Agricultural Intelligent Monitoring and Targeted Poverty Alleviation System Based on Internet of Things

Ping Yu, Weihao Du[a,*]

School of Art & Design, Guilin University of Electronic Technology, Guilin, Guangxi, China

[a]2139973632@qq.com

*Corresponding author

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Abstract: Internet of Things (IOT) is an emerging industry with huge potential for development. This paper designs a monitoring and management system based on the ZigBee wireless transmission network and sensor technology on the Internet of Things technology, as well as MySQL database technology. It has the functions of real-time monitoring, threshold value early warning, data analysis and display of soil temperature and humidity information in each period of crop growth cycle in targeted poverty alleviation area. The system can monitor crop soil temperature and humidity data completely and accurately. At the same time, it can be applied to the intelligent monitoring and management of agricultural information in a large area of targeted poverty alleviation at a lower cost. It effectively promotes the agricultural modernization process in this area, and is a sustainable, controllable and intelligent new mode of agricultural poverty alleviation.

1. Introduction

1.1 Research Background of the Paper

As an important parameter of environmental data, air and soil temperature and humidity are indispensable conditions for crop growth [1]. The Internet of things has penetrated into all aspects of human life, including agriculture, at an unprecedented speed [2]. By collecting documents, summarizing and analyzing, the author found that the technology implantation, transformation and contribution rate in poor areas is not high. Most of the farmers in the poor areas tend to rely on their own experiences in roughly grasping the soil temperature and moisture conditions at each stage of crop production. Its accuracy is not high and timeliness cannot be guaranteed, which to a certain extent affects and restricts the high-yield, high-quality and high-efficiency of crop production as the economic foundation and pillar [3].

1.2 Research Status at Home and Abroad

At present, in developed countries such as the United States, the Netherlands, and Japan, agricultural production environment monitoring technology has been widely popularized and applied [4]. Professional system is used to regulate the temperature and humidity of the soil, and according to the growth characteristics of the crops, specific irrigation conditions is formulated to create conditions suitable for the growth of different crops [5, 6].

Domestic research on agricultural production environment monitoring started relatively late, but it has entered a period of rapid development. It has achieved excellent results in data monitoring and wireless transmission technology, crop growth model and other aspects. Software and hardware design is becoming diversified, concise, accurate and intelligent [7, 8].

1.3 The Purpose and Significance of this Design

This design combines agricultural Internet of Things technology, sensor technology and database technology to work out a set of systematic solutions with relatively low overall cost and high accuracy

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for targeted poverty alleviation. It improves the implantation of science and technology in poor areas and is a new model of agricultural poverty alleviation, which is very necessary and feasible [9].

2. Integrated System Design

The system architecture is shown in Figure 1. The overall design of the system consists of two parts: The ZigBee wireless sensor network terminal and the agricultural intelligent monitoring and targeted poverty alleviation system. For ease of presentation, the two parts are marked with A and B in the figure.

