Application of Internet of Things Technology in Intelligent Orchard

Zuliang Wang, Hongtao Yu, Chuanglue Cao and Ting Zhang
Xijing University, Xi’an Shaanxi 710123, China
*Corresponding author e-mail: wangzuliang@xijing.edu.cn

Abstract. In this paper, an internet of things (IOT) system of the intelligent agricultural is designed, and the system is described in detail. On this basis, taking kiwifruit orchard as an example, the architecture of the IOT of the intelligent orchard is designed, and the complete elements of each layer are designed in detail. The design scheme and architecture are simple and practical, which can be used as a reference for similar intelligent orchard design. The intelligent IOT system designed according to the scheme of this paper has important reference value for improving the level of orchard informatization, intelligence and standardization.

Keywords: Internet of Things, Intelligent Orchard, Kiwifruit Orchard, IOT Architecture.

1 Introduction
With the development of Internet of things, big data and artificial intelligence as the strategic emerging industries, it is an urgent and worthy measure to promote the application of Internet of things system in intelligent agriculture and intelligent orchard. The intelligent orchard collects and displays all kinds of agricultural information in real time through various sensors and instruments, or links the collected parameters with the control system to realize the automatic control of agricultural facilities such as integrated water and fertilizer system. The sensors used here mainly include temperature sensor, humidity sensor, carbon dioxide sensor, illuminance sensor, pH sensor, weather sensor, etc. These sensor technologies themselves are mature technologies, but how to apply them to the intelligent orchard efficiently still needs to be further studied. Therefore, it is meaningful to design a suitable Inter-net of things systems, according to the needs of the smart orchard, to make it operate effectively and provide real-time data collection for the smart orchard [1-5].

Smart orchard needs to integrate systems such as Internet+, Internet of things and AI. Relying on a variety of intelligent sensor nodes and multi-source heterogeneous communication networks deployed in the orchard site, the goal of planting standardization, management accuracy, decision-making intelligence, sales branding, etc. is achieved.

2 System Design
Take kiwifruit orchard as an example, design the IOT system of intelligent orchard, as shown in Figure 1.

The system is composed with three parts: sensors on the left, system processing platform in the middle and functions realized by the system on the right.
Meteorological sensor is used to collect meteorological data in real time. Meteorological data, including sunshine, temperature, rain and other important data, is an important parameter affecting the growth process of kiwifruit. They play a decisive role in fruit growth, fruit bearing capacity, fruit sweetness and maturity.

![Figure 1. The block diagram of wisdom kiwifruit orchard](image)

Soil data include soil pH value, soil temperature, soil moisture, soil carbon dioxide, soil conductivity and other parameters. It is suitable for most kiwifruit to grow in the soil with pH of 5.5-6.5, containing 0.12% phosphorus pentoxide, 0.86% calcium oxide, 0.75% magnesium oxide and 4.19% iron oxide. It can also grow in neutral (pH7.0) or slightly alkaline (pH7.8) soil, but it often appears yellow phenomenon in seedling stage, and the growth rate is relatively slow.

Agricultural machinery includes water and fertilizer integration, pesticide spreading, automatic picking robot, etc.

Agricultural materials include pesticides, fertilizers, growth regulators, etc. Accurate collection of these information plays an important role in monitoring the rational use of pesticides, fertilizers and regulators. For example, excessive use of plant growth regulator can cause fruits to be harmful to people.

The middle part is the system processing platform, including multi-source information preprocessing subsystem and multi-source information processing platform. The multi-source information preprocessing subsystem deals with the information collected in the first part, such as dimensional unification, spatio-temporal alignment, data filtering, data cleaning, and abnormal data elimination. The multi-source information processing platform uses the new generation of information technology, such as deep learning, big data analysis, artificial intelligence and so on, to conduct deep fusion processing on the data from the front-end, so as to provide users with useful decision-making information [6-10].

The right part is the intelligent application realized by the system, including intelligent monitoring, standardized production, technical consultation, quality traceability, product promotion and other functions.

3 IOT Architecture of intelligent orchard

The architecture of agricultural network applied to smart orchard is shown in Figure 2.
Figure 2. The architecture block diagram of IOT

The data acquisition layer uses kinds of sensors, QR codes, RFID and so on to obtain all kinds of perceptual information and multimedia information. Perceptual information includes kinds of parameter perception, environment perception, position perception and state perception. Among them, the main function of RFID is to obtain the identification of various entities, and then realize intelligent identification, positioning, control and management.

The perceptual network is a bridge to transmit the perceptual information to the bearer network. The most popular networks, such as nb-iot, Lora, ZigBee and WiFi, are used here.

The carrying network transmits the information gathered by the sensing network to the remote server or various cloud platforms. The available carrying networks include next generation networks, collaborative processing networks, mobile networks and the Internet.

Intelligent computing technology includes platform enhancement technology, cloud computing, etc. It is used to provide unified resource services, including policy cloud, market cloud, agricultural cloud, etc., to reduce the cost investment of the application side [10-13].

Services and management layer provide data services, cloud resource services, security management, operation and maintenance management, etc.

The intelligent service layer provides rich application management service functions, such as garden production, facility agriculture, quality and safety, etc. The platform can be used for rapid application design and development, information release, etc.

