Design and manufacture of watering system based on Bluetooth Technology

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Abstract: This paper mainly designs and develops an intelligent watering control system which uses STC89C51 single chip microcomputer as the main control core. Through the independent research and development of software and hardware, it can detect the soil moisture in the flowerpot in real time and quickly, and also can automatically perform the watering function according to the current soil moisture situation, and can send the detected soil moisture value to the user's mobile phone. Line display mainly depends on the overall frame structure of this design. STC89C51 single-chip microcomputer, LCD1602 liquid crystal display, ADC0832 converter, active buzzer, Bluetooth communication module, soil humidity sensor and relay are built into independent circuit modules to make the minimum system, liquid crystal display circuit, ADC0832 analog to digital conversion circuit, alarm signal generation circuit and Bluetooth wireless communication The signal circuit, soil moisture detection circuit and relay drive circuit realize reasonable connection and data interaction. This design also debugged and operated the intelligent watering system, making the defects and improper design of the system in the normal operation state modified and improved. Finally, it can make the system have high performance index, which is very suitable for popularization, and is conducive to improving the working performance of related products.

Keywords: Intelligent watering system, STC89C51 single chip microcomputer, Bluetooth wireless communication, soil moisture monitoring.

1. Introduction

For the development process of intelligent watering system in the history, we need to start from the early stage of its development. According to the earliest intelligent watering control system recorded on the data, this type of system appeared in the market a long time ago, but it was limited by the development level of science and
electronic technology at that time, making the function and performance of intelligent watering system far less than the market today [1-3]. Therefore, people will soon forget its rudimentary state. In the course of development for many years, it can be clearly found that no matter what the development direction of electronic science and technology is, the research center of the designer is focused on how to improve the general function of the intelligent watering system [3-5]. In the process of reform and replacement, the designer continues to implant the latest technology into the intelligent watering control through code in the system, the intelligent watering system gradually presents a variety of functions and more and more outstanding intelligence. This evolution mainly comes from the user's use requirements, although there is no fundamental change for the application requirements. Nevertheless, people are more and more demanding for the vertical requirements, such as the working accuracy and response speed of the intelligent watering system, the user needs to In order to get a better use experience, technicians must continuously implant the latest hardware equipment and software code, so that the development of intelligent watering system can meet the needs of users. In fact, the so-called intelligent watering control system is an electronic system that can realize the rapid calculation of data, signal data collection and signal output through the high-performance microprocessor in it. Through the rapid response to the massive signal data, it can realize several functions. Many users still retain the deep impression on the traditional intelligent watering system in the future In terms of development trend, which will still make full efforts in its main functions, so as to achieve a higher breakthrough in the effect of intelligent watering system. Meanwhile, in the development process in recent years, the concept of highly intelligent has been richly embedded in the intelligent watering control system, which will still be the core goal of development in the next few years. At present, there are some differences in the key tasks of intelligent watering system research and development at home and abroad. Influenced by a series of events such as trade war, more and more attention is paid to independent intellectual property rights at home. Nowadays, most of the core chips in the intelligent watering control system developed in the mainland still need to be provided by foreign countries. These core devices determine the working performance of the whole intelligent watering control system. And the key to the realization. If there is any problem on these core chips, if they are no longer provided overseas or the capacity is insufficient, it will determine the failure of the research and development of all intelligent watering control systems. Therefore, at present, the state has invested a lot of energy and research and development costs to fully support the chip localization. The same is true for the research of intelligent watering systems in the mainland, because of the lack of intelligent watering The most important part of the flower system is the main control microprocessor chip. In the near
future, it is impossible to develop a high-performance chip with this effect in the mainland. Therefore, it is a long way to go for the intelligent flower watering system to be fully localized.

After the detailed introduction of the development background of this intelligent watering control system in the last part, it can be found that the system is widely distributed in the market at present. Each research and development unit is participating in the design of middle and high level intelligent watering control system, and the establishment of the subject is intended to develop an intelligent watering control system with high performance and low research and development cost, so as to choose Through the combination of STC89C51 single chip microcomputer, LCD1602 LCD screen, ADC0832 sampling chip, active buzzer, Bluetooth module, soil moisture sensor and relay, the data collected in the intelligent watering control system can be displayed to the user with high display effect.

2. Scheme Design and Component Selection

After the establishment of the research and development content of this intelligent watering control system in the previous part, this part will start to research and develop the framework of this system, so as to construct the overall implementation scheme. In the aspect of the main control microprocessor, STC89C51 single chip microcomputer is used, which will realize the control and drive of each functional index. In order to make the realization scheme of this system more concise and clear The function of each circuit is as follows: the key module is mainly composed of mechanical keys, which is used to set the parameters of the humidity measurement system; the alarm module is used to alarm when the humidity parameters are abnormal It is composed of buzzer; display module is used to realize the real-time display of humidity data of humidity control system, mainly composed of LCD1602 LCD; water pump switch is composed of relay and MOSFET, which is used to realize the opening and closing of water pump, so as to realize the watering of flowers; soil humidity detection module is mainly composed of yl-69 sensor, which is used to realize the real-time display of soil humidity parameters Fast detection; the Bluetooth module adopts the hc-05 Bluetooth module, which is used to send the detected soil moisture data to the Bluetooth app of the user's mobile phone for display; the analog-to-digital converter module is mainly composed of ADC0832 chip, which is used to collect the DC analog voltage output by yl-69 soil moisture sensor, convert it into a digital signal, and input it to the MCU for internal processing.

STC89C51 single chip is a kind of microprocessor chip with MCS-51 core as an important part. At present, there are many versions of STC89C51 single chip on the market. The processor with the highest performance has been able to achieve 1t
instruction cycle. Through the careful design of the research and development enterprise, it has formed a variety of classification of different storage scales. The selected one in this design has the storage capacity of 4kbbyte, which is suitable for In this paper, the construction of this small and medium-sized system. STC89C51 single chip microcomputer has a small volume, as shown in the figure below, which can meet the requirements of portable indicators. It is common in some handheld devices. Developers are very fond of using the low-end high cost performance module to build the system. The system implemented by STC89C51 single chip microcomputer often has a particularly high indicator performance.

In this paper, the LCD1602 LCD screen is implanted into the software and hardware of the intelligent watering system. It is easy to build the software and hardware system of this device. In addition, there is an important highlight that the contrast adjustment function of the LCD1602 LCD screen allows users to input different DC voltage, so that it can show different contrast. At the same time, in normal operation, as long as It consumes 0.25W energy of the system and will not cause interference to other circuits in the system. The LCD1602 LCD used in this design has 16 pins, as shown in the figure. The LCD1602 LCD pins selected in this paper are respectively GND, VCC, V0, RS, RW, en, db0 ~ DB7, BL + and BL - of the profile package used in this paper. The user needs to build its drive circuit through the circuit structure provided in the reference materials. General information In this case, as long as some data adjustments are made on the basis of the standard circuit, the interface connection between STC89C51 and STC89C51 is fixed, and the user can realize multi-functional LCD without complex trimming.

In the expected index function of this paper, because it is necessary to realize the function of Bluetooth wireless communication, this paper designs the most commonly used Bluetooth in the market in the early stage of scheme design. After summarizing and summarizing the key parameters provided in the technical specifications of these Bluetooth, we can know that hc-05 is the most appropriate option, which can be used
for 20 yuan The cost of Bluetooth wireless communication is very high. When using hc-05, users need to pay special attention to its power supply requirements. According to the suggestions in the module data, in most STC89C51 single-chip systems, engineers use +5V DC voltage to power it, which is more conducive to the maximum performance of each functional circuit in hc-05. This design will also use this power supply to build hc-05.

Figure 3 physical figure of hc-05 master-slave integrated Bluetooth module
When the ls5v soil moisture sensor is used correctly, the user needs to apply the power through the system voltage within the range of +3.3 to 5V. The main advantage of this device is the rapid detection of soil moisture parameters, and its disadvantages are also quite obvious, such as the need to manually adjust the threshold value. In this design, a soil moisture sensor of ls5v model is used to realize the function of soil moisture detection. Under the flexible drive of STC89C51 single-chip microcomputer, it can orderly perform various functions. It can be known by consulting the data that the main working principle of the device is that a circuit structure is integrated inside the soil moisture sensor to realize the water content detection, The water content can be converted into analog voltage signal for output, which makes STC89C51 single-chip microcomputer realize the detection of water content parameters by collecting the analog voltage signal.

Figure 4 soil moisture detector module
In order to achieve the performance parameters of the A/D conversion part, this paper adopts a kind of ADC0832 A/D converter which is used more frequently in the micro control system, as shown in the appearance of the module in the figure, this ad converter has a very high integration, and the designer has integrated some core functional modules such as voltage and resistance network, acquisition channel management, bus module, power processing and comparator The user only needs some simple configuration to make it work with high performance. At the same time, STC89C51 MCU will drive it through three wire serial interface.
3. **System Hardware Design**

After the last part of the design of this type of intelligent watering control system, the main control position of STC89C51 is established. This chapter will start to configure the minimum system circuit of this microprocessor, which mainly includes STC89C51 chip, reset circuit and clock circuit. Next, the two circuits will be designed. The function of the reset circuit in the minimum system is to make STC89C51 single chip computer have the reset function. This circuit mainly combines the rst pin RST of STC89C51 single chip computer. Through a large number of research on domestic and foreign related literature, it can be known that the pin in high power level can make the code program in flash run stably, and the reset phenomenon will occur immediately when receiving low power level. The circuit structure shown in the figure below is the reset circuit. It can be seen that after 10K ohm resistance and 10uF capacitor are connected in series, a key is connected in parallel at both ends of the capacitor, and VCC is used to supply power to the circuit. When the key is not pressed, the circuit will provide the output high level to the rst pin of STC89C51 single chip computer, and when the user presses the reset key, the output low level will be sent to the rst pin The internal program of STC89C51 is restarted.

![Figure 6 reset circuit design](image)

The function of crystal oscillator circuit in the minimum system of STC89C51 is to form a complete circuit with the high-precision oscillator inside the microprocessor, so as to provide the performance of clock signal for STC89C51. The circuit structure is simple and consists of three devices. This design adopts 12m high-precision crystal oscillator, which connects two 30pf capacitors to both ends of the crystal oscillator and to stc89 xtal1 and xtal2 pins of C51 single chip microcomputer are the circuit principle design of crystal oscillator circuit.
Figure 7 crystal oscillator circuit design

Through the description of the basic parameters of LCD1602 LCD in the previous part, the research and development of the underlying hardware circuit of this device will start here. As shown in the circuit schematic diagram in the figure below, this paper connects the +5V system voltage to pin 2 of LCD1602 LCD to supply power. STC89C51 single chip microcomputer will allocate unused output and input pins to connect RS, RW, en and db0 ~ DB7 pins of LCD1602 liquid crystal screen, so that STC89C51 single chip microcomputer can realize efficient and stable control of LCD1602 liquid crystal screen, and the connection relationship needs to follow the figure. In terms of LCD1602 liquid crystal screen power supply, according to the data recommendations, adopt +5V DC voltage to power this device, pin 3 is the contrast adjusting pin, and the best contrast is achieved by applying +1V voltage. Then RS, RW and en are connected to p2.7-p2.5 of STC89C51, while db0-db7 are connected to P0 port of STC89C51.

Figure 8 schematic design of LCD1602 liquid crystal display circuit

After the last part of the design of the minimum system of this intelligent watering control system, we will start to design the hardware circuit of the active buzzer. As shown in the figure, its two pins correspond to GND and VCC respectively. These pins are divided into two parts: power supply pin and signal control pin. The R & D content of the power pin is relatively simple, because the active buzzer needs to be used in the range of +3.3 to 6V, the reasonable power supply to can share the same power supply...
with other circuit modules in the intelligent watering control system. The main design content is the gate pole of MOS transistor with data pin of active buzzer.

![Figure 9 circuit design of active buzzer](image)

In order to achieve the performance of Bluetooth wireless communication, this paper needs to connect the IO pin of STC89C51 and the signal control pin of hc-05 according to the circuit schematic connection relationship in the figure. The hardware driving circuit between STC89C51 and hc-05 is simple. This paper needs to connect the hc-05 Bluetooth module in two aspects of power supply and data communication pin. Firstly, TXD and RXD pins of hc-05 Bluetooth are used to output the received Bluetooth data, and RXD pins are used to receive the Bluetooth data to be transmitted. In this paper, these two pins are connected to P3.0 and P3.1 pins of STC89C51 single chip microcomputer respectively. Next, the power supply circuit configuration of hc-05 Bluetooth module is used to connect + 5V DC voltage. Connect VCC pin and GND pin of hc-05 Bluetooth to ground.

![Figure 10 Schematic design of HC-05 Bluetooth communication circuit](image)

In order to make ls5v soil moisture sensor realize the performance of soil moisture detection under the control of STC89C51 single-chip microcomputer, it is necessary to connect the IO interface of STC89C51 single-chip microcomputer to ls5v soil moisture sensor according to the hardware drive circuit structure below. The power supply...
circuit structure of soil moisture sensor is relatively simple. This soil moisture sensor module uses a single power supply, only needs to The system power supply voltage +5V can be connected to the VCC pin. Through this voltage power supply, each high-performance detection module inside the soil moisture sensor can realize the accurate detection of the water content in the soil, and the detection results are output with the analog voltage signal, and sent out of the module through its Ao pin. In order to make STC89C51 MCU directly use this water content detection number According to, the analog-to-digital converter circuit is configured to collect and convert the Ao pin output signal through the CH0 sampling channel of the circuit. As shown in the circuit schematic diagram below, first, configure the driving control pin of ADC0832 analog-to-digital converter. According to the connection relationship below, connect the chip selection pin CS of ADC0832 analog-to-digital converter to the p3.5 pin of STC89C51, connect the clock pin CLK to the P3.6, and connect the input and output pin di / do to the P3.7 pin of STC89C51 at the same time. The next step is to configure the power supply pin. The chip needs +5V DC power supply, so connect its VCC pin to the +5V power bus. Through the construction of the circuit topology, the STC89C51 single chip computer will be able to realize the efficient driving control of ADC0832 A/D converter, so that ADC0832 A/D converter can achieve the normal a/D conversion efficiency.

![Figure 11 design of soil moisture collection circuit](image)

According to the reference circuit provided in the reference materials of this type of hk4100f relay, the user needs to connect the two signal pins and the microprocessor chip to realize the data communication between them. As shown in the circuit diagram, the best power supply voltage of the small relay selected in this paper is +5V, which needs to consume 30mA DC current in normal operation. The power of GPIO pin of STC89C51 single-chip microcomputer does not meet the requirements of electrical
parameters. The intelligent watering control system needs to be equipped with relay driving circuit to realize the flexible control of relay circuit. According to the expected functional index of the intelligent watering control system, P1.6 pin of STC89C51 single-chip microcomputer will be allocated to construct the system. After connecting MOSFET and relay according to the circuit structure in the figure, and supplying power through +5V DC voltage, STC89C51 MCU can realize the hardware drive control of the circuit.

![Circuit Diagram](image)

**Figure 12 design of the driving circuit of the waterer**

### 4. System software design

Considering that the intelligent watering control system to be realized in this paper has a high performance index, in order to make the final intelligent watering control system have the highest performance index as possible, this design combines a large number of excellent research and development programs, through the combination of software and hardware design, the design of the software program workflow strictly follows the hardware system foundation, through The method of mutual adjustment of the two levels maximizes the functional indexes. Next, this chapter will start the research and development of the main program and subprogram workflow of this intelligent watering control system. After initialization, the control system will enter into a formal working state. First, yl-69 soil moisture hairpin probe inserted in the deep soil of flowerpot will start to detect the water content in the soil, and the detection result will be output as an analog voltage signal. The voltage value of the signal will be proportional to the soil moisture, and then the analog voltage signal and Digital signal conversion, the processing results will be output with a series of 8 bit serial signals, sent to the STC89C51 single-chip microcomputer, after decoding the serial signals, the single-chip microcomputer will get the actual value of soil moisture, and then compare the value with the normal soil moisture range, if it is lower than the normal range, it means that the soil moisture is too low, so it is necessary to irrigate the soil with flowers.
At this time, P1.6 pin of STC89C51 will output high level to power on the relay to realize the power supply to the water pump. Under the action of the water pump, the system will start to water the soil and increase the soil humidity. At the same time, p2.0 pin of STC89C51 will output high level to turn on the active buzzer and send out the alarm signal of low soil humidity. Then the MCU will send the detected soil moisture data to the hc-05 Bluetooth module through UART serial port, and the Bluetooth app of the user's mobile phone will display the data value. Finally, the LCD1602 LCD will display the soil moisture under the drive of STC89C51 MCU.

5. Summary
The software and hardware system of this intelligent watering control system are realized comprehensively. In order to further verify the design results of this system, the STC89C51 single chip microcomputer minimum system, LCD display circuit, analog-to-digital conversion circuit, active buzzer circuit, hc-05 Bluetooth circuit, soil moisture detection circuit and The relay driving circuit and other parts constitute the overall physical appearance of the intelligent watering control system.

References