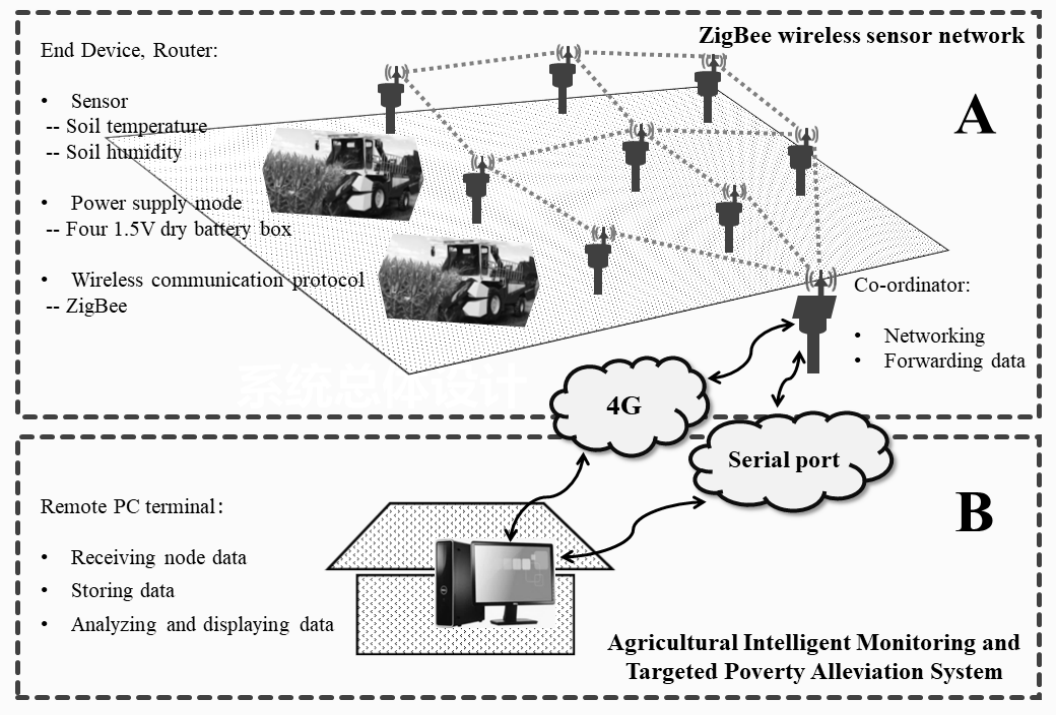

Figure 1 System architecture.

The sensor data collection terminal is composed of digital temperature and humidity sensors. The ZigBee wireless sensor network terminal is composed of end devices, routers and coordinator. The temperature and humidity data collected by the sensors are transmitted to the gateway node through the end device, the router, and the coordinator in turn. The gateway transmits the data to the PC-side agricultural intelligent monitoring and targeted poverty alleviation system through 4G or serial port.

The agricultural intelligent monitoring and targeted poverty alleviation system realizes the management of agricultural information monitoring data, the management and precise guidance and assistance for poor households. The data transmitted by the gateway node will be stored, and through data calling, data processing, data analysis and interface rendering, the environmental information of the farmland soil temperature and humidity in the targeted poverty alleviation area is monitored, managed and visualized [10, 11]. At the same time, the system administrator (poverty alleviation commissioner) can manage the poor households in the region in a unified way, and provide one-to-one guidance and assistance to adjust the farming plan through the background monitoring data.

3. Technical Route

3.1 Hardware Design

3.1.1. End Device Module

The end device module is composed of 4 parts: sensor module, processor module, wireless communication module and power module, as shown in Figure 2.

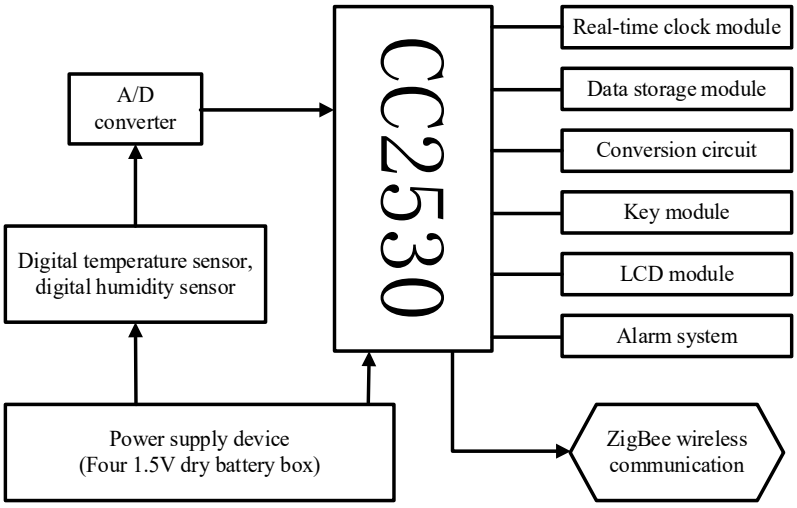

Figure 2 End device module.