4 Expert model of Intelligent orchard
After building the Internet of things system, the intelligent orchard needs an expert system to model and analyze the obtained data. The expert system model of intelligent kiwifruit orchard is shown in Figure 3.
Figure 3. Expert system model of intelligent kiwifruit orchard

Kiwifruit expert system includes kiwifruit breeding, seedling, growth process model, disease and pest early warning model, maturity prediction model, yield prediction model, etc. Based on the data of environmental monitoring and recording, we use these models to analyze whether the environment is suitable for kiwifruit growth, disease incidence rate, maturity, expected output and market demand, thus providing valuable guidance for scientific planting of kiwifruit growers. The health index of the monitored agricultural products is calculated by the model, which provides quality reference standards for the base and consumers.

5 Conclusions
This paper presents the design idea and case of intelligent orchard based on the Internet of things. Taking the kiwifruit orchard as an example, the detailed architecture design of the Internet of things is given. Using this design scheme, the intelligent monitoring, intelligent management and intelligent decision-making of orchard can be realized. This paper has an important reference value for improving the level of orchard informatization, intelligence and standardization. The design scheme introduced in this paper has been successfully applied to a kiwifruit orchard, realizing intelligent control and management, saving human cost and improving product popularity [14-16].

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References
[1] Zhang, Fang L . Design of Agricultural Environmental Parameters Monitoring System Based on Internet of Things[J]. Applied Mechanics and Materials, 2014, 608-609:1115-1119.
[2] Li-Li Z , Cheng-Zhong L , University G A . Design of environment monitoring system for vegetable greenhouse based on internet of things[J]. Journal of Gansu Agricultural University, 2014, 49(1):151-155.
[3] Du K , Chu J , Sun, Zhongfu*, et al. Design and implementation of monitoring system for agricultural environment based on WebGIS with Internet of Things[J]. Transactions of the Chinese Society of Agricultural Engineering, 2016.
[4] Xu B , Zheng J , Wang Q . Analysis and Design of Real-Time Micro-Environment Parameter
Monitoring System Based on Internet of Things[C]/ 2016 IEEE International Conference on Internet of Things (iThings) and IEEE Green Computing and Communications (GreenCom) and IEEE Cyber, Physical and Social Computing (CPSCom) and IEEE Smart Data (SmartData). IEEE, 2016.

[5] Jansson A M, Lagergren F. Potential use of seasonal forecasts for operational planning of north European forest management[J]. Agricultural and Forest Meteorology, 2017, 244-245: 122-135.

[6] Shi Guiming,Suo Jidong. Internet of things control mechanism based on controlled object information perception and multimode image signal processing[J]. Journal of Ambient Intelligence and Humanized Computing, 2020,11(2).

[7] Zuliang Wang, Ting Zhang, Linyan Fan, Shiqi Huang, Xuejing Su & Chuangle Cao Dynamic frame-slotted ALOHA anti-collision algorithm in RFID based on non-linear estimation, International Journal of Electronics, 2019,106(11), 1769-1783.

[8] Akash Sinha,Gulshan Shrivastava,Prabhat Kumar. Architecting user-centric internet of things for smart agriculture[J]. Sustainable Computing: Informatics and Systems, 2019,23.

[9] Fenil Dankhara,Kartik Patel,Nishant Doshi. Analysis of robust weed detection techniques based on the Internet of Things (IoT)[J]. Procedia Computer Science, 2019,160.

[10] Cui Xiaojun. Exploration and research of laboratory construction based on Internet of Things in Agriculture[C]. Institute of Management Science and Industrial Engineering,Proceedings of 2019 International Symposium on Agriculture,Food and Biotechnology(ISAFB 2019).Institute of Management Science and Industrial Engineering, 2019:88-92.

[11] Morteza Hadipour,Javad Farrokhi Derakhshandeh,Mohsen Aghazadeh Shiran. An experimental setup of multi-intelligent control system (MICS) of water management using the Internet of Things (IoT)[J]. ISA Transactions, 2019.

[12] Jing Li. A Discussion on the Application of Internet of Things Technology in Intelligent Agriculture[C]. International Information and Engineering Association,Proceedings of 2018, 2nd International Conference on Systems,Computing,and Applications(SYSTCA 2018).International Information and Engineering Association, 2018:278-282.

[13] Yu Li. Concept of an IoT(Internet of Things)-based smart cloud service platform for agriculture[C]. AEIC Academic Exchange Information Centre(China),Proceedings of 2018 4th International Conference on Humanities and Social Science Research(ICHSSR 2018),2018:106-110.

[14] Yong Li.Problems of Application of Internet of Things in Agricultural Infor-mationization andRecommendations for Shandong Province[J].Asian Agricultural Research, 2018, 10(02):51-54.

[15] Miao Zhuang. Research on Intelligent Agriculture Monitoring System Based on Internet of Things[C]. Institute of Management Science and Industrial Engineering,Proceedings of 2018 3rd International Workshop on Materials Engineering and Computer Sciences(IWMECS 2018).Institute of Management Science and Industrial Engineering, 2018:219-222.

[16] Lei Peng. An Analysis on Implementation Plan of Intelligent Agriculture Based on Internet of Things[C]. Singapore Management and Sports Science Institute, Singapore、 Hong Kong Education Society, Hong Kong,Proceedings of 2017 5th International Conference on Social Sciences Research（SSR 2017,2017:16-19.