Application RFID and Wi-Fi Technology in Design of IOT Sensor Terminal

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Abstract. In this paper, the author studies on the design of picking robot using IOT sensor terminal based on RFID and Wi-Fi Technology. It provides comprehensive information for scientific research, this paper designs a precision agriculture information perception system based on automatic picking robot. The whole system consists of wireless sensing network, transmission node, GPRS and upper computer management system. The wireless sensing network is composed of sensing terminal and sensing module, and connected through standard interface. The system can sense the information of crop growth environment and crop physiology in real time. And the data is reliably transmitted to the upper computer management system. The upper computer management system first processes the data, writes the data into the database, and displays and publishes the data online through the web system. Long time running test shows that. The system performance is stable and reliable.

Keywords: picking robot, vision system, Wi-Fi Technology, RFID

1. Introduction
Precision agriculture is a new measure to reduce blind investment in agricultural production, save costs and increase output, improve the utilization rate of agricultural materials, reduce environmental pollution and prevent the further deterioration of the ecological environment in the development process of modern high-tech agricultural technology [1]. The core idea is to obtain the crop yield and the environmental factors (such as soil structure, soil fertility, topography, climate, diseases, pests and weeds) that affect crop production, analyze the reasons that affect the yield difference in the plot, take technically feasible and economically effective control measures, implement the positioning of crop cultivation management, and change quantitative input into variable input [2-3]. Precision agriculture is an important modern production form and management mode developed on the basis of modern information technology, crop cultivation and management technology, agricultural engineering equipment technology and a series of high and new technologies. It is not only the trend of agricultural development in the world today, but also the trend of agricultural development in the future. In the implementation of precision agriculture, accurate and real-time acquisition of crop growth information and environmental information is the key. High density and comprehensive agricultural information acquisition is the premise of precision agriculture [4]. Aiming at the problems of incomplete
parameters and poor real-time performance in the current agricultural information collection system, this paper designs the information collection system.

2. System function and structure

The rapid development of China's agricultural information technology has laid the foundation for the implementation of precision agriculture. As a product of the development of modern information technology, the Internet of things provides a powerful tool and reliable guarantee for the acquisition of agricultural production and environmental information [5]. The Internet of things is a network connecting the physical world with the characteristics of comprehensive perception, reliable transmission and intelligent processing. It realizes the connection of any time, any place and any object, and extends the network technology to anything that needs real-time management. Compared with the conventional technology, the Internet of things greatly improves the ability of human perception of the world with its more thorough perception function; enhances the ability of human remote cognition with its more comprehensive interconnection; and improves the ability of human harmonious coexistence with the world with its more in-depth intelligence. The functional characteristics of the Internet of things provide a reliable guarantee for the comprehensive, reliable, in-depth and extensive perception of precision agriculture related information [6-7].

Precision agriculture information perception system based on Internet of things is composed of perception layer, transmission layer and intelligent processing layer. It is composed of a large number of intelligent transmission layer nodes, which can be set up by the number of sensing, storage and processing nodes. The overall structure of the system is shown in Figure 1. As can be seen from Figure 1, the perception layer adopts a typical clustering network structure. The network consists of sink node, cluster head node and sensing node. Sink node is the gateway node of sensing layer, and cluster head node communicates with sink node through single or multi-hop routing. The sensing node is the basic functional unit to realize information sensing, and transmits the sensing information to the cluster head through wireless transmission.

According to the proposal of ITU, the main function of the perception layer is to obtain large-scale and distributed information and state identification of static / dynamic information such as material properties, environmental state and behavior situation through various types of sensors. According to specific sensing tasks, collaborative processing method is adopted to calculate and identify multi-type, multi angle and multi-scale information online Control. Perception node is the undertaker of object attribute and environment perception task. The first is to complete the perception of the object's environmental information, but also the perception of the object's attributes. The sensing node also has the functions of GPS positioning and wireless transmission.

WSN is mainly composed of sensor nodes with small communication and computing capacity, which can realize the layout of a large number of and intensive monitoring area points, and then organize the sensor network nodes into a network by means of wireless communication.

