Research and Implementation of a Modern Agricultural Greenhouse Cultivation System Based on Internet of Things

Shouying Lin, College of Mechanical and Electronic Engineering, Fujian Agriculture and Forestry University, Fuzhou, China
Shuyuan Li, College of Mechanical and Electronic Engineering, Fujian Agriculture and Forestry University, Fuzhou, China
Qijie Feng, College of Mechanical and Electronic Engineering, Fujian Agriculture and Forestry University, Fuzhou, China
Tengyue Zou, College of Mechanical and Electronic Engineering, Fujian Agriculture and Forestry University, Fuzhou, China

ABSTRACT

With development of internet and information technology, the traditional agricultural production cannot meet people’s demand. The IoT (Internet of Things) technology is now taking this opportunity to modernize agriculture especially the greenhouse planting industry. This paper proposed a novel intelligent greenhouse cultivation system which not only liberate the farmers’ labor force but also break constraints on disastrous weather shock, pest outbreak and other undesirable environment limitations. This system have been put into practice in southeastern China, including four functional parts, which are environmental parameters collection, data transmission, information processing, and data regulation and feedback control. These useful data acquired from IoT sensors were utilized to evaluate plant growth and predict the amount of liquid fertilizer to minimize waste of resources. Besides, a reliable PLC (Programmable Logic Controller) was adopted to enhance resistance to interference. Meanwhile, remote computers were adopted as a monitoring center to guarantee the flexibility of whole control system.

KEYWORDS
Greenhouse, Internet of Things, Plant Cultivation, PLC

1. INTRODUCTION

As the process of industrialization, arable land on the earth is less and less, while the population has increased dramatically. In order to address the basic problem of human survival such as food, clothing and so on, the development of agricultural greenhouse cultivation is imperative (Huang & Tseng, 2005; Foody, 2003; Hang, Yu, & Li, 2010). Agricultural greenhouse is artificially controlled environment for the agricultural production process. With the development of Internet of Things technology, people can make use of computer and mobile phone to measure temperature, humidity, carbon dioxide concentration, light intensity, and other environmental parameters of the greenhouse remotely. In addition, monitor of the growth of plants, pests and diseases based on the captured images information can be helpful for early warning and decision-making. Moreover, greenhouse can also

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be remotely controlled by computers and mobile phones. However, management of the greenhouse is very onerous and complicated, as management and control systems for agricultural greenhouse are not the same in different regions due to the obvious differences in natural and social conditions. For example, in the establishment of greenhouse, insulation measures must be taken into consideration in northern China with the cold weather, while cooling measures must be taken into consideration in southern China with the hot weather.

This paper introduces the establishment of a reliable and intelligent agricultural greenhouse cultivation system under the natural conditions in Pingnan County, Fujian Province, China. Pingnan area lies between 26°44’N and 27°10’N with no cold winter, as the annual average temperature is between 13 °C and 18 °C. Thus, insulation measures can be ignored based on this kind of superior natural conditions. The intelligent greenhouse is about 50 meters long and 25 meters wide. The actual appearance is as shown in Figure 1. It can be seen from Figure 1 that plastic film and steel structure are used in the greenhouse.

2. AGRICULTURAL GREENHOUSE CROPPING SYSTEM DESIGN

2.1. Outline

Greenhouse cultivation system includes the following parts. (1) Information gathering: Air and soil temperature and humidity, carbon dioxide concentration, light intensity, fertilizer conductivity, images and other information in greenhouse are collected by relevant sensors. (2) Signal transmission: Sensors and PLC (Programmable Logic Controller) are communicated with each other through the wireless NRF module (radio frequency module produced by Nordic Semiconductor Inc.). The connection between PLC and touch-screen are established by the Ethernet. Computer communicates with PLC by the switch, while communicating with other computers or cellphones via Internet and etc. (3) Information processing: Intelligent expert system constructed by Intelligence Mode Recognition Algorithms automatically regulates various parameters for the planted crop by self-learning and adaptive system. (4) Information controlling: According to the processing result, the system adjusts the fan, water-screen, sunshade, overshadowing, ventilation, and etc. to regulate the temperature, humidity, carbon dioxide concentration, and light intensity of greenhouse, so that the water fertilization can be optimized and the use of chemical fertilizers can be reduced at the same time. The system structure was shown in Figure 2.

2.2. Information Collection System

Agricultural greenhouse cultivation system is a complicated system. Research and application of agricultural information technology are earlier appeared in Europe and America and other developed
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