The Early-Warning and Inspection System For Intelligent Greenhouse Based on Internet of Things

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Abstract. The early-warning and inspection system for the intelligent greenhouse is an inspection robot based on the Internet of things and equipped with various sensors and intelligent cameras with 4G or 5G communication functions, such as temperature and humidity, light, gas, and flame. Which uses the wireless network transmission to the cloud computing platform for data analysis, sending warning information through smartphones to enable farmers to real-time monitoring in agricultural greenhouse crop growth status, temperature and humidity, illumination, CO₂ concentration, plant diseases, and insect pests, etc., to achieve automatic control, scientific planting and raising the yield and increase their income. This paper mainly analyzes the hardware and software structure of this early-warning and inspection system, data transmission and processing, and Android application, so as to promote the application of intelligent planting.

Keywords: intelligent greenhouses, early warning, control system, cloud computing

1. Introduction
With the development of artificial intelligence and the Internet of Things technology, intelligent agriculture promotes the development of modern agriculture. Scientifically and effectively manage, reduce labor costs, increase production, and incomes are an important way to ensure the value-added of farmers' agricultural industry. This paper aims to build an early warning and inspection system for planting greenhouses by using the Internet of Things technology and combining artificial intelligence identification technology and cloud computing platform. Through the arrangement of sensors in each information to collect the data of the intelligence greenhouse such as temperature, humidity, light, soil ph, etc through the inspection robot vehicle intelligent camera gathering crops blades pictures [1],
using 4 g or 5 g wireless networks to transmit sensor data and photos to the cloud computing platform for node data storage and management, which can identify pests, diseases, and weeds. The farmers can understand greenhouse crop information in real-time, anywhere at any time grasp the real-time situation of farmland, and according to the smartphone to send the warning information for the remote control operation.

This system can not only monitor and warn the growing state and environment of crops, but also can undertake the corresponding automatic spray irrigation, spraying, roller, ventilation control, to speed up the process of the modernization of agriculture production, efficient use of the resources of diverse Agricultural Garden, which has realistic significance, such as to promote agricultural industrialization and informatization, and to promote agricultural efficiency and farmers' income [2].

2. The system structure

This system integrates the AI and the IOT technology, using an intelligent robot car or six-foot crawling robot implementation according to the greenhouse crop planting density to collect related data and photos and transmitting them to the cloud computing platform for data analysis using 4G or 5G wireless network. Compared with the information in the database, the alarm device is triggered when the threshold is reached. Then the alarm information will be a push to smartphones, enable farmers to various state real-time monitoring in agricultural greenhouse crops, according to early warning information to realize the remote control, achieving scientific planting, increase production, increase income.

This system makes full use of IOT technology and AI technology. Cloud computing and mobile Internet and other related technologies are used too. Through all kinds of sensors and dynamic video inspection devices to collect information that is relevant to affect crop growth using a 4G or 5G wireless network to transmit information to the web platform of cloud computing, and the information will be pushed to the application equipment after processing. Then intelligent identification will be realized to achieve the result of intelligent early warning and remote control, and modern management for the agricultural greenhouse will be realized. Compared with traditional agriculture, which mainly relies on natural resources and human resources, intelligent greenhouses can control crop growth more accurately and intelligently, increase production efficiency, and modernize agriculture [3].

This system is a three-layer structure of the information collection perception layer, information transmission network layer, and data computing, processing, and knowledge mining application layer. It consists of intelligent hardware devices, a background cloud, and an Android client. The structure of the intelligent greenhouses early warning and inspection system is shown in Figure 1.
2.1 Hardware devices

The hardware of the system consists of a sensor network, patrol robot, display device, and control device.

The sensor network includes all kinds of sensors, such as temperature, humidity, light, gas, PH value, etc., by which we collect the temperature, humidity, light, PH value, and other data in the greenhouse [4-5].

The inspection robot is composed of an intelligent inspection vehicle and a hexapod robot, which can be used according to the planting density of greenhouses. Both inspection robots are equipped with GPS positioning modules, raspberry PI app development boards, and high-definition cameras that can continuously upload photos of crops along the inspection route and locate coordinates in the greenhouses where they are located. The intelligent inspection car is shown in Figure 2. Hexapod robot is shown in Figure 3.
Dot-matrix LED display and voice speaker can display the temperature, light, PH value of the greenhouse in real-time, and will carry out voice broadcast and warning for parameters exceeding the threshold.

The control device is an android mobile phone, light shade shutter, sprinkler irrigation equipment, supplementary light lamp, humidifier, heater, fan, etc. Through an android mobile phone, the relevant data of the crop growth process can be viewed, and spraying irrigation, drug spraying, shutter, ventilation, and other control can be carried out.

2.2 The background in the cloud

Background IOT management platform uses SpringBoot to build the framework, uses the Vue framework to write front-end interface, uses MySQL to store data, and uses Redis to cache data. Ali Cloud (or Baidu Cloud) is used to store and manage real-time uploaded sensor data. Raspberry PI is used as a gateway to connect data to the system platform. Android APP can monitor and control the intelligent greenhouse application scene in real-time, as shown in Figure 4.

Fig. 4 The background control flow

The raspberry PI gateway is connected to the wireless communication technology. After acquiring the sensor data, the raspberry PI gateway will integrate the data processing and upload the data to the remote IOT management platform through 4G or 5G or Wi-Fi wireless communication. Cloud computing technology realizes data processing, analysis, and storage operations. Users receive warning information through Android phones, view real-time visual data, and control devices in the smart greenhouse, as shown in Figure 5.
2.3 The Android client
The Android client needs to install the mobile APP of IOT control and enter the login interface. Enter the correct user’s name, password, and dynamic verification code, then click "OK" to log into the "Internet of Things Control Platform", view the control scene, obtain real-time data related to the intelligent greenhouse, and receive warning information, and remote control operation, can achieve spray irrigation, drug spraying, curtain, ventilation, and other control.

3. Conclusion
This article embarks from the national rural revitalization strategy layout, to achieve modern agriculture industrialization, informationization, support agricultural production and farmers' income function, information system, combined the technology of three-layer structure of IOT corresponding to various sensors to collect data, the intelligent inspection robot localization, through 4 g or 5 g or Wi-Fi wireless communication network transmission to the cloud platform for data processing, display the related information to application terminal, and early warning and remote controls.

In order to ensure the rate and effectiveness of data and information transmission, the communication architecture adopts direct connection, gateway, and cloud operation mode, which is supplemented by cloud mode. Gateway in the cloud, with the help of Ali cloud platform (or Baidu cloud platform) to provide protocol conversion, data processing, and other cloud services, the cloud control platform can be accessed through the external network, data viewing and analysis of abnormalities, remote control of agricultural equipment in the intelligent greenhouses according to early warning information. Therefore, in modern agricultural production, artificial intelligence
technology, Internet of Things technology, and cloud computing technology are integrated to carry out real-time analysis, processing, and display of perception data, and intelligent decision feedback is made to promote agricultural production increase and benefit improvement and achieve modern agricultural refined management [6-8].

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