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Design of control system in mushroom greenhouse based on embedded platform

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ABSTRACT

This paper focuses on the application of an embedded system based on the structure of ARMv7. A new design of fungi greenhouse control system is proposed based on the cortexA8 platform. In this design, parameters such as temperature, humidity, CO_2 concentration, etc. are collected by the perception layer, transmitted through ZigBee wireless network and then gathered and displayed on a PC and an embedded system development board. Subsequently, these parameters are compared with the database to generate a signal that triggers the devices in the greenhouse to adjust and stabilize the parameters as desired in the aim of controlling the greenhouse.

KEYWORDS

ZigBee; CortexA8; Embedded system; Fungi; Greenhouse.

INTRODUCTION

China is the world's largest edible mushrooms production country. According to statistics, the total area of greenhouse in China accounted for 80% of the world, but most of the edible mushrooms are still produced by traditional working mode, this mode leads to low yield, poor quality, it seriously restricts the transformation of agricultural production to the past by rough precision type[1]. Under the premise of the development of China's rural economic restructuring, the article focused on the problem of management style's extensive, low efficiency, low yields and poor quality, combined with the actual needs of large-scale development and production process of standardization of the edible mushrooms industry, use embedded systems technology and ZigBee wireless network for controlling of mushroom greenhouse, this system can realize the collection, transmission, control, monitoring. This article's design advantage is the use ARMv7 architecture cortexA8 processor, compared to the traditional single-chip, it has the advantage, for example, low power consumption, strong analog video output, strong anti-interference and rich human-machine interface processing systems and so on. In the transmission, as compared to conventional greenhouse monitoring system sensor which uses wired connection, a large number of wires in the greenhouse is very difficult to the agricultural operation, using ZigBee wireless transmission module to help solve the limitations of the cable system, and by establishing nodes, forming a tree node or nodes in a star network, to facilitate the overall display and integrated management on the host computer or gateway.

THE CHARACTERISTICS OF FUNGUS IN GREENHOUSE

Fungus growth cycle is short, growth stage is too many and unlike other greenhouse modern fungus' greenhouse has many different characteristics, different fungus has different environmental parameters, and the same fungus at different growth stages required in not the same, so to ensure normal growth of fungus and achieve high yield quality purposes, it must take appropriate measures, provide suitable growing environment. Part of fungus growth humidity parameters shown in Table 1. Fungus Greenhouse Control System Based on cortexA8 platform, mainly in real-time detection and control for fungus greenhouse environmental parameters, and supporting video surveillance, the purpose is to let fungus growth healthy. The operator can by man-machine interface show, operation of the controller to monitor and manage the growth of the fungus, and establish a database to manage backup, users can set up their own environmental parameters required for each growth stage, independent of each greenhouse environment control, through the Real-time regulation of greenhouse-related equipment, so that reach of greenhouse environmental factor requirements needed for the growth phase of fungus[2].

TABLE 1 fungus growth relative humidity parameter list

Fungi species	mycelium			Fruiting		
	Soil moisture	Air Humidity	Suitable Temperature	Soil Moisture	Air Humidity	Suitable Temperature
Mushroom	55-60	65-75	23-25	60-65	80-90	12-18
Needle mushroom	50-60	60-70	20-23	65-70	85-90	8-14
Agaricus	60-65	60-70	22-24	60-70	80-90	13-17

SYSTEM COMPONENTS

Hardware components of the system were equipped with CC2530 wireless module which carried various sensors and relays, embedded gateway which based cortexA8 platform, PC machines, monitoring equipment and other components. Hardware system provides users with LCD, keyboard and other man-machine interface and camera surveillance, and can also use handheld devices to observe and control greenhouse. By divided the associated growth stage, equipment, operation mode selection, user databases, etc. to achieve detection and control the air temperature, air humidity, soil temperature, soil moisture, such as carbon dioxide and light, through the greenhouse Real-time regulation of related equipment, so that the environmental parameters within the reach of greenhouse environmental factors require different growth stages of the fungus needed[3].

ARM Cortex-A8 processor is a processor suitable for complex applications, support for smart energy management technologies ARM Artisan libraries and advanced leakage control technology, making the Cortex-A8 processor to achieve a remarkable speed and power efficiency. ARM cortex-A8 processor power consumption less than 300mW, able to provide high performance and low power consumption[4].

The main function of the system is achieved real-time monitoring about temperature, soil moisture, light intensity, CO_2 concentration and so on, and compared with environmental parameters settings from database, when the environmental parameters collected exceeded, will set the alarm information to the host and handheld embedded gateway, users can modify the environmental parameters and establish a database according to the data of host and field monitoring equipment, allow users doing spraying, cooling, shading, ventilation and other operations according to their related own experience, can also provide research based to agricultural experts, video surveillance can help staff to remotely manage fungus greenhouse, truly integrated monitoring and control of agricultural greenhouses[5].

