Research on Wireless Water Quality Monitoring Method Based on STM32

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Abstract. Since the 21st century, people's production and life have caused water pollution to varying degrees, so real-time monitoring of water quality has become crucial. Based on STM32, this paper proposes a water quality monitoring method that can continuously monitor three water quality parameters: water temperature, PH value, and turbidity. The water quality monitoring method is mainly based on the extended circuit of the STM32 series single-chip microcomputer, including PH sensor control circuit module, temperature sensor circuit module, wireless network communication circuit module, turbidity sensor circuit module, etc. Then based on the C language to write the MCU data acquisition program and the PC program developed on the virtual instrument design language platform, the PC program is mainly composed of the main PC and the MCU communication, data analysis and processing, process monitoring and other subroutines. The water quality monitoring method proposed in this paper can detect different water quality in real time through wireless transmission. This new method is not only suitable for the future development of the current water quality monitoring market, but also has a very promising application prospect.

1. Introduction

With the continuous development of my country's society, economy and culture, water quality safety has involved people's daily life and production activities. Moreover, our country is now in a high-speed stage of overall economic and cultural development. Science and technology continue to develop, and economic culture continues to improve. Therefore, domestic sewage and industrial wastewater caused by economic and social development have also become a thorny issue. Treatment of water pollution, protecting water resources has become very important [1~3]. The STM32-based wireless water quality monitoring system is composed of various sensors and is a multi-hop self-organizing system formed by wireless communication. Its purpose is to cooperatively sense, collect and process the information of the sensing objects in the network coverage area and send it to the observer. "Sensors, perception objects and observers" constitute the three elements of the network. It not only integrates the sensor module, the data processing module and the wireless communication module into a small physical unit, but also can not only perceive the environment information, but also has the functions of data processing and wireless communication. With the help of various types of sensors built into the sensor, it is possible to measure the turbidity, temperature and other factors in the environment. At this stage, the excellent solutions for water quality monitoring and treatment at home and abroad include the joint use of a variety of methods such as water ecological treatment and recycling water and reverse osmosis seawater desalination. The more commonly used method is water ecological treatment. The aquatic ecological treatment project proposed in the literature [6] uses aquatic bioremediation to guide the water environment improvement...
technology to build a healthy aquatic ecosystem, and endow it with the ability and vitality to self-circulate, and achieve endogenous pollution through the conversion and migration of nutrients. The control of external source pollution, thereby establishing a relatively complete and reasonable water ecosystem, is very worthy of promotion, fully conforms to the concept of green environmental protection and sustainable development, and has a profound impact on water pollution control. Literature [7] proposes that water pipes and sