Flower “Dock” - Single Chip Microcomputer-Based Smart Flowerpot

Shengyue Fan¹, Tiantian Wang¹, Bo Wang¹, Yuting Zhang¹, Yao Cai¹ and Baojun Liu¹,*

¹School of electrical and Information Engineering Jilin Agricultural Science and Technology University, Jilin, China

*Corresponding author e-mail: fanshengyue0818@163.com

Abstract. The design of the smart flowerpot is based on STC89C52 single-chip microcomputer, which uses photosensitivity and photoelectricity, that usually used in the environment detection sensor, to perform the real-time monitoring of flower growth, in order to maintain the environmental parameters suitable for flower growth inside the flowerpot, and guarantee a stable and healthy living environment for plants and evaluate the health status. The overall system adopts a modular design, and takes the measurement of soil temperature and humidity sensor module as an example for detailed design. The smart flowerpot has the advantages of simple and stable operation and convenient debugging.

Keywords: Single-Chip Microcomputer, Sensor, Return-Difference Control, Real-Time Monitoring

1. Introduction
In the wake of sustained progress in science and technology, flower gardening technology has stepped into a new epoch. Meanwhile, people are paying closer attention to green and health. Therefore, smart flowerpots have become the "new darlings" under the background of modern sensor technology.

It is a modern plantation management system based on sensory technology and changes of soil moisture. Smart flowerpots not only can maximize the plant survival rate, achieve sustainable development, but also are an effective way to achieve high quality, low energy consumption and environmental protection. Let flowers grow become a part of your leisure and entertainment, it is a good option for home and office decoration. While enriching and decorating people's daily lives, it also gives new choices to those who love flowers but don't have time to take care of flowers.

This system can monitor soil temperature and humidity, automatically water and carry out water storage, and has intelligent control of light. So that the plant will not wither even people are busy, and not at home. Other paragraphs are indented (BodytextIndented style).

2. System Hardware Design
The system hardware design consists of four parts, which are, central control unit, temperature acquisition part, light collection part, and temperature and humidity display. The components required
for the automatic watering system include STC89C52 single-chip microcomputer[1,2,4,5], DS18B20 digital temperature sensor, YL-69 humidity sensor, photo-resistor, AD acquisition chip ADC0832, light emitting diode, LCD1602 liquid crystal display, buzzer, resistor, capacitor, potentiometer, 12M crystal oscillator, potentiometer, water pump, DC fan, etc.

2.1. Central Control Unit - STC89C52 Single Chip Microcomputer

As a CMOS 8-bit microcontroller with low power and high performance, the STC89C52 has an agile 8-bit CPU on the single chip as well as in system programmable flash memory, and it provides many solutions of high flexibility and efficiency for applications of embedded control.

2.2. Temperature and Humidity Collection and Display

Digital temperature chip DS18B20 is utilized for temperature measurement, while the output signal has been completely digitalized, which facilitates the processing and control of individual chips, and eliminates various peripheral circuits in conventional methods of temperature measuring. In addition, the physical and chemical performances of the chip are extremely steady, and it can be applied as a thermometric element in industry. In the range of 0-100 °C, the maximum deviation from linearity is lower than 1 °C. The mentioned DS18B20 uses a unibus for data transfer. The digital temperature signal is directly output by the temperature measuring device of the digital thermometer DS18B20 as well as the microcontroller STC89C52, and it can establish a direct connection with the computer. With this method, the temperature detection system is optimized and reduced in size for the easy installation inside the flowerpot.

The soil moisture sensor (Figure1, Figure 2) module is used to measure the actual humidity of the soil, and the potentiometer is used to adjust the threshold of soil moisture control, thereby achieve a wide range of soil moisture control. The DO output is high when the humidity is below the set point; DO output is low when the humidity is above the set point. [2, 3, 7, 9, 10] The comparator uses LM393 chip with stable operation. The operating voltage ranges from 3.5V to 5V. The module's digital output DO can be linked directly to the microcontroller while the AD value can be used to obtain accurate soil moisture values. The surface of the soil moisture sensor module is nickel plated and has a wide sensing area, which can improve electrical conductivity and prevent rust from contacting the soil. [6, 8]

![Figure 1. The soil moisture sensor](image1)

![Figure 2. Measure the actual humidity of the soil](image2)

3. Design of System Software

This system adopts a rich data structure, the C language program with large-span design and rich operators. It is small, flexible, easy to implement, and easy to transplant and expand.

3.1. Part of the Designed Process

Temperature reading subroutine

text

```c
uint read_temp()
```
uint value;
uchar low;  // If the interrupt occurs too frequent during reading the temperature, the interrupt should be turned off, otherwise it will affect the timing of 18b20.

EA = 0;
Init_18b20 (); // initialize 18b20
Write_18b20 (0xcc); // skip 64-bit ROM
Write_18b20 (0x44); // start a temperature conversion command
Delay_uint(50); //500us

Init_18b20 (); //initialize 18b20

Write_18b20 (0xcc); // skip 64-bit ROM
Write_18b20(0xbe); // Issue the read scratchpad memory command

Low = read_18b20(); //read temperature low byte
Value = read_18b20(); //read temperature high byte
EA = 1;
Value <<= 8; //Shift the high position of the temperature to the left by 8 bits
Value |= low; // put the read temperature into the lower eight bits of value
Value *= 0.0625; //convert to temperature value
Return value; // return the read temperature

4. Design Optimization

4.1. Return-difference Control
When debugging, we add return-difference control. In fact, star the automatically water when it is larger or smaller than expected. Because the sensor is so sensitive that the system will often start the pump autonomously, which will increase the unnecessary energy waste. And this cannot be achieved by any automatic watering systems that consist of other humidity sensors and amplifier circuits on the market. Because the change of soil moisture is very slow, even change cycle is in hours, while the operating cycle of the microcomputer is in u seconds. The energy consumption will be extremely high if it is working constantly, so our intelligent quantifiable automatic watering system works every twelve hours and will go into hibernation for the rest of the time. In this way, the power consumption of the smart flowerpot is controlled at the micro-ampere level, which is an effective way to achieve low consumption and sustainable development of environmental protection.

4.2. Water Level auto Control System of Storage Tank
There is an automatic water level control system in the water tank at the bottom of the flowerpot, which consists of a float, lever, pump and travel switch. Figure 3 is a schematic diagram of the internal circuit of the travel switch.

Solution: as it is shown in Figure 3, when the water storage capacity is saturated, the float floats, and the travel switch (Fig. 5) is disconnected, and the pump will not work. As it is shown in Figure 4, when watering the water level drops, and the float drops to the extreme point, and the travel switch (Fig. 5) closes, thus the pump starts to pump water until the float floats to the position showed in Figure 3 due to buoyancy, which will cause the travel switch (Figure 5) disconnected again and the pump stops working. Repeatedly, it can achieve self-controlled of the water level, under such circumstances it has achieved the long-term work of the smart flowerpot with the stable self-control ability.
Figure 3. Storage tank saturation state

Figure 4. Storage tank unsaturation state

Figure 5. Travel switch.

5. Conclusion
The automatic watering system designed by this uses a temperature and humidity acquisition circuit and a single-chip microcomputer control technology, which forms a soil temperature and humidity collection and control system. And achieved real-time monitoring of flower growth environment parameters with the lowest cost and perform an intelligent management of the parameters while maintain a suitable environment for the growth of the plant inside the flowerpot. After accomplishing the soldering of the hardware circuit and repeated simulation experiments, measurement and analysis, it concludes that the smart flowerpot can effectively detect and control the temperature, humidity, light and other environmental parameters of the flower growth environment.

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