter device and the fertilizer feed device start to work at the same time. After taking the appropriate water and fertilizer ratio, it enters the water and fertilizer mixing device. After the mixing, it is transported to the pipeline for drip irrigation.

4.2 Network Layer
The network layer is mainly composed of ESP8266 network module, router, serial port communication, ZigBee network, etc., which is mainly composed of two parts.

Short-distance data transmission: short-distance data transmission consists of two parts. Each sensor transmits relevant data to the ZigBee network through a serial port, and the ZigBee network transmits the data to the master MCU STM32F407. ZigBee wireless communication module is the foundation of sensor system network. It has excellent anti-interference ability and has multiple network nodes. Each sensor node needs to be used in the ZigBee module.

Long-distance data transmission: long-distance data transmission USES ESP8266 WIFI module, which is configured to enter the Internet network through AT instruction, and enters aliyun lot Internet of things platform through MQTT protocol configuration built on TCP/IP protocol, enabling users to observe or adjust farmland conditions from a distance. The network transmission diagram is shown in figure 3.

Fig 3. The design of network layer

5 The Design of Application Layer
The application layer is mainly divided into three parts: Internet of things platform service and Web development, database development, mobile APP development.

5.1 Internet of Things Platform Service and Web Development
Platform services are developed by IoT Studio, and simple business logic design of the Internet of things can be quickly completed by arranging service nodes. For users who are not familiar with server development, a code-free solution for developing Internet of things services can be provided, which can be used only by simple learning. Provide high-order users with JS script, extension library and other high-order capabilities. Provide cloud hosting capability, service development can be used, you do not need to buy additional servers. Also, online debugging is supported.

Web development: visual development with IoT Studio Web, which can help you quickly set up the device control panel, device monitoring screen, and service development IoT Studio to realize a fully functional Internet of things application. The web page interface is shown in Figure 4.
Add latitude and longitude coordinates for the device. Through the map API provided by aliyun platform, relevant sensor positions can be positioned on the map, as shown in figure 5.

The interface of outdoor environment, air data and soil data is provided for the webpage, and the curve change diagram of relevant data can be drawn. Meanwhile, the weather data of the corresponding city can be displayed by calling the weather API, as shown in figure 6 below:

By setting the relevant device connection and dragging the component, the relevant control interface can be displayed, as shown in figure 7.
5.2 Database Development
Based on cloud Database RDS, Relational Database Service (RDS) is a stable, reliable and elastic online Database Service. Based on Ali cloud distributed file system and SSD disk high performance storage, RDS supports MySQL, SQL Server, PostgreSQL, PPAS (Postgre Plus Advanced Server, highly compatible with Oracle database) and MariaDB TX engine, and provides disaster recovery, backup, recovery, monitoring, migration and other aspects of the full set of solutions.

The cloud database RDS MySQL was adopted to complete the task. The soil variable data and environment variable data collected in the agricultural Internet of things were stored.

5.3 Mobile APP Development
The mobile APP adopts the Android Studio programming environment, and the front-end interface is mainly composed of the registration and login interface, the data display interface, the device control interface, the expert diagnosis interface and the personal center interface. First, the user needs to enter the user name and password in the login interface to log in. After clicking login, the page will automatically jump to the data display interface, and the user will click the corresponding button according to his own needs.

Conclusion
This paper introduces a development scheme of agricultural Internet of things, Ali cloud content networking platform, the stm32 series chips, Openmv4 cameras, all kinds of sensors and the organic integration of various network communication technology, develop more rapidly, for the user to achieve more human, intelligent agriculture management environment, to provide agricultural data storage container, build a bridge of agriculture, agricultural workers and agricultural experts, improve the efficiency of agricultural production. In the next step, artificial intelligence module will be introduced to carry out image recognition based on photos taken, automatically identify the growing period of crops or judge whether there are diseases and pests, and provide scientific basis for decision-making.

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