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A Framework of the Intelligent Plant Factory System

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Abstract

In this article, we proposed a framework of the intelligent indoor plant factory system. In the proposed system, we will plant with the natural agricultural cultivation, that is, no fertilizers and pesticides in our system. The proposed system includes four modules. They are the setting up system, the collecting data system, the transmitting data system, and the analysis of data systems. We introduce the big data and artificial intelligence technologies to achieve the best plant growth environment.

CCS CONCEPTS

• **Computer systems organization** → Intelligent plant factory system • **Networks** → Wireless sensor networks

Keywords: Intelligent system, ubiquitous computing, plant factory

1. Introduction

Plant factories could be referred to the environment that could be controlled and opened according to the plan and could be the open sites for the plant production throughout the year [1-3]. The successful conditions of the plant's production include the appropriate growth environment controlling and the plant growth stress reducing. In the growth environment controlling, if it needs the shadow effects, the light from the artificial device should be turned down lightly. Similarly, it does the same processes for the temperature and humidity control [4-7].

In this article, we propose a framework of the intelligent indoor plant factory system. The system is based on wireless sensor network [8-14]. In the system, we will plant with the natural agricultural cultivation. There are no fertilizers and pesticides in the system. There are four modules in the proposed system. They are the setup model of the plant factory system, the collecting data model, the transmitting data model, and analyzing the data module.

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Based on these models, the best plant growth environment is described with the big data and artificial intelligence technologies.

The rest of this paper is organized as the follows. In Section 2, we describe the type of plant factory. In Section 3, we propose the framework of intelligent plant factory system. Finally, Section 4 gives the conclusion.

2. The Type of Plant Factory

Plant factories currently can be characterized by three types. One is called as full sunlight, another is called as partial sunlight, and the other is as full artificial light. The former fully utilize sunlight, the last mainly employs the artificial light to cultivate plants. All types of artificial crops and sunshine ones are different. Although these three kinds of crops are planted with the different light resource, the control methods are roughly similar.

The full artificial crops are not weather-oriented, that could be stacked to the upper layers, there a small amount of land area is needed for the mass-produce crops. The environment for the full artificial type crops could be controlled to meet the requirements. Hence, the crops could grow for the purpose, e.g. higher vitamins and other minerals. However, the extra cost, e.g. the electrical energy, is a major disadvantage [15]. So, the major work is to reduce light spending and to improve the efficiency of lighting in the plant factory. Currently, almost plants reduce the emitted heat from lamps with the air conditioning. Comparing with the cost of lighting and cooling, the air conditioning system takes a quiet small amount of electricity. For the cost consideration, the fee of the lighting electricity could be cheaper if it is applied to the economic rate in Taiwan.

The category of plant factory could be classified two types. One type is the outdoor plant factory and the other is the indoor one. The outdoor plant factory is located in an open area. The sunlight or the partial sunlight could be applied to the lighting resource. During the daytime, there is no artificial light needed. However, in the night, the plant factory needs the artificial light. Since the outdoor plant factory does not need the energy for the lighting in the night, it could save the cost of electricity. On the other hand, the indoor plant factory is constructed in a closed space. The weather could not affect the plants in the factory. It could provide a steady growth environment.

Depending on the size, the plant factory could be classified as large plant factory, medium one, and the small one. Generally, the size of outdoor plant factory is large. The medium plant factory has space likes a building. A small plant factory looks like a box.

3. The Framework of Intelligent Plant Factory System

Chou et al. proposed a project to optimize the use of solar energy and the traditional energy to develop an advanced plant factory production system [9]. There are four modules in their system architecture. It includes the short-term vegetable three-dimensional cultivation plant plants, the plant growth monitoring and quality testing system, the wireless sensor network crop growth environment monitoring system, and the Manager monitoring platform and expert knowledge base system as shown in Fig. 1.