Design of unmanned plant monitoring system based on cloud platform

LI Tao\textsuperscript{1,a}\textsuperscript{*}, SHA Wen\textsuperscript{2,b}

\textsuperscript{1}School of electrical engineering and automation, Anhui, Hefei, China
\textsuperscript{2}School of electrical engineering and automation, Anhui, Hefei, China
\textsuperscript{a}email:2271986843@qq.com, \textsuperscript{b}email:04069@ahu.edu.cn
\textsuperscript{a}email:04069@ahu.edu.cn

Abstract: Aiming at the phenomenon that people are keen to cultivate green plants in life, but because of busy work and business trips, they forget to water in time and cause plants to die due to lack of water. Based on this, this paper proposes a plant unmanned monitoring system design based on cloud platform. Using STM32 as the main control chip and ESP8266 wireless module as the communication module. Using the Internet of Things cloud service technology to send the data collected in the smart home to the cloud combine various sensors and hardware circuit design to realize remote control of the intelligent watering system. The tested system has stable operation, low design cost, easy expansion of functions, strong real-time effect, high precision and broad application prospects. The system debug results show that the design can meet the unmanned online real-time monitoring of plants and it is suitable for home use.

1. Introduction
With the development and progress of today's science and technology, the quality of our daily living standards has been significantly improved. With the rapid economic development, the pace of life is also accelerating and work and overtime are busy. So many people cannot take care of the plants they maintain in time. The plant will dry up and die if it lacks water. There are roughly two devices to deal with this situation: one is the physical siphon method, which uses the penetration technology for automatic watering and other is used of timer control technology to achieve automatic watering. This watering design method is relatively single and it cannot be watered in real time according to the current growth state, so it often appears too dry or too wet.

In response to this problem, this paper designs an unmanned monitoring system for plants based on a cloud platform \cite{1}. The device collect plant environmental information through sensors and display it on the LCD screen. The STM32 main control processor is used for data processing and analysis. Thus the ESP8266 module communicates with the server and transmits the collected plant environment data to the cloud server of the Internet of Things. The server stores the received plant environment information into the database. The user can view the plant's environmental information and remotely control watering in real time after successfully logging in on the web page, which can not only realize the user's remote control of watering, but also display plant environmental information in real time.

2. The overall framework of the system
This system is mainly composed of sensor module, main control module, display module, ESP8266 wireless transmission and control water pump module \cite{2,3}. The overall block diagram of the system is
shown in Figure 1. The design system uses STM32 single-chip microcomputer as the main control unit. Using sensor modules to collect soil moisture and other parameters. Sending the detected data to the single-chip microcomputer for data processing and then displaying it on the TFTLCD display perform data display on the Internet, so that users can more intuitively observe the real-time data in the home. The ESP8266 wireless module is used to transmit the detected data to the cloud platform and the server side stores the relevant data information in the database[4]. After successfully logging in on the web page, users can view the environmental information of flowers in real time and remotely control watering[5].

3. System design

3.1. Power module

The system uses a 24V lithium battery for power supply, but the ESP8266 wireless module and the LCD display in the system use 3.3 V power supplies. Sensors such as the smallest system of the STM32 single-chip microcomputer and the soil moisture sensor require a 5 V power supply. Therefore, it is necessary to reduce the 24 V power supply voltage to 5 V and 3.3 V in the circuit design. The power module is shown in Figure 2. The front part of the power module adopts a switching power supply with the LM2596S chip as the core, which converts the externally input 24V voltage into a stable 5V voltage. Then it is converted to 3.3V by the SPX3819 chip to supply power to the system. The module design has outstanding advantages such as small size, low power consumption and high operating efficiency.
3.2. Sensor module
The sensor module includes soil humidity, air temperature and humidity sensors. The YL-69 type soil humidity sensor can collect the humidity data of the plant soil. YL-69 is a resistive sensor. Its principle can be regarded as a rheostat whose resistance value changes with humidity. The output voltage of the circuit changes with the change of the resistance value. When the resistance changes, the output voltage of the circuit will also change accordingly.

DHT11 is a composite temperature humidity sensor, which is composed of a temperature and a humidity measuring device. The output waveform is stable and the driving ability is strong. Collecting analog signal can be directly converted into digital signal.

3.3. ESP8266 module
The ESP8266 chip has functions such as serial port and low power consumption. It can connect the user's smart device to the wireless network. Using the TCP/MQTT protocol of the network for wireless network communication and realizing the wireless end networking. The schematic diagram of ESP8266 module design is shown in Figure 3. The network system parameters through the AT command AT+<COMMAND>=<VALUE> of the serial port and support the TCP multiple connection function. The network is divided into three modes: AP, STA and AP+STA. This design adopts the AP+STA mode. This mode not only allows the system to be connected directly through a computer but also through a wireless router, so as to achieve remote control of smart watering.

3.4. Display module
In order to be able to display the detected data value simply and clearly, the TFTLCD module is used for real-time display. The TFTLCD touch display module uses multiple pins to connect to the outside, which has a very good control effect. The schematic diagram is shown in Figure 4. It can realize real-time display of parameter data. The display will update the data every set update time and the user can monitor the relevant changes of the parameters at any time.

![Figure 3 ESP8266 module](image)

![Figure 4 shows the schematic diagram of the module interface](image)
4. System software design
The software design of this system is based on C language as the programming foundation. The main realization includes the design of the main control circuit program, the configuration of ESP8266 and the construction of the cloud platform.

4.1. Main control circuit program
The main program circuit design is shown in Figure 5. After the system successfully initializes the ESP8266, the soil moisture sampling, the air temperature and the humidity sampling modules. It determines whether they have completed the corresponding functions and then it establishes a back-end server. The main control unit analyzes the corresponding collected data to realize the data transmission and the sending and receiving of instructions. By comparing the data analysis with the initial value setting. After receiving the instruction, sending the corresponding instruction. It controls the on-off of the watering execution module by controlling the output level of IO port, so as to achieve the purpose of remote control of watering.

![Figure 5 Block diagram of the main program circuit](image)

4.2. ESP8266 configuration
The ESP8266 distribution network flow diagram is shown in Figure 6. After the system is powered on, the ESP8266 module needs to configure the network. If there is wireless network information, it will connect to the current wireless network and establish a TCP/IP connection server. After the connection is successful, setting will enter the business working subroutine. If the ESP8266 itself does not store the wireless network Information, setting the mode by pressing the button. Then connecting to the network and establishing a TCP/IP connection server and entering the business work subroutine.
4.3. Cloud platform construction
The basic process of cloud platform access is shown in Figure 7. First, open the One-NET website and register to complete the login. Then open the platform enter the management console, create your own products and add your own devices. Setting the device's For related information and modifying the demo code. Then burning it to the development board, performing device binding and debugging for the created product and performing web development. After the background server is successfully connected with the ESP8266 module. It will receive the environmental information from the wireless module at regular intervals and store the information in the database.

5. Results & Discussion
After the software and hardware of the system are designed, the system tested the actual operation effect of each module. The test interface is shown in Figure 8. The information collected by the sensor will display the information collected by the sensor in real time on the LCD screen. After the system is powered on and enter the main interface of the program, the default state is in "automatic mode and
you can switch between "manual" and "automatic" by pressing button K4. In "automatic mode": button K1 can enter the setting of variable thresholds and switch settings. The threshold value of light, temperature, humidity, smoke and ">" point to the threshold value being set. In "manual mode": realize the control of the action through the buttons K1, K2, K3 and the corresponding position of the LCD shows "on" or "Off" state.

When the smoke concentration exceeds the set value, the buzzer will alarm and the alarm status will display "ON". All parameters and thresholds will be compared with data. If any real-time data is in an abnormal state, the real-time data will be displayed as a red reminder. Otherwise it will be displayed normal color.

Figure 8 Main control unit display

After successfully logging in on the web page, enter "My Device". As shown in Figure 9. You can view the real-time environmental information of flowers and the last watering time, historical data, etc.

Figure 9 Web page interface
6. Conclusion
The design of an unmanned plant monitoring system based on cloud platform is designed in this paper. It uses sensors to collect soil moisture, air temperature and humidity information. Using the main control unit STM32 for information processing and analysis. It uses ESP8266 module to establish a connection with the background server to transmit flowers data and background instructions [7,8]. Using Web technology to develop the system web page. Completing the real-time display of plant growth environment information and remote control of watering. After testing, this design can complete the expected work well. The design is stable and reliable. Controlling is simple and convenient. The function is easy to expand and the terminal is convenient to carry. The practicability is strong, which has broad application prospects. In the future smart lifestyle of the Internet of Things, we can increase its development and appropriately change the sensitivity of the system. Adding monitoring modules to supplement the system and meet the future smart life style.

Acknowledgments
This article is one of the phased results of the National Natural Science Foundation of China (61505001)

References:
[1] Gao Wei, Dong Yanchen, Ma Qinglei. Intelligent watering system based on STM32F103C8[J]. China New Technology and New Products, 2018(3): 25-26.
[2] Lin Sen, Wang Guanglong, Qiao Zhongtao, et al. Design of miniature intelligent servo driver based on ARM[J]. Sensors and Microsystems, 2018, 37(09): 101-104.
[3] Su Yang, Yang Zhijun, Ding Yangyang, et al. Analysis of temperature and humidity data acquisition platform based on wireless sensor network[J]. Foreign Electronic Measurement Technology, 2017, 36(8): 51-54.
[4] Chang Xin, Wang Qi. Scalable IoT system implemented with STM32 and ESP8266[J]. Microcontroller and Embedded System Applications, 2018, 18(12): 58-61.
[5] Li Yuxuan, Chen Gang. The design of the IoT intelligent watering system based on single chip microcomputer[J]. Computer Times, 2018(6): 32-34.
[6] Cheng Jie, He Chen. Design and implementation of temperature and humidity detection system based on single-chip microcomputer [J]. Instrumentation Technology, 2011 (6): 56-58.
[7] Li Shuyuan, Feng Qijie, Yu Wenquan, et al. Design of a remote control system for home watering[J]. Journal of Chifeng University, 2016, 32 (11): 21-22
[8] Zhu Shidong, Gao Hongzhao, Yang Yanfen, et al. Design of intelligent watering system based on the Internet of Things[J]. Industry and Technology Forum, 2017, 16 (11): 42-43.