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Design and implementation of orchard irrigation system based on Internet of Things

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ABSTRACT:

Today's water resources have developed into an important scarce resource, the combination of irrigation technol ogy and Internet of Things technology, you can use science and technology to promote agriculture, change the tr aditional operation mode of orchards, fundamentally reduce the input of human and material resources, and impr ove efficiency.

In view of this problem, the design project is based on the orchard design and implementation of the orchard irri gation system, mainly using the 8051 single-chip microcomputer technology to achieve real-time temperature, soil moisture and other data collection and control of the orchard, and display it on the LCD s creen of the lower computer; On the basis of data analysis, the motor can be controlled to pump water and releas e water, and the relevant data information can be displayed on the host computer screen, so that the user can und erstand the basic situation of the orchard through the data indoors. After testing, the system completed the basic functions, which can control, analyze, and display the basic situation of the orchard.

Keywords: 8051microcontroller, Wi-Fi module, sensor technology, host computer display module

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I. INTRODUCTION

Due to the large population of our country, the demand for food is greater, of which the proportion of orchard industry is higher, but compared with developed countries, China's orchard intelligence is low [1], orchard irrigation is too primitive, but also need manpower irrigation. So that China has a large number of labor waste in the traditional farming, and according to statistics China's water for orchard irrigation accounted for up to 80% of the water [2], and the traditional orchard system water use rate is very low, so that a large number of water waste loss, and crop water demand cannot be effectively and timely supplementation, not only affect the yield of crops, but also waste a lot of manpower and material resources [3]. Therefore, the reform of traditional orchards is imminent, and the Internet-based wheat field irrigation system proposed in this paper can effectively solve the low irrigation efficiency, reduce the waste of water resources, and help reform traditional orchards [4].

This paper uses the Internet of Things technology to detect the temperature, soil relative humidity, light intensity, soil nutrients and other physical parameters in the environment through the system temperature sensor, soil moisture sensor, light intensity, soil nutrients and other physical parameters in the environment in a timely and accurate manner and processing [5-8], drawn into a concise statistical chart, clear and concise display to people, set controls in the host computer interface, indoor control implementation, so as to achieve irrigation intelligence, to ensure that crops have a suitable growth environment, It can also achieve the purpose of saving resources [9].

II. OVERALL SYSTEM DESIGN

The system adopts the combination of soft and hard methods as shown in Figure 1, mainly divided into two modules of the upper computer and the lower computer, the lower computer adopts 51 single-chip microcomputer[10] development board, ESP8266WiFi module, LCD1602 liquid crystal display board, and the data acquisition inside the use of light sensors, water level sensors, soil moisture sensors, temperature sensors, and voltage comparator modules plus small motors and pumping systems[11-13], all using serial port communication, The lower computer part can display the collected data on the LCD screen, and people can determine whether they need to pump water by observing the data on the top. The software part is mainly to receive the data transmitted by the next bit machine, process this data and issue commands to the next bit machine [14-16]. The data of the next bit machine should also be specifically presented on the host computer, and these data are adjusted with the changes in the data of the next bit to maintain a certain degree of synchronization. The lower computer has a button that can directly control the pumping and discharging water, and the upper computer also needs to have the control of judging these data and watering and stopping. Finally, the data presentation effect hopes to be in the form of a graph, which can be more convenient and clearer.

