ISSN: 2664-9640

# Wearable IoT in smart farm application basing embeded Linux

Xinfeng Chen *, Zicheng Zhang, Yihua Zhu

Wenzhou Polytechnic College, Wenzhou 325000, China

* Corresponding Author

## Abstract

**Smart agriculture are applying wireless communication technology, smart sensor device, big data analysis and precise farming technology to assist agriculture development. This paper present a internet-of-things device which consists of RS485 sensor communication, user interface, remote control and sensor data visualization.**

## Keywords

**Internet of things, Embedded Linux, RS485, wireless communication,remote control.**

## 1. Introduction

In terms of traditional agricultural management, it makes farmers labor-intensive, and cause heavy waste of water resources. Then, due to lack of supervision, relying farmers' experience without any capability of intelligent environment adjustment.

### 1.1. Trends of agriculture IoT

Smart agriculture is to fully apply the achievements of modern information technology, integrate the application of computer technology and network technology, Internet of Things technology, wireless communication technology, and expert wisdom and knowledge, etc., to realize agricultural visual remote diagnosis, remote control, and disaster warning, and other intelligent management.

### 1.2. Competition of agriculture IoT system

1. Cost reduction

The current cost of purchasing a comprehensive set of agricultural equipment is relatively high, which is unbearable for ordinary farmers. Therefore, to achieve comprehensive smart agriculture, low-cost smart agricultural equipment will become one of the trends in smart agriculture.

2. Simple operation

The fundamental of smart agriculture is to serve agriculture and farmers. Therefore, to make farmers connect with smart agriculture faster, the system must be easy to operate and learn. Customers must know that the current level of education of farmers is generally low-level. Simplifying the operation can assist farmer to be able to operate it proficiently.

3. delay tolerant

Delay of remote control and delay of hardware feedback become a competitive factor for some special requirement of enterprise.

Three main requirement presents future development trend of smart agriculture. Therefore, with the continuous development of modern Internet technology, the low network latency brought by 5G technology, and the popularization of Internet of Things technology in the industrial service, gradually, an evolution of traditional agriculture is coming. The integration of agriculture and IoT technology not only implemented in smart factory or smart home, but also in agriculture.

ISSN: 2664-9640

### 1.3. System architecture of agriculture IoT

The construction of a smart agriculture includes the monitor of temperature, humidity, light, and carbon dioxide concentration in the greenhouse. Change the environment in the greenhouse according to the growing conditions of crops, so that crops can grow in a suitable environment. The precision, sustainability and intelligence take important roles in the agriculture in the future[1]. High precision needs more sensor implemented in the field. Except monitoring environment factors, data processing is vital to get core information. With various external sensors to monitor air temperature, air humidity, wind speed, wind direction, $CO_2$ concentration, pH value, soil temperature, soil moisture, luxury and extra, upload information and store them in real time through Wi-Fi wireless network technology has been widely implemented in industry and smart home. Nevertheless, IoT brings convenience for users to remotely view various information of the target area. Then, collecting digital environment parameters and remote control form a closed loop in entire smart agriculture, which is demonstrated in figure 1.

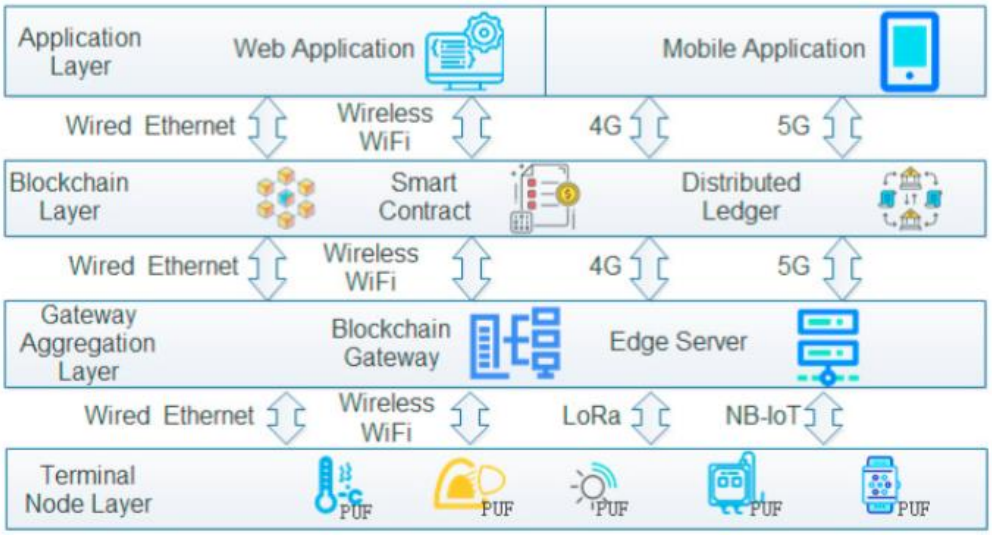


Figure 1: IoT system architecture[2]

## 2. IoT Device Technology

### 2.1. Wireless Communication Technology:

Micropower wireless communication technologies such as Bluetooth, 802.11(Wi-Fi), Zigbee[3], RF (Radio Frequency), Near Field Communication (NFC), etc.

