The Cloud Platform of Maintenance and Supervision of Intelligent Potted Plants Based on Arduino

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Abstract. To study a simple and practical intelligent potted plant maintenance and supervision cloud platform. The Arduino main controller was used as the under computer to connect the input end of the sensors that collected the potted growth environment factor and the output end of the actuators that regulated the potted growth environment factor. The responsive website system designed and developed by Java is deployed on the cloud server as the upper computer, which can communicate with the lower computer anytime and anywhere, receive, analyze, process and store the data uploaded by the lower computer, and finally respond to the corresponding control instructions to the lower computer, so as to control the working state of the lower computer actuator and achieve the effect of intelligent regulation. When the air temperature collected by the lower machine exceeds the range of 20℃ to 30℃, the cooling fan will automatically turn on. When the soil moisture is less than 50%RH to 70%RH, the irrigation pump will automatically irrigate; When the light intensity is greater than 5000LX, the fill light will automatically turn on. Moreover, through the upper computer system, the growth environment factors of potted plants can be observed in real time and manually controlled. This system can be easily supervised and maintained anytime and anywhere by simply deploying and debugging hardware.

Keywords: Smart Pot, Growth Environmental Factors, System Development

1. Introduction
With the increase in the level of urbanization and the improvement of people's quality of life, there is an increasing demand for flowers and green plants, and most of them are provided in the form of potted plants. At present, my country's pot planting and maintenance are basically carried out in traditional ways, relying on manual and traditional experience to carry out watering, fertilization and other maintenance operations on pots. In this regard, many scientific researchers and scholars in my country have conducted research in this area, and added scientific and technological content on the basis of saving manpower. For example, the courtyard automatic watering device designed by Yang Yun realizes automatic alarm and watering based on Arduino, but it cannot be artificially controlled [1]; the smart agricultural greenhouse monitoring system designed by Zhao Yune and others can comprehensively monitor the environmental factors of the greenhouse. At the same time, it can be
controlled by the mobile terminal of the mobile phone [2], but its disadvantage is the data transmission based on GSM.

2. Design Scheme of the System

2.1 System Architecture
The system uses Tencent Cloud Server as the host computer to realize serial port data reception and transmission to the serial port data. In the host computer, the system adopts JavaEE for R&D and design, which realizes the reception, analysis, storage, display and regulation of potted growth environment factor data. The system uses Arduino as the lower computer, which is composed of 5 parts: control module, power module, input module, output module and communication module. The system monitors and collects the growth environment factors of potted plants through sensors, and then sends them to the upper computer system through the WIFI communication module in the form of HTTP. After receiving the data, the upper computer analyzes and responds to the lower computer. After controlling the lower computer to receive the response command, The output module is controlled by the Arduino program to adjust the growth environment factors of potted plants. The system architecture is shown in Figure 1.

![Figure 1. Overall architecture of the system](image)

2.2 System Function Introduction
According to the characteristics of pot planting and maintenance, when building this intelligent maintenance supervision cloud platform, this article mainly considers from the two dimensions of pot planting and maintenance and user experience. The system needs to implement the following functions:

1) Realize the real-time collection, transmission, analysis and processing, storage and feedback control of data of potted growth environment factors (air temperature and humidity, soil humidity, and care intensity).

2) The software system needs to realize data reception, processing, storage and display, and at the same time it must be able to analyze the data and issue instructions.

3) When a certain value of the growth environment factor of the potted plant exceeds the specified threshold, the automatic alarm function will be initiated and self-adjustment will be carried out.

4) The historical data can be viewed in multiple dimensions, and the historical data can be managed at the same time.