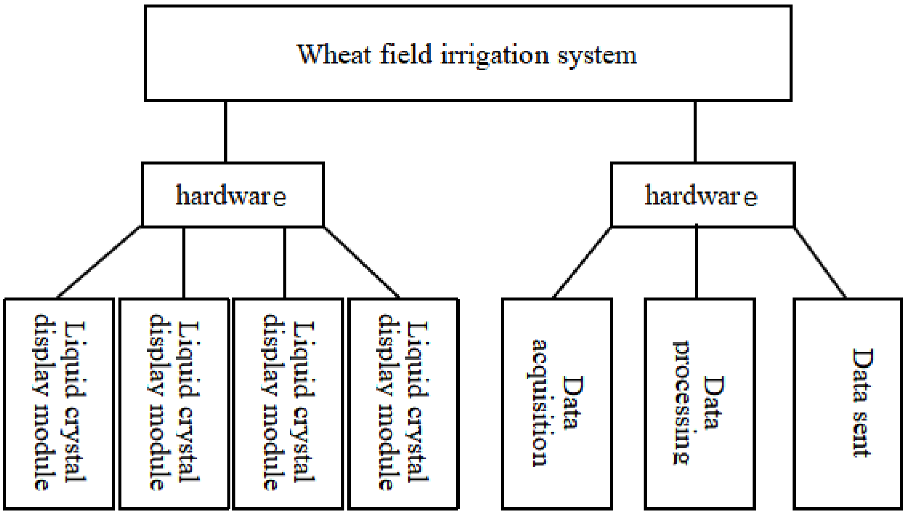

Fig. 1 Structural diagram of the irrigation system of the orchard

III. SYSTEM HARDWARE DESIGN AND IMPLEMENTATION

1 Temperature sensor

The temperature sensor senses the temperature and converts it into a usable signal. Temperature detectors are a central part of temperature measuring instruments and come in a wide variety of types. According to the measurement method, it is divided into 2 categories of contact and non-contact type, and 2 categories of thermal resistance and thermometer according to the characteristics of detector materials and electronic components. The temperature sensor is shown in Figure 2:

Fig. 2 Physical view of the temperature sensor

2 Soil moisture sensor

The moisture sensor is the simplest humidity sensor. There are two main types of moisture sensitive components: resistive and capacitance. Soil moisture sensor Its physical diagram is shown in Figure 3

The characteristic of moisture sensitive resistance is that when the water vapor in the air can be adsorbed on a moisture-sensitive film, the resistance and resistance data of the component changes, and this feature is used to measure humidity.

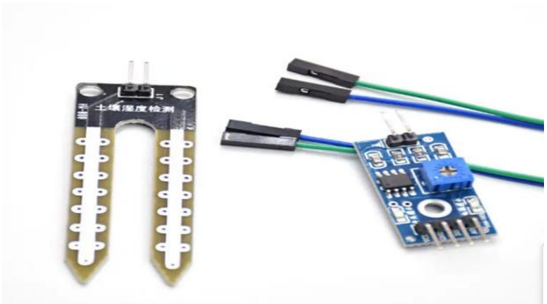

Fig. 3 Physical diagram of the soil moisture sensor

3 Water level sensor

Water level sensor, the water level signal is transmitted to the controller, so the PC in the controller compares the measured water level signal with the set signal to obtain a deviation, so the installed electrical valve is issued with the same "on" and "off" commands as the deviation characteristics to confirm that the instrument has reached the set water level. Its physical image is shown in Figure 4:

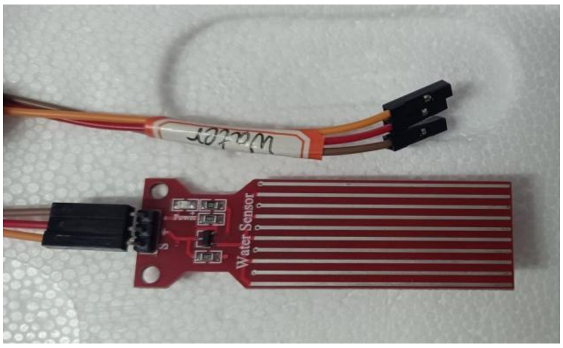

Fig. 4 Physical view of the water level sensor

4 Light sensors

Photosensitive sensor It is a detector device that uses a light-sensitive element to convert a lightweight signal into an electrical signal, which is sensitive to wavelengths close to the wavelength of visible light as well as infrared wavelengths and ultraviolet wavelengths. The light sensor is not limited to detecting sunlight, it can even be used as a sighing component to make an alternative sensor to detect some non-electric, if the non-electrical is reborn as a change within the lightweight signal.
The photosensitive sensor utilized in this case may be a special kind of resistance, manufactured by semiconductor materials such as chemical compound barriers, the rules of which rely on internal photoelectric influences. The stronger the sunlight, the lower the resistance value, and as the strength level rises, the resistance value decreases dramatically, so the bright resistance value is as small as 1KΩ or less. The physical image of the light sensor is shown in Figure 5:

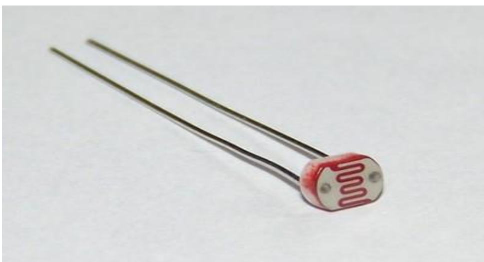

Fig. 5 Photo of photo resistor

5 Wi-Fi module

SP8266 is an ultra-low power UARTLAN pass-through module, with a very competitive package size and ultra-low power technology, designed for mobile devices and Internet of Things applications, can connect the user's physical equipment to Wi-Fi wireless network, ESP8266 is widely used in good power grid, good transportation, good furniture, handheld equipment, industrial management, etc. The antenna will support PCB antennas, IPEX interfaces, and stamp hole interfaces.

The main functions that ESP8266 can do include interface transmission, PWM regulation, and GPIO management.
Serial port transmission: Knowledge transmission.
Smart is responsible for transmission, and the maximum transmission rate is 460800bps.
PWM control: lightweight adjustment, tricolor junction rectifier adjustment, motor speed management, etc.
GPIO management: control switches, relays, etc.
ESP8266 has a rich hardware interface and can support UART, IIC, PWM, GPIO, ADC, etc., suitable for various IOT applications. As shown in Figure 6:

Fig. 6 Esp266 physical diagram

IV. SOFTWARE DESIGN AND IMPLEMENTATION

The overall design code has a total of three classes, namely form loading class Form.cs, data processing class Date-Processing.cs, send data class Send-processing .cs. The host computer is mainly divided into three functions: obtaining data from the cloud platform and sending data to the lower computer, and displaying the data sent by the next computer to the cloud platform on the interface, (1) the data obtained from the cloud platform has temperature, light intensity, soil moisture, water volume, water level and watering times, (2) sending data to the lower computer is to send watering commands and stop watering commands, and (3) the data sent by the next computer to the cloud platform is processed and displayed through certain codes.
1 Host computer total interface design
The controls that need to be shown in the interface design as shown in Figure 7 are:
(1) Two graphs showing light intensity and watering volume (chart control).
(2) Six text boxes displaying the cloud platform data flow module: temperature display text box, light intensity display text box, soil moisture display text box, water quantity display text box, water level display text box, water number display text box.
(3) The soil moisture and watering status display text boxes analyzed by the two systems are displayed.
(4) Watering command send button and stop watering command text box.

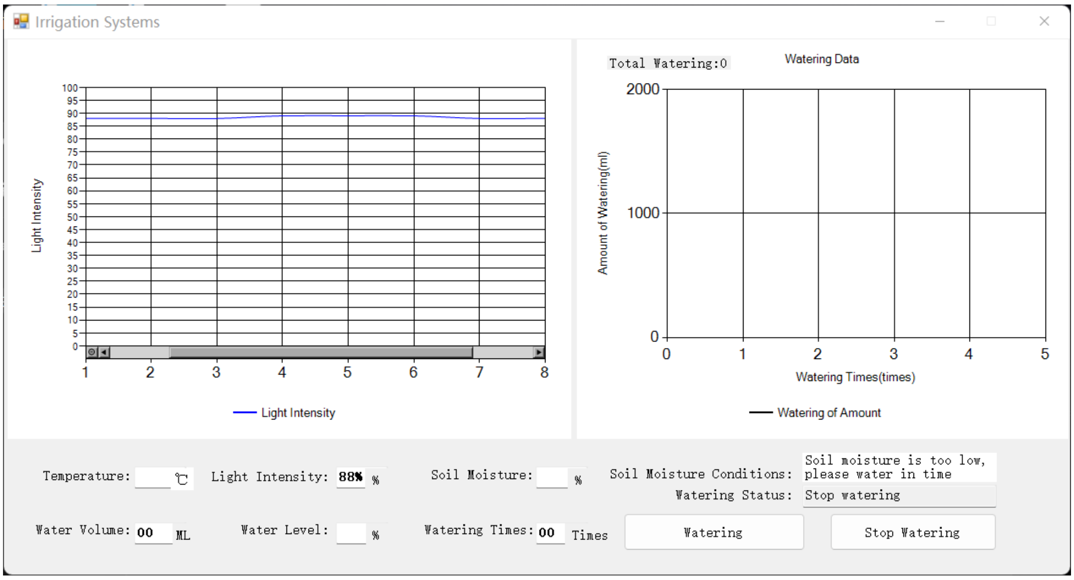

Fig. 7 General interface diagram of the upper computer system

2 Data stream processing such as temperature

(1) The design of each data interface is shown in Figure 8, and this part of the method is wrapped in the Date-Processing class.

(2)

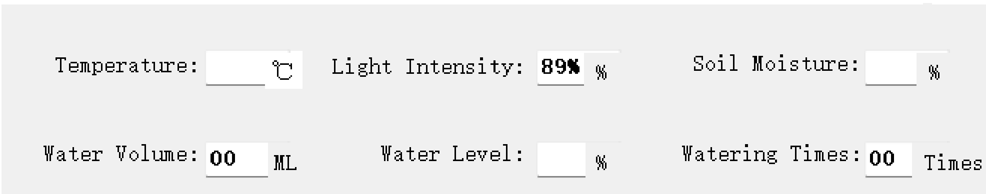

Fig. 8 The interface design shows a diagram

(2) The specific implementation interface diagram of the data flow is shown in Figure 9:

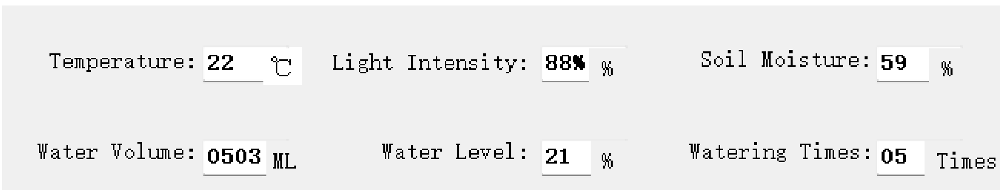

Fig. 9 The data interface shows a diagram

3 Watering status and soil moisture display

(1) The watering status interface design is shown in Figure 10:

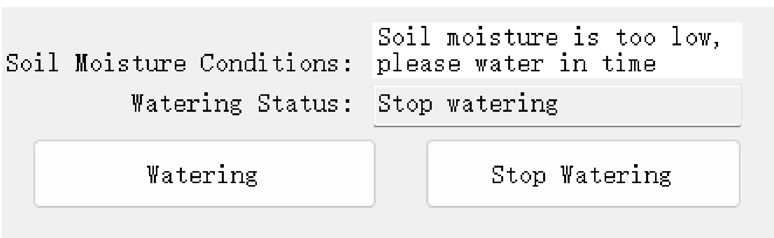

Fig. 10 Watering status interface design display diagram

(2) Algorithmic thinking

This part of the function is done because of obtaining the data flow of the cloud platform and performing data processing. The watering status is achieved by judging the data of the led data flow module of the one-net cloud platform, led=1 is watering, led=0 is watering stop, the same judgment of soil moisture < 50% when the text box displays soil moisture is too low to prompt the user to water in time otherwise the soil moisture is normal.
The algorithm program flowchart is shown in Figure 11:

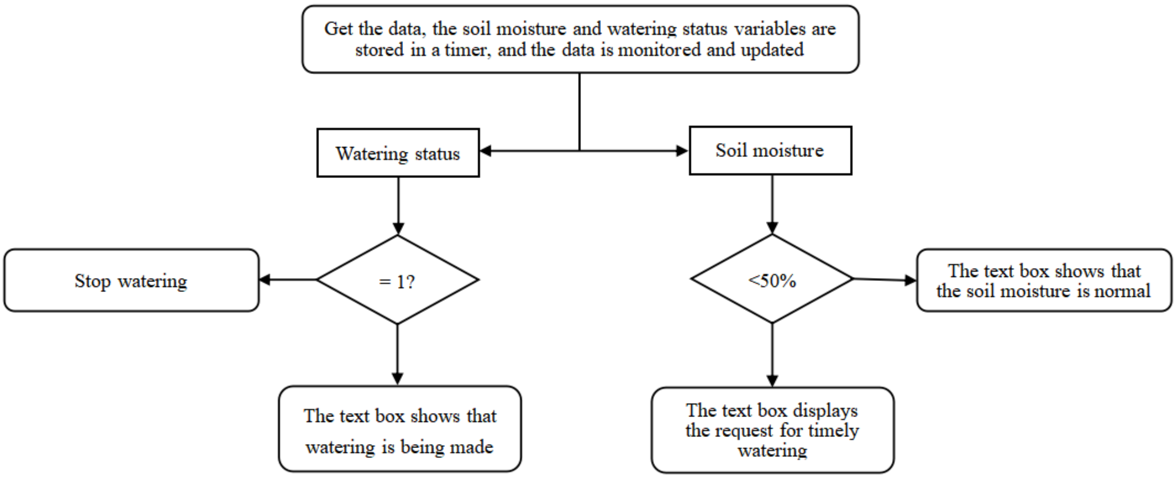

Fig. 11 Algorithm program flowchart

(3) The specific implementation interface diagram is shown in Figure 12:

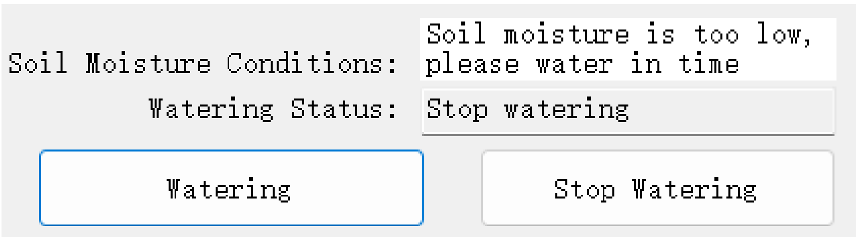

Fig. 12 Boundary map of watering status and soil moisture

4 Water button and Stop watering button
(1) The design of the watering interface is shown in Figure 13:

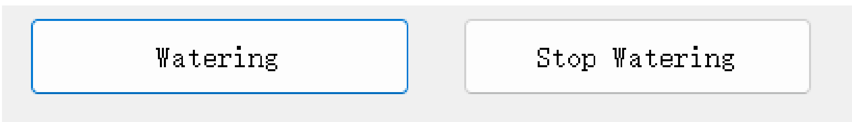

Fig. 13 On-stop watering control button boundary surface

(2) Algorithmic thinking

Through the POST method requested by the HTTP protocol, the post method is invoked to call the one-net platform to send commands to the upper computer to the lower computer, and the lower computer starts to water after receiving the watering command, and the watering stops after receiving the stop watering command.
Its algorithmic program idea flowchart is shown in Figure 14:

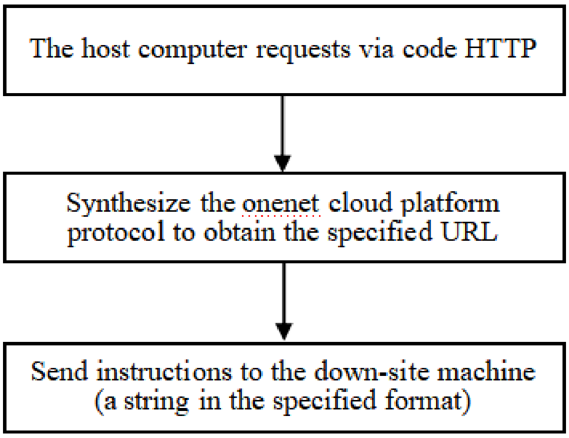

Fig. 14 Algorithmic thought flowchart

(3) The specific implementation interface diagram of the watering control button is shown in Figures 15 and 16:

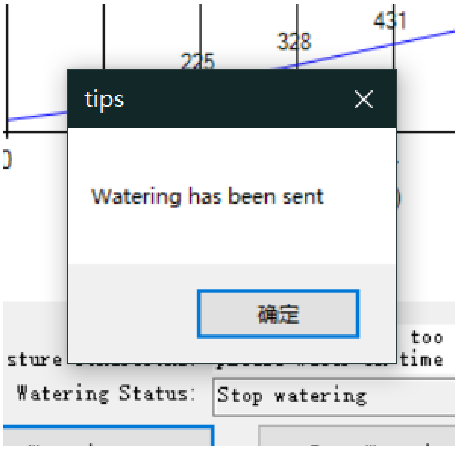

Fig. 15 Stop watering the page

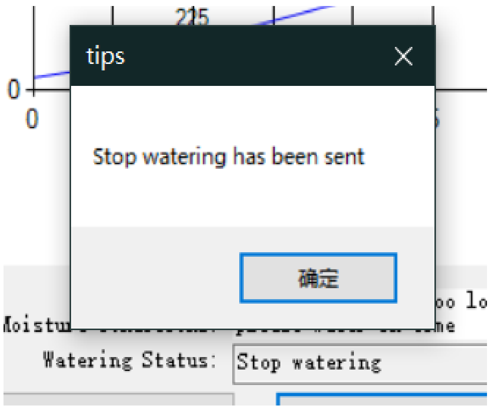

Fig. 16 Start watering the page

V. SYSTEM TESTS AND RESULTS

1 Hardware test

After drawing the schematic on the platform, the steps for physical testing of the hardware are

(1) First correctly connect all modules of the next computer.
(2) Connect the power supply, turn on the switch to observe whether the power lamp is lit, if not lit to check whether there is a connection error in the device; If normal, the LCD screen will prompt that the Wi-Fi is not connected, please follow the prompt to open the mobile phone hot spot for network distribution, and the system will prompt Wi-Fi connect after successful network distribution.
(3) The four data appear on the LCD screen are soil, light, water, and temp, and the initial value is 00.
(4) A sample test can be carried out with a wet wipe, and the observation data changes of temperature, water level and soil moisture can be tested in turn; By covering the light above the photosynthesis with your hand, it is easy to test the change in luminosity.
According to the test, the values of the four data such asil, light, water, and temp can be changed normally on the liquid crystal display, and the liquid crystal display can also display the data stably, and the data can be accurately measured, as shown in Figure 17:

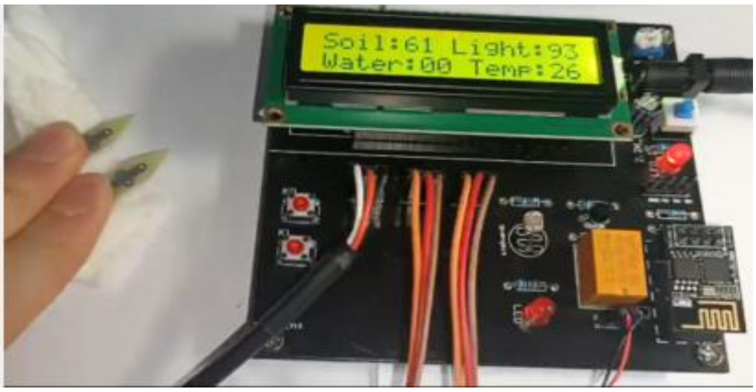

Fig. 17 The next bit computer data display diagram

2 Software Testing

Open your computer to locate the Irrigation Systems folder:
(1) Find the bin file to open the debug file, open the irrigation system application, which presents the light and temperature statistics chart and the watering and watering times statistical chart.
(2) The interface displays the values of temperature, light intensity, soil moisture, water level, water volume and number of watering, and has the current soil moisture situation such as: "Humidity is too low, please water in time" or "Soil moisture is normal" prompt words and "Watering" and "Stop watering" control buttons for watering.
(3) After connecting with the lower computer, the data of the lower computer is received and processed, and the lighting and other elements are drawn into a line chart on the left, and a line chart of the number of watering and watering times; According to the interface prompt information, select watering or stop watering, and observe whether the next computer can execute the instruction normally.
The value of temperature, light intensity, soil moisture, water level, water volume and number of watering times in the upper computer is normal and dynamic, when the humidity is too low, please water in time or the prompt words of normal soil moisture can also be displayed normally and the connection between the "watering" and "stop watering" control button and the lower computer is also used normally, and the light and temperature statistical chart and the watering and watering frequency statistical chart can also be normally changed as shown in Figure 18:

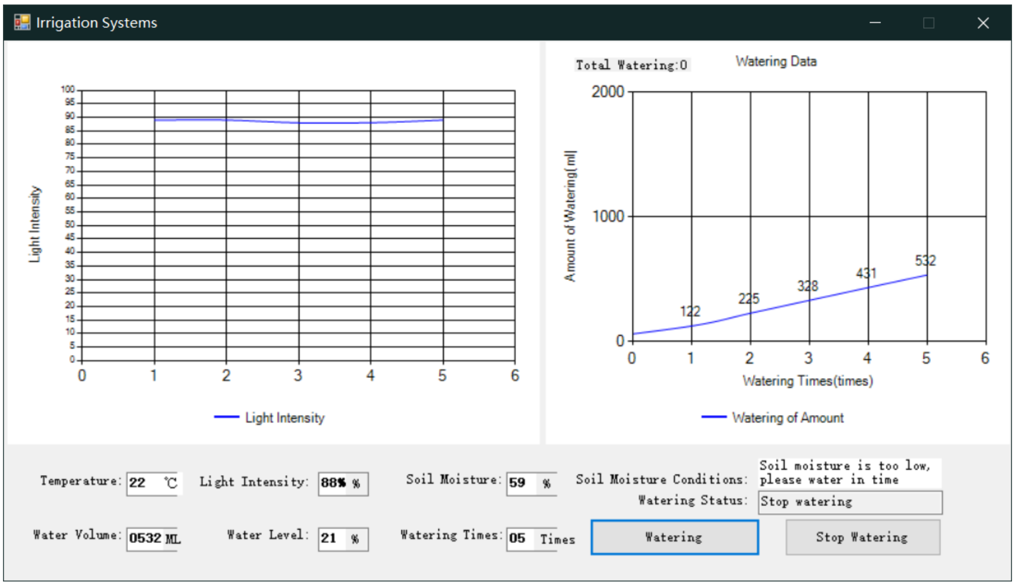

Fig. 18 The host computer data shows a diagram

VI. CONCLUSION

From the system test results, through the temperature sensor and light sensor, the orchard light intensity and temperature change can be sensitively measured, the soil moisture sensing can also transmit the soil moisture change data in real time, and the water level sensor can measure the water level change in the current reservoir. These data can not only be displayed to the liquid crystal display module to show people, if connected to the host computer can also be transmitted to the controller computer in real time, the system after the drawing of the corresponding temperature, light element changes of the line chart, in addition to the water level and the number of watering bar chart, convenient for managers to quickly understand the current information of the orchard. And in the figure, there are relative data values to specifically display, control the operation interface of adding water and stopping water, so that indoor control operation can be realized.