Cellular wireless communication technologies, such as NB-IoT (Narrowband Internet of Things)[4] , GPRS, LTE, etc.

### 2.2. Wired communication technology:

Industrial field bus technology: an industrial data bus, mainly used for field devices such as intelligent instruments and control equipment for digital communication between devices, such as RS485 and CAN bus.

Power line communication technology: a technology for data transmission through power lines, without the need for additional communication lines, such as multiplexing power line communication (PLC-IoT, made by Huawei).

### 2.3. Sensor data collection

Physical property sensors, biosensors and micro electro-mechanical sensors domain the major part of agriculture sensor[5]. In the future, better sensing of process in farming, such as plant

ISSN: 2664-9640

growth, animal behavior, resource utilization will become a competitive factors for environment sensing[6].

### 2.4. Controller selection

Application of IoT agriculture needs a real time controller. PLC[7], single circuit board such as STM32, Arduino with esp8266 module[8], Embedded Linux such as raspberry pi [9].

## 3. Project object

This project is to develop a brand new IOT architecture in agriculture with embedded Linux and wi-fi communication, the construction of this project is illustrated in figure 2.

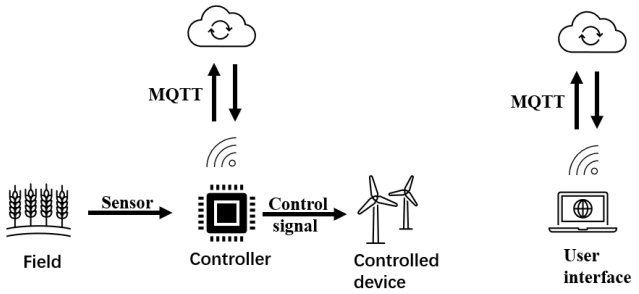


Figure 2. IoT technology implemented diagram

Field data will be collected by sensors through controller, and controller can send message to cloud via MQTT. And users can receive message or send command to cloud to manipulator controller.

## 4. Methodology

### 4.1. Configuration of Embedded Linux

Environment: Raspberry pi 3 NOOBS, linux stretch release, programming language python with version 3.5, code can be accessed in GitHub (under repository /cxf9203/iot).

### 4.2. Cloud

Alibaba cloud become our IoT platform which information will upload and download via MQTT. Alibaba Cloud IoT platform is an all-in-one platform that integrates capabilities of device management, data security communication, and message subscription. It supports connecting a large number of devices, collecting device data and uploading it to the cloud. It provids with cloud API to upload messages. Moreover, the server can send instructions to the device by calling the cloud API to realize remote control.

### 4.3. Sensor

Agricultural sensors mainly include life information sensors and environmental sensors. The life information sensor is to analyze the plant growth status by detecting the content of plant information elements, pesticides, fertilizers and other elements in the process of plant growth, and digitizing the plant growth signs. The signal transmission method of modern sensor equipment is usually serial communication protocol, the RS485 communication is domain in this project. Monitor sensor deployment is showed at below, including soil moisture and temperature sensors, temperature and moisture sensors.

### 4.4. RS485 communication

RS485 is a standard that defines the electrical characteristics of drivers and receivers in balanced digital multipoint systems, defined by the Telecommunications Industry Association and the Electronics Industry Alliance. Digital communication networks using this standard can

efficiently transmit signals over long distances and in environments with high electronic noise. RS-485 makes it possible to connect to local networks and to configure multidrop communication links.

RS485 has two types of wiring: two-wire system and four-wire system. The four-wire system can only realize point-to-point communication. It is rarely used now. The two-wire wiring method is mostly used. Up to 32 nodes can be attached to the same bus.

In the RS485 communication network, the master-slave communication method is generally used, that is, a master with multiple slaves. In many cases, when connecting the RS-485 communication link, the "A" and "B" ends of each interface are simply connected with a pair of twisted pairs, and the connection of the signal ground is ignored.

The core advantage is that the RS485 support multi sensor devices equipped in the same bus. It can resolve the problem of shortage pins of controller. The features includes 1)bidirectional, 2) two lines for receiving and transmitting data, 3) multi nodes work together in the same device. Each nodes receive message from master signal and send back information.

## 4.5. Actuator

Irrigate system and watering system is controlled by electromagnetic valve. Irrigation requires the pipe water under pressure to spray. Usually, the water is sucked, pressurized, transported to the pipelines at all levels and each nozzle by a water pump, and sprayed out through the nozzle. Sprinkler irrigation can use various agricultural pumps, such as centrifugal pumps, submersible pumps, deep well pumps, etc. Electric motors are often used as power generators for water pumps where there is an electric power supply.

Stepper motor control will carried on this project. Stepper motors are DC motors that move in discrete steps. They have multiple coils that are organized in groups called "phases". By energizing each phase in sequence, the motor will rotate, one step at a time.

With a computer controlled stepping, stepper motor can achieve very precise positioning and/or speed control. For this reason, stepper motors are the motor of choice for many precision motion control applications.

In this project, a TB6600 motor driver is implemented. TB6600 is a driver suitable for 57/42 type two-phase hybrid stepping motor with phase current below 40A. It can be set to 7 subdivisions (1/2A/2B/4/8/16 /32) and 8 output currents (0.5A/1.0A/1.5A /2.0A/2.5A/ 2.8A/3.0A/3.5A). Widely used in various small and medium automation equipment and hardware, such as: engraving machine, marking machine, cutting machine, laser imagesetter, plotter, CNC machine tool, crystal grinding machine, automatic assembly equipment, etc.

ventilation system could help greenhouse humidty and temperature keep balance with outside.

## 4.6. Data visualization and remote control

The data visualization is extraordinary important for farmer to acquire plant, environment information directly instead on-site inspection. Furthermore, data process may provide suggestion and accurate strategy for farmer to take effective and necessary action.

This project choose alibaba IoT application development (IOT STUDIO) as a user interface, which is a productivity tool provided by Alibaba Cloud for IoT scenarios and is part of the Alibaba Cloud IoT platform. It can cover the core application scenarios of various IoT industries, help developers efficiently and economically complete IoT data analysis, equipment, service and application development, and accelerate the construction of IoT SAAS.

IoT application development provides a series of convenient IoT development tools such as WEB visualization development, mobile visualization development, business logic development and IoT data analysis to solve the problem of long development links, high degree of customization, and input-output in the field of IoT development. There are problems such as

ISSN: 2664-9640

low ratio, complex technology stack, high collaboration cost, and difficulty in program migration.

# 5. Result

## 5.1. Data visualization and remote control

In figure 3, upload data to Alibaba cloud via MQTT and visualize data in web, which displays important data basing on raw data collection.

Using mobile terminate such as cell phone or computer, project add friendly interface for user to remote control device, which assist people to manage the whole field and reduce human labor.

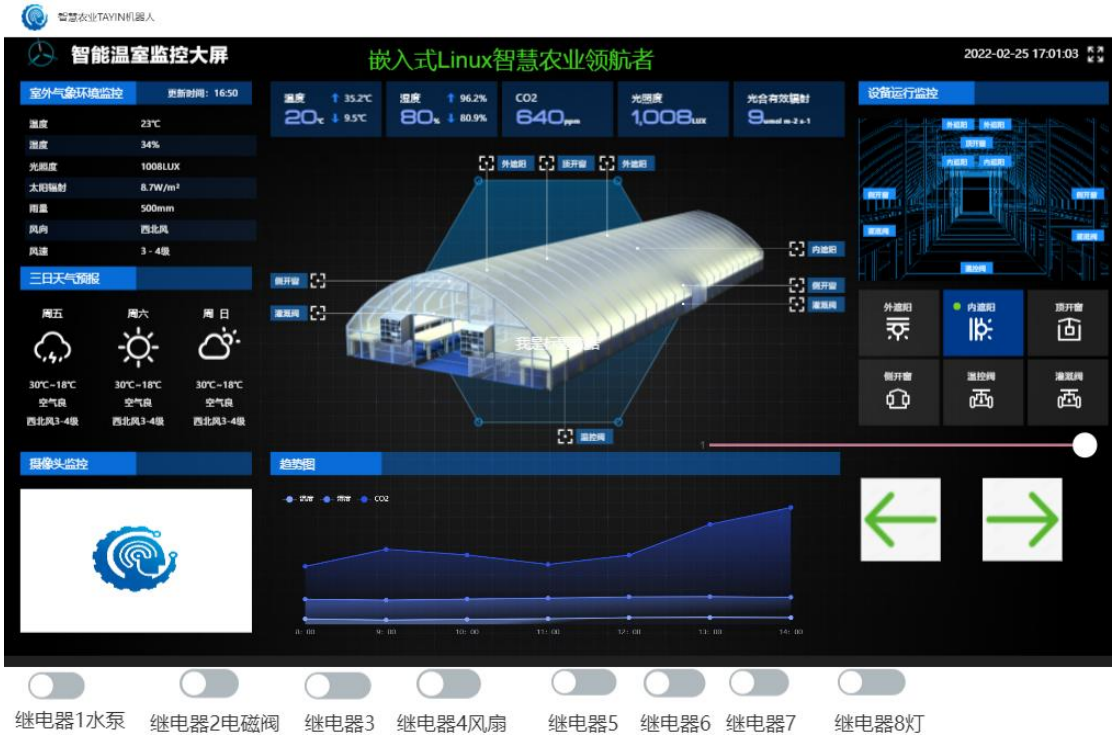


Figure 3 data visualization and remote-control pane

Wherever you are, farmer can browse website sf.cntayin.com to get real data from field and remote control irrigate system and other systems. Now it is open access for anyone.

By clicking button 1 to control relay which leads to control water pump.

By clicking button 2 to control electromagnetic through relay as well.

Control stepper motor via Directional keys and change motion axis by slider.

Get real environment data through sensor and upload data to cloud. People can stay at home or office to analysis data and remote control device instead of on-site inspection and action.

Hardware connection complex, each sensor use RS485 communication with controller, and controller use WLAN or wifi to upload data, which means power line and network construction takes more time in the whole project.

Real time hardware information feedback and real time remote control even farmer locate in far distance or in foreign.

# 6. Conclusion

Implement our internet of things' project could assist farmer to manage wide field, farm, greenhouse, because data is visualized in big screen in office and people can collect important information from data instead of inspection in field to care each crop and livestock.

## Acknowledgements

Wenzhou Polytechnic college school normal project foundation(WZY2021035).

## References

[1] Mengjie Zhang, Xuepei Wang, Huanhuan Feng, Qiuyi Huang, Xinqing Xiao, Xiaoshuan Zhang,Wearable Internet of Things enabled precision livestock farming in smart farms: A review of technical solutions for precise perception, biocompatibility, and sustainability monitoring, Journal of Cleaner Production, Volume 312,2021,127712.

[2] Zhixiang Li, Yunxia Chu, Xuning Liu, Yuekui Zhang, Jiu Feng, Xiaoyang Xiang, Physical Unclonable Function Based Identity Management for IoT with Blockchain, Procedia Computer Science, Volume 198,2022, Pages 454-459.

[3] M.T. Yang, C.C. Chen and Y.L. Kuo, Energ. Build., 60 (3) (2013), pp. 364-371, 10.1016/j. enbuild. 2013.01.034

[4] K.F. Muteba, K Djouani, T. Olwal, 5G NB-IoT: Design, Considerations, Solutions and Challenges, Procedia Computer Science, Volume 198, 2022, Pages 86-93, ISSN 1877-0509,https: //doi.org /10.1016/j.procs.2021.12.214.(https://www.sciencedirect.com/science/article/pii/S1877050921024534).

[5] W.J. You and S.Y. Tang&J. Chin. Agric. Mech., 34 (3) (2013), pp. 233-236, 10.3969/j.issn.2095-5553.2013.03.057.

[6] Cor Verdouw, Harald Sundmaeker, Bedir Tekinerdogan, Davide Conzon, Teodoro Montanaro, Architecture framework of IoT-based food and farm systems: A multiple case study, Computers and Electronics in Agriculture, Volume 165,2019,104939.

[7] Jacob Mellado&Felipe Núñez, Design of an IoT-PLC: A containerized programmable logical controller for the industry 4.0, Journal of Industrial Information Integration, Volume 25, 2022, 100250, ISSN 2452-414X, https://doi.org/10.1016/j.jii.2021.100250.

[8] Yu-Ju Lin, Chih-Fan Tan& Chin-Yin Huang, Integration of Logic Controller with IoT to Form a Manufacturing Edge Computing Environment: A Premise, Procedia Manufacturing, Volume 39, 2019, Pages 398-405, ISSN 2351-9789, https://doi.org/10.1016/j.promfg.2020.01.383.

[9] R. Karunamoorthi, Mohit Tiwari, Tripti Tiwari, Radha Kuruva, Arvind K. Sharma, M. Jemimah Carmichael, T.C. Manjunath, Design and development of IoT based home computerization using Raspberry pi, Materials Today: Proceedings, 2020, ISSN 2214-7853, https://doi.org /10.1016 /j.matpr.2020.10.673.