3. Hardware Design
The Arduino-based intelligent pot maintenance and supervision system mainly realizes the monitoring and automatic adjustment of the environment including air temperature and humidity, soil humidity and light intensity for the plants growing in the pot. At the same time, in order to achieve a better user experience, this study also The monitoring of water storage depth is added, which can monitor the amount of irrigable water. The hardware schematic diagram of the lower computer is shown in Figure 2.
The system uses the open source hardware Arduino module that has developed rapidly in recent years as the main controller module [3]. After the secondary development of the Arduino, the single-chip computer weakens the basic principle knowledge of the single-chip computer, and the project development and design based on the C language can be carried out through the simple development environment Arduino IDE. This article uses the WeMos D1 motherboard based on the Arduino secondary design, which integrates the ESP8266 chip with WIFI communication function. Since the developed motherboard has only one analog output port, this paper uses a PCF8591AD/DA converter, which can convert the collected digital signals into analog signals [4]. The soil moisture, care intensity, and water storage depth of this paper are the analog value obtained by the converter, compared with the digital signal with only two values, the accuracy of the data has been greatly improved. Because the digital output port is equipped with a PWM function, the actuator only needs to be connected to GND at one end, and the other end is connected to a pin with PWM function to achieve controlled operation.

4. System Design

4.1 Lower Computer System Design
Arduino is the main body of the entire system development in this article, and it is also the main controller of the lower computer. The functions of the lower computer are all dependent on Arduino [5]. The intelligent potted plant maintenance and supervision system needs to realize the collection of data such as air temperature and humidity, soil humidity, light intensity, water storage depth, etc., and can determine the operation to be performed according to different data. In addition, the system also needs to realize that the responsive website deployed on the cloud server can receive and display the data collected by the lower computer, and at the same time can issue an attackable command to the lower computer and manually control the execution module of the lower computer to work. Because
Arduino is single-core and single-threaded, in order to ensure that the system can work in an orderly manner, the system program flow chart designed in this article is shown in Figure 3.

![Flow chart of lower computer system program](image)

**Figure 3.** Flow chart of lower computer system program

The specific working process of the lower computer is as follows: after the first computer system is powered on and started, the initial configuration is performed, which includes the setting of the I/O serial port and the connection of the network[6]. Then, the system starts to collect data, and transmits the collected potted growth environmental factors to the upper computer system deployed on the cloud server through the WIFI network. After receiving the data transmitted by the lower computer, the upper computer system performs corresponding processing and analysis, and then respond to the lower computer control commands to the lower computer. After receiving the data command returned by the host computer in response, the lower computer first analyzes the command, and then controls to start or shut down the corresponding actuator according to different commands. The results of the actuator execution will continue to be uploaded and fed back to the host computer system, and then a new round of data monitoring will begin. If the host computer does not respond to the relevant control commands when uploading the environmental factor data, the lower-level machine will wait for 5 seconds and then monitor the environmental data again, and so on.

4.2 Host Computer System Design

The host computer system is a responsive website system. The back end is mainly implemented through the Java programming language. The JavaEE enterprise version is adopted. The integrated SSM framework (Spring + SpringMVC + MyBatis) is used for rapid development. The front end is through HTML, CSS, JavaScript basic technology and JQuery, Layui and other components were developed to achieve the effect of a simple atmospheric responsive website. Figure 4 is the main system flow chart of the host computer.
5. System Deployment and Testing

Since this system is composed of two major subsystems of the upper computer system and the lower computer system, the deployment of this system mainly has two parts: one is the deployment and debugging of the lower computer system, the main work of this part is to ensure the normal connection of WIFI, Data is collected and sent normally[8]. The debugging is mainly carried out through the serial port, that is, input or output data on the serial port to detect whether the lower computer subsystem is operating normally. The second is the debugging of the host computer subsystem. The deployment of the host computer system needs to install the JDK and MySQL database, and configure the related operating environment, and then test the software through the Postman interface to test whether the data receiving API is normal. Figure 5 is the result of successful operation after system deployment.