The typical WSN structure is mainly composed of sensor nodes, self-organizing network, sink nodes, wireless transmission network and remote client. Its application in the positioning and navigation system of picking robot can greatly improve the accuracy and efficiency of navigation. In order to further improve the navigation accuracy of the robot and realize the autonomous obstacle avoidance function, RFID radio frequency technology based on ID identification is introduced. RFID tag can be used to mark obstacles and navigation path, so that the robot can effectively avoid obstacles and verify the direction specified by the tag. In the process of picking, the robot walks along the path of label layout for many times, and then plans the path according to the image features. Finally, combined with WSN network, the precise navigation and positioning is realized.

The beacon node of the picking robot is connected with the robot through the serial port, and the signal strength of the RFID tag node is transmitted to the picking robot. After the information is processed by ARM9 main control processor, the robot sends out operation instructions to realize autonomous navigation. The overall design framework is divided into two layers, including API and OS kernel. It uses embedded system to provide efficient task scheduling, time queue and interrupt
processing unit. It is also compatible with network protocol and provides driver for node hardware devices. The structure of the sensing node, as shown in Figure 2.

The design of the sensing node adopts a modular structure, with the information sensing motherboard as the core, supplemented by the corresponding functional modules according to the needs. MSP430F149, which has ultra-low power consumption, abundant on-chip resources and fast instruction execution speed, is selected as the microprocessor of information sensing motherboard. In addition to 8 ADC conversion interfaces, the microprocessor also has 5 8-pin IO interfaces. All of them are supplemented with 10 pin standard socket (1 pin and 10 pin are connected to the ground and power supply respectively), which can be connected to the required sensor parts through the cable.

Figure 1. Schematic diagram of the overall structure of the system

Figure 2. Structure diagram of sensing node

3. The Detailed Design
The sensing node mainly completes the perception and transmission of information. After receiving the acquisition command, the sensing node completes the task of information collection and forwarding. That is to say, after receiving the task, the microprocessor of the sensing node collects and processes the information first. The processed data is transmitted to the transmission node by the wireless transmission module, and then transmitted to the upper computer by the transmission node. The communication between the microprocessor and the wireless module adopts the universal serial asynchronous protocol, and defines a unified data receiving and sending protocol in the wireless transmission. Figure 3 is the schematic diagram of the connecting rod coordinate system.
The algorithm is shown as below:

\[ C^1 = C - C^0, \quad e^1 = e - e^0, \]

\[ \eta^1 = \eta - \eta^0, \quad \rho_1 = \rho - \rho_0 \]  
\[ f(x, \omega) = f^0(x, \omega) + \int_{\nu} S(x - x')(L'F(y') + \rho_1 \omega^2 g(R)T_y f(y')S(y')dy') \]

The we get:

\[ \frac{1}{\Gamma(1+\alpha)} \int_{x} f(t) \frac{(dt)^\alpha}{(t-x)^\alpha} = \lim_{\epsilon \to 0} \frac{1}{\Gamma(1+\alpha)} \int_{-\infty}^{x-\epsilon} f(t) \frac{(dt)^\alpha}{(t-x)^\alpha} + \int_{x+\epsilon}^{x} f(t) \frac{(dt)^\alpha}{(t-x)^\alpha} \]

\[ g_{\omega} (\kappa, \omega) = -\frac{1}{\eta_{11}^0} \frac{1}{k^2} + \frac{1}{\rho_0 \omega^2} \left( \frac{e_{15}^0}{\eta_{11}^0} \right)^2 \frac{\beta^2_\perp}{k^2 - \beta^2_\perp}, \gamma_1 (\kappa, \omega) = \frac{1}{\rho_0 \omega^2} \left( \frac{e_{15}^0}{\eta_{11}^0} \right)^2 \frac{\beta^2_\perp}{k^2 - \beta^2_\perp} m_i \]

In which,

\[ \alpha^2 = \frac{\rho_0 \omega^2}{C_{11}^0}, \]

\[ \alpha^2 = \frac{\rho_0 \omega^2}{C_{66}^0}, \quad \beta^2_\perp = \frac{\rho_0 \omega^2}{C_{44}^0}, \]

\[ C_{44}^0 = C_{44} + \left( \frac{e_{15}^0}{\eta_{11}^0} \right)^2 \]