SOFTWARE DESIGN

H0 and T0 is used to indicate pre-set data which is the most suitable temperature and humidity, H and T, respectively, are the actual humidity values and temperature values returned by the sensor, by the relationship between the parameters established the parameter equation:

$e'_H=Xe_H+(1-y)e_T$ (1)

$e'_T=(1-X)e_H+Ye_T$ (2)

e_H and e_T represent the error between the current value and the actual detection value. X, Y is decoupled parameters, its role is to digestion coupling. By comparing the input humidity measurement obtained deviation e_H and e_T, By quantifying converted into fuzzy E, fuzzy subset of the table within a certain range, the experimental results corresponding to the error rate of change e_{CH} and e_{CT} quantized into EC, by expert experience and knowledge establish the fuzzy control rule table, through fuzzy inference rules can be derived input-output relationship. Input-output relationship can be drawn through the fuzzy control amount corresponding U. By recycling, get control of the controlled object. Note that when the deviation is large, corresponding to the amount of change should be controlled so that the deviation becomes smaller, when the deviation is small, the system should prevent oscillations and maintain system stability.[6] The fuzzy control system structure as shown in figure 1.

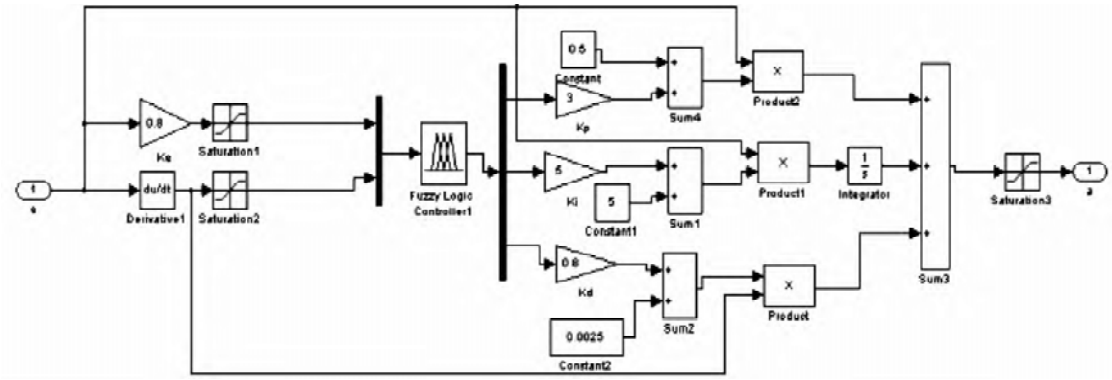

Figure1: Simulink simulation

WinCE6.0 is embedded operating system developed by Microsoft which Supporting a variety of peripherals and network systems. it supports more than 1,000 commonly used Microsoft Win32API and some additional programming interface, To provide users with a comprehensive source code can be used to develop applications. Windows CE development process can be divided into: OAL, drivers, application development. OAL most basic step is to develop board support package (BSP), BootLoader has a crucial role in the development of the BSP. In the driver design provides developers with an API function directly through WinCE hardware interaction can be achieved, DLL interface, which interface driver realized, directly to the kernel, including the serial driver, analog-to-digital converter drives, etc. Applications for access to peripherals directly through API. Communications, the host application is a Windows system service in the form of a service program. Transport nodes and are connected to the upper application service program through the network. Communicate using the service program, communication process of equipment and service program is divided into two stages. The first stage is to communicate with the intermediate service, mainly to establish a connection with inter mediate services and complete identification of the type of device and initialize some communication parameters, the second stage requires the upper layer application, If the upper application to connect to the service, the device begins to communicate with the upper application, at this function is headed services, coordination of communication between the upper application and device, no data processing. After the application is complete, you can also make the device and C / S architecture, desktop application sand Web Service to communicate. The system is designed by modular. There are good operability and extensibility in the system through the corresponding software according function selection[7].

The fungus greenhouse system control interface to provide user the parameters of the real-time temperature parameters. Users can configure the system through time display of the function module parameters, including the parameters of temperature humidity light, etc. Fungus greenhouse control system's Instrumentation dynamic interface, real-time reporting and remote monitoring. The user can grasp the actual production of greenhouse and to provide real-time alarm device control. Signals received from various sensor, users can control the parameters of the controller, establish a data base to facilitate real-time query and history query.

RESULT AND DISSCUSS

The main purpose of the study of this subject is to carry out real-time detection and control of the environmental parameters of greenhouse design a fungus greenhouse controller. We by the division of growth stages, equipment association, select the running mode, the choice of database, realize the detection and control of

the greenhouse air temperature, air humidity, soil temperature and soil moisture. Through the real-time control on the temperature of indoor related equipment, so that the environmental parameters of temperature indoor environmental factors needed to achieve the requirements of each growth stage of mushroom.

CONCLUSIONS

This paper presents a fungus greenhouse control system based cortexA8 platform, usecortexA8 as central controller, use CC5230 wireless module for the front-end sensor nodes, after the field data aggregated and then passed to the embedded controller, while for video monitoring. By greenhouses field experiments, show a systems of high degree of intelligence, simple and intuitive, achieve agricultural automation, centralized management, and established a database which can provide research evidence for the agricultural expert, The system can also be used in other fields, and has broad application prospects

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