Figure 4. Flow chart of upper computer system

The main work flow of the host computer system is: after the system deployment starts, first load the pre-defined lower computer instructions, and then after receiving the data uploaded by the lower computer, analyze, process and judge the data, if the uploaded data exceeds the For the predefined value range, the corresponding lower computer control commands will be obtained and added to the response queue[7]. Finally, after all the uploaded data has been parsed, the system will gather and serialize the commands that need to be returned, and then respond to the lower computer.
6. Conclusion
This article mainly introduces the research of the Arduino-based intelligent pot maintenance and supervision cloud platform, which realizes the monitoring of the growth environment factors of pots based on the Arduino main controller and the data transmission based on WIFI communication. After the upper computer receives the data transmitted by the lower, it can parse, process and store, and respond to the processing result of the response to the lower computer, and the lower computer controls the relevant execution to start or shut down according to the response result of the upper computer[9]. In addition, the host computer system in this article is based on Java design and development of a responsive website deployed on the cloud server, users can view and manually adjust data anytime, anywhere [10-13].

The benefit of the Arduino processor simplifies the design of the hardware circuit, and it is convenient to use modular components to design the hardware system. Through Java programming, you can use the existing programming framework to quickly write efficient websites. Then, there are some deficiencies in this article, such as the verification of the data collected by the sensor, because the soil moisture is only a relative value, and it needs to be verified with professional precision instruments.

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References
[1] Yang Yun. Design of solar garden automatic watering device based on Arduino[J]. Integrated Circuit Application, 2020,37(05):55-57.
[2] Zhao Yun'e, Zhang Fengyan, Wu Yihui. Design of Arduino-based intelligent agricultural greenhouse monitoring system design[J]. Microcontroller and Embedded System Application, 2019,19(04):72-76.
[3] Liu Jin. Intelligent monitoring system for greenhouse[J]. Southern Agricultural Machinery, 2020, 51(06): 28-29.
[4] Jia Xiaobao, Bi Yujie, Yao Weifeng, Tan Lingfeng, Liu Pengcheng. Design of Arduino-based smart home voice control and energy management system [J]. Journal of Shenzhen Vocational and Technical College, 2020, 19(01): 23-28.
[5] Wang Yingying, Xu Yue, Jin Ge, Huang Gangsheng, Liu Yilin. Interactive intelligent pot
design based on Arduino platform [J]. Wireless Internet Technology, 2020, 17(08): 58-59.

[6] Wang Yingying, Xu Yue, Jin Ge, et al. Interactive intelligent pot design based on Arduino platform [J]. Wireless Internet Technology, 2020, 17(08): 58-59.

[7] Jin Yuanshan, Kang Yong, Da Zhiwei, et al. Simple potted automatic water supply device [J]. Technology, 2019, (25): 3. DOI: 10.19392/j.cnki.1671-7341.201925003.

[8] Cao Yating, Wang Bo. Indoor mini-greenhouse pot plant for smart home [J]. Electronic Test, 2019, (13): 37-38, 82. DOI: 10.3969/j.issn.1000-8519.2019.13.013.

[9] Yang Jiyun, Xu Qianhao, Shen Lian, et al. Intelligent flower pot system based on Python and Arduino [J]. Value Engineering, 2019, 38(35): 180-181.

[10] He Jianhua, Wu Yanfeng. Design and development of intelligent environment parameter monitoring system based on Arduino [J]. Information and Computer, 2019, 31(24): 64-65.

[11] Liu Chunlin, Liu Lan, Li Penggang, et al. Greenhouse intelligent control system based on Arduino and Android system [J]. Hubei Agricultural Mechanization, 2019, (17): 124. DOI: 10.3969/j.issn.1009-1440.2019.17.102.

[12] Su Xiang, Hu Jianwei, Cui Yanpeng. An easy-to-deploy dynamic monitoring program for Android applications [J]. Computer Science, 2020, 47(2): 262-268. DOI: 10.11896/jsjkkx.190100117.

[13] https://www.arduino.cn/forum-45-1.html