In summary, this paper takes orchard irrigation as an example by using 8051 single-chip microcomputer technology to achieve real-time temperature and humidity harvesting control of orchards, and transmits these data to the host computer and then directly displays them to people by the screen, so that the staff can understand the basic situation of the orchard through data indoors, and then can better cope with the growth status of orchards under different circumstances, improve orchard yields, and reduce resource waste.

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REFRENCES

[1]. Zuozhi Yu, Weifeng Rui, Maohan Ping, et al. [2023]" Design and experiment of a multi-channel mobile orchard irrigation and fertilizer applicator" Agricultural Mechanization Research, Issue 04, pp.95-100.

[2]. Hai Tao, Lu Meng, Zhouwen Jie, et al. [2021]" Research on Precision Irrigation of Orchards Based on LPWAN Internet of Things and Expert System."China Rural Water Conservancy and Hydropower, issue 09, pp.128-133.

[3]. Zengjing Yuan, Hongtian Sheng, et al. [2020]. Development and experimentation of real-time monitoring system for irrigation IOT in orchards. Journal of South China Agricultural University Issue 06: pp.145-153.

[4]. Longxiao Ming., Wangyue Ting, et al. [2018] "LORA communication-based irrigation system for mountain orchards" Water Saving Irrigation, issue12, pp.114-117.

[5]. LIgui Hong, DU Xin, et al. [2019]. "Design and practice of automatic irrigation system for orchards based on negative water head principle." Agricultural Machinery, issue06, pp. 104-106.

[6]. Ding Meiling. [2019]. "Study on the technical model of irrigation and fertilization in mountain orchards." Agriculture and Technology, issue 02, pp. 34-35.

[7]. Cheng Peng. [2021] "Application of efficient water-saving irrigation technology in mountain orchards of Zhuanglang County." Agricultural Science and Technology and Information, issue10, pp. 69-70+74.

[8]. Yang, Ting. [2020]." Exploration and research on irrigation methods of orchards in Zhengning County."Farmers' Counselor, Issue14, pp. 234+240.

[9]. Zhang Jiong. [2020] "Study on the application of micro-wetting irrigation technology in Gan Nan navel orange orchards." Jiangxi Water Conservancy Science and Technology, issue01, pp. 38-42.

[10]. Ouzhi Qiu. [2018]. "A smart orchard irrigation monitoring system based on COAP and MQTT." Electronic Technology and Software Engineering, issue14, pp. 10-12.
[11]. Chenwei Sen, Yu Long & Sundao Zong. [2018]." Design and experimentation of water-saving irrigation control system for orchards" Water Conservation Irrigation, issue01, pp. 73-77.
[12]. Wangjiu Rong. [2022]." Problems of farmland irrigation management and countermeasures" New Agriculture, issue11, pp. 75-76.
[13]. Gaoxue Hua. [2022]." Problems of underground irrigation technology and measures to deal with them. "Agricultural Science and Technology and Information, issue10, pp. 81-83.
[14]. Zhangsheng Hai. [2022]." Analysis of irrigation water demand and water-saving irrigation development ideas." Agricultural Science and Technology and Information, issue08, pp. 90-92.
[15]. Zhengyu E. [2022]." Problems and countermeasures of water irrigation management" Agricultural Science and Technology and Information, issue07, pp. 56-58.
[16]. DuanYun He. [2022]" A brief introduction to low-pressure pipeline irrigation technology for small farmland water conservancy projects" Sichuan Cement, issue04, pp.71-99.