The sensor module is responsible for the collection of temperature and humidity information and data processing. The processor module is the core of the end device, which controls and dispatches the sensor module and stores, processes and displays the data sent by the sensor. The wireless communication module is responsible for communicating with other nodes, exchanging information and sending and receiving data. The power module is responsible for providing the end device with the necessary energy for operation, and the power management mechanism extends the service life of the wireless sensor network [12].

3.1.2. Gateway Node Module

The gateway node is the transfer station between the ZigBee wireless sensor network and the remote agricultural intelligent monitoring and targeted poverty alleviation system. Its main work is to process and store the collected soil temperature and humidity data information sent from each end device controlled by the ZigBee network coordinator, as shown in Figure 3.

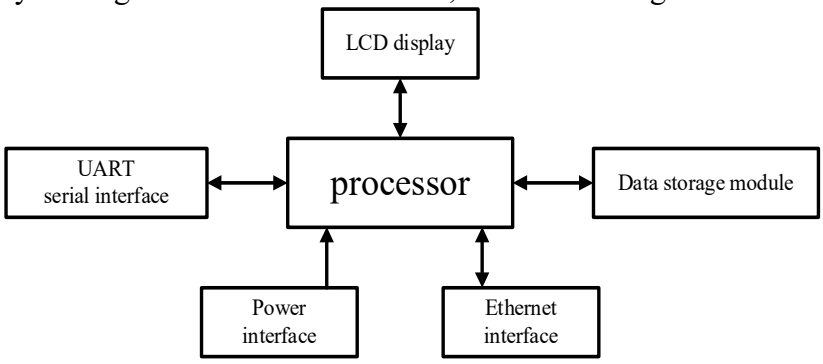

Figure 3 Gateway node module.

3.2 Software Design

3.2.1. ZigBee Network Design

The ZigBee network is divided into three network architectures: star topology, tree topology and mesh topology. Based on the consideration of the actual application site situation and monitoring area of the monitoring system, and the mesh network topology makes the information communication between nodes more stable and efficient. Therefore, the ZigBee mesh network topology is selected in this design to collect and transmit temperature and humidity data of agricultural soil in the targeted poverty alleviation area [13]. The network topology is shown in Figure 4.

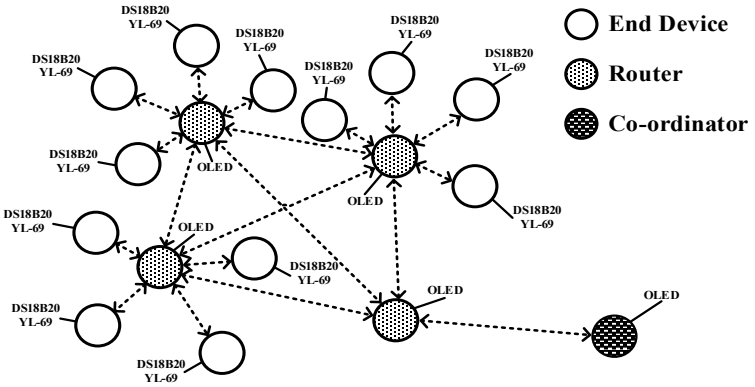

Figure 4 Network topology architecture.

3.2.2. Sensor Node Software Design

The sensor node software design is based on the ZigBee protocol stack (Z-Stack) introduced by TI. The ZigBee protocol stack includes application layer, network layer, media access control layer (MAC) and physical layer (PHY) [14], as shown in Figure 5.

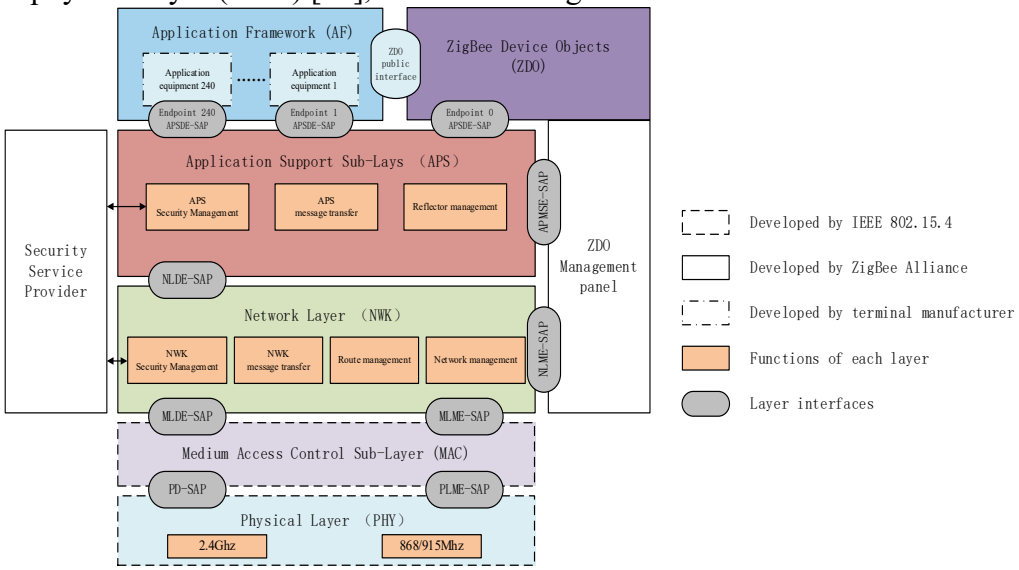

Figure 5 System architecture.

The program flow chart of sensor node is shown in Figure 6.

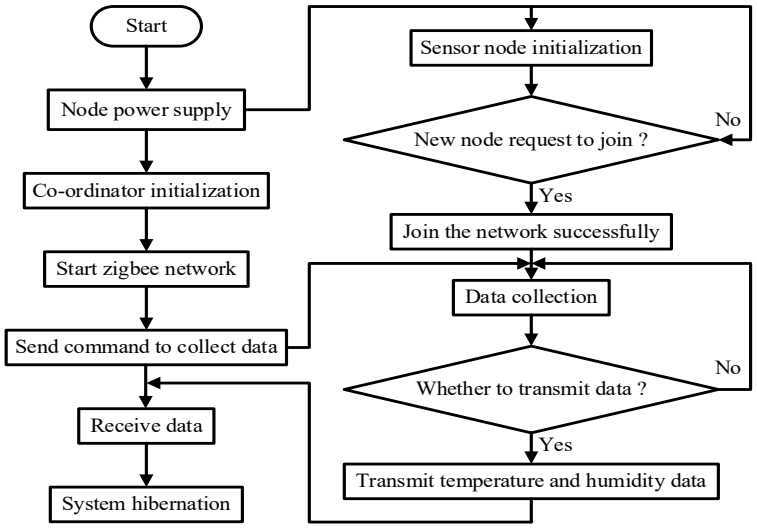

Figure 6 Program flow chart of the sensor node.

3.2.3. Agricultural Intelligent Monitoring and Targeted Poverty Alleviation System Design

The web service background agricultural intelligent monitoring and targeted poverty alleviation system based on Internet is developed by using javal.8 and MySQL database to realize user management, system parameter setting, data analysis and processing, and data presentation. The functional structure diagram of PC-side agricultural intelligent monitoring and targeted poverty alleviation system is shown in Figure 7, and the effect diagram of the PC-side remote monitoring interface is shown in Figure 8.