Rewrite again Eq. (4) as

\[ \tilde{f}_{\omega}''(x) = \frac{1}{\Gamma(1+\alpha)} \int_{-\infty}^{x} f(t) \frac{(dt)^\alpha}{(t-x)^\alpha} = \frac{1}{\Gamma(1+\alpha)} \int_{-\infty}^{x} f(t) g(x-t)(dt)^\alpha = f(x) * g(x) \]
\[
\partial_j \left( C_{ijkl} \partial_k u_i + e_{ijkl} \partial_k \varphi \right) - \rho u_i = 0 \\
\partial_j \left( e_{ijkl} \partial_k u_i - a_{ijkl} \partial_k \varphi \right) = 0
\]

The linear equation can be expressed into the following simplified forms:

\[ L(\nabla, \omega) f(x, \omega) = 0 \]

In which,

\[ T(\nabla) = T_{ik}(\nabla) t_i(\nabla) \]

\[ J = [\delta_{ik}, 0, 0] \]

\[ f(x, \omega) = \left[ u_i(x, \omega), \varphi(x, \omega) \right] \]

The hardware system is shown in Figure 4.

Ccll00 is selected as the information transmission module in the design of sensing node. Ccll00 module has low power consumption, mainly set in 315 / 433 / 868 / 915MHz ISM (industrial, scientific, medical) and SRD (short range equipment) frequency band, and can also be set to any frequency between 300mhz -348mhz, 400mhz -464mhz, 800mhz -928mhz. Built in frequency compensation function, compensation can be set, data transmission efficiency is high, data whitening function makes data transmission function more secure. The built-in RSSI function is convenient for routing. PQT preamble quality threshold can easily select nodes with better signal quality to transmit data. It can effectively reduce the number of data retransmission and data collision, and improve the efficiency of data transmission. The real-time detector for chlorophyllin content is shown in Figure 5.

The principle is that the changes of crop physiological information will affect the color, thickness and morphological structure of crop leaves, resulting in the changes of spectral absorption, reflection and projection characteristics.

4. Results and Discussion

The upper computer software system mainly completes the functions of data receiving, data storage and data processing. The system uses Java open source framework development, the system uses...
MVC three-tier design pattern, namely: JSP + servlet + JavaBean.

In other words, MVC separates the input, processing and output processes of an application in the way of model, view and controller. An application is divided into three layers: model layer, view layer and control layer. MVC is the main control layer. By accepting the user request from JSP, calling and initializing JavaBean, and then passing it to the client through JSP. JavaBean is the MVC model layer, which cooperates with JSP and servlet to complete the user's request.

JSP is the MVC view layer, which acts as the receiving and responding client. The implementation process is as follows: the client sends the request to the controller servlet, the servlet instantiates the model component according to the request, stores the data and operates the business logic, returns the operation result to the JSP, and the JSP parses the information to the client. The database is designed with my sql5.0 and published online through Tomcat server. After users log in, they can view real-time and director data. The process is shown in Figure 6.

In the data processing, the decision-making model of automatic precision irrigation for field crops is also developed. According to the model, the system can automatically irrigate crops according to the perceived environmental information and crop growth information.

The test can be carried out according to the following steps:

1) Insert the test code to obtain the processor time and memory usage of the digital driver module in each key node.
2) Write a simple structure digital driver module to achieve the same function.
3) Insert the test code to obtain the processor time and memory usage of the simple structure digital driver module in each key node.
4) The processor time and memory usage of the two designs are compared and analyzed.
5) Insert the test code to obtain the ratio of processor time and memory usage of the digital driver module in the 6-DOF control system software.
6) According to the occupancy rate, the influence of the design mode of data-driven state machine on the six degree of freedom control system is estimated.

Before the test, we need to determine how to design the test code to obtain processor time and memory usage. And determine the selection of key nodes in the code. Fig. 7 and Fig. 8 show respectively the picking robot's working space drawn with Matlab's three dimensional plotting function plot 3 and its projection on Plane xoz.

![Figure 6. The working space for picking robot](image-url)
5. Conclusions

Based on the Internet of things and reliable transmission technology, the agricultural information perception system is designed. The system is composed of perception layer, transmission layer and intelligent processing layer. The sensing nodes in the perception layer are connected with sensors through standard interfaces, and different types of sensors can be connected according to the needs, so as to realize the thorough perception, reliable transmission and intelligent processing of different types of information. After the successful development of the system, a large number of experiments for a long time show that the system is stable and reliable, easy to maintain, easy to expand, and has high application value.

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