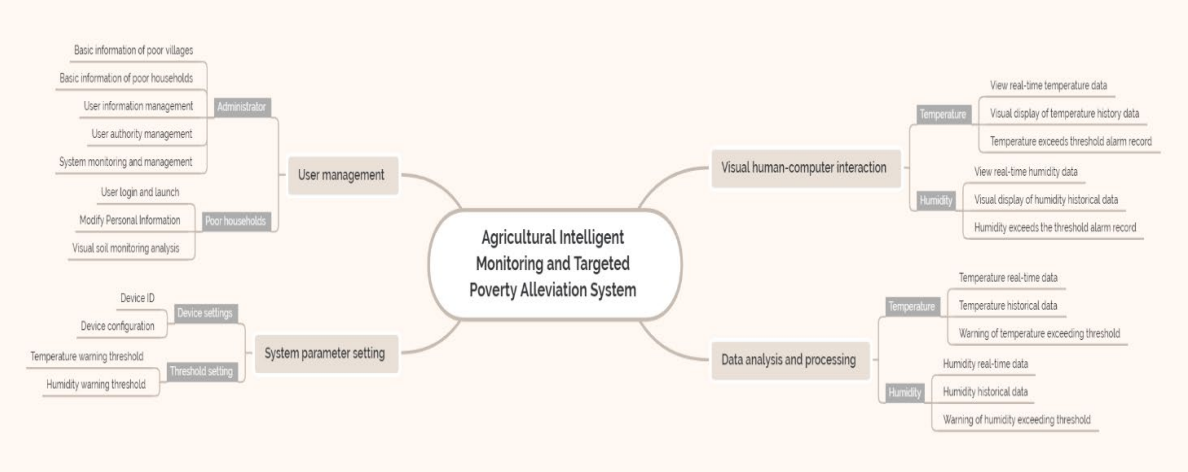

Figure 7 Functional structure diagram of PC-side agricultural intelligent monitoring and targeted poverty alleviation system.

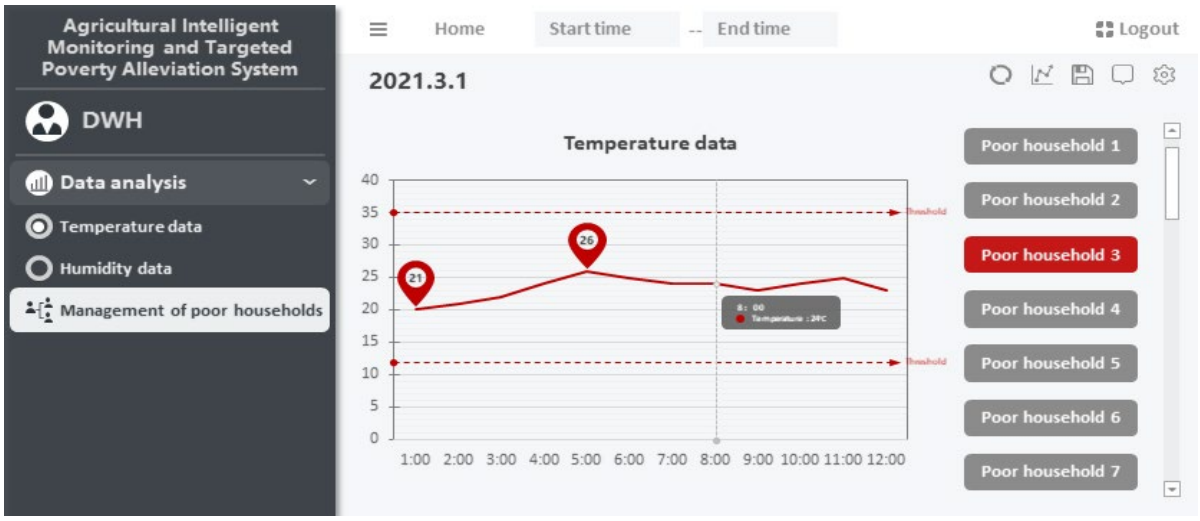

Figure 8 Effect diagram of the PC-side remote monitoring interface (System administrator).

The system administrator (poverty alleviation commissioner) can input the basic information of the poor villages and the poor households. They can also retrieve the information of farmland soil temperature and humidity and the periodic change trend of each poor households' farming area through the background, so as to realize the centralized and unified management of the poor households in the poor area, the accurate individual retrieval of the poor households and the monitoring of the soil temperature and humidity information of the corresponding crop farming area. In addition, timely notification can be made to the poor households based on the data feedback, so as to achieve the role of one-to-one accurate help and guidance. The poor households can check the environmental monitoring information of their own cultivated land by logging in the poor household's terminal, and can intuitively adjust their farming conditions through the system's temperature warning, watering reminder, and the change trend of temperature and humidity, so as to achieve the purpose of increasing production scientifically and increasing income and getting rid of poverty.

4. Conclusion

This design takes the soil temperature and humidity of the crop growth cycle in the targeted poverty alleviation area as the monitoring object, and comprehensively uses the ZigBee wireless transmission network and sensor technology and MySQL database technology on the Internet of things technology which develops rapidly in recent years. It considers the cost of system components, the difficulty of monitoring node wiring, monitoring accuracy, coverage area, and targeted poverty alleviation to work out and develop a set of practical, easy-to-operate, low-cost, efficient and convenient agricultural intelligent monitoring and targeted poverty alleviation systematic solutions. At the same time, the design improves the implantation of science and technology in poor areas, and achieves targeted poverty alleviation through the power of science and technology.

References

[1] Anupama, C.G. and C. Lakshmi, A comprehensive review on the crop prediction algorithms. Materials Today: Proceedings, 2021.

[2] A., A., et al., Internet of Things: A Survey on Enabling Technologies, Protocols, and Applications. IEEE Communications Surveys & Tutorials, 2015. 17(4): p. 2347-2376.

[3] Kumar, G.R., et al., Smart agriculture – Urgent need of the day in developing countries. Sustainable Computing: Informatics and Systems, 2021. 30.

[4] Moysiadis, V., et al., Smart Farming in Europe. Computer Science Review, 2021. 39: p. 100345.

[5] Fountas, S., et al., Farm management information systems: Current situation and future perspectives. Computers and Electronics in Agriculture, 2015. 115: p. 40-50.

[6] Braun, A., E. Colangelo and T. Steckel, Farming in the Era of Industrie 4.0. Procedia CIRP, 2018. 72: p. 979-984.

[7] L., Z., et al. Planning and Design of the Plant Growth Model Based on Internet of Things. in 2018 14th International Conference on Computational Intelligence and Security (CIS). 2018.

[8] Z., L. and J. C. Research on Agricultural Panorama Intelligent Monitoring and Early Warning System. in 2019 IEEE 3rd Information Technology, Networking, Electronic and Automation Control Conference (ITNEC). 2019.

[9] Charania, I. and X. Li, Smart farming: Agriculture's shift from a labor intensive to technology native industry. Internet of Things, 2020. 9: p. 100142.

[10] Colezea, M., et al., CLUeFARM: Integrated web-service platform for smart farms. Computers and Electronics in Agriculture, 2018. 154: p. 134-154.

[11] Murtaza, C. and Ç. Ali, Smart agriculture with internet of things in cornfields. Computers and Electrical Engineering, 2021. 90.

[12] W., C., et al. Low power research and design in plant eco-physiological monitoring system based on ZigBee. in 2010 World Automation Congress. 2010.

[13] Sai, Z., et al., Optimized algorithm of sensor node deployment for intelligent agricultural monitoring. Computers and Electronics in Agriculture, 2016. 127: p. 76-86.

[14] M., R.P., et al., Standardized Protocol Stack for the Internet of (Important) Things. IEEE Communications Surveys & Tutorials, 2013. 15(3): p. 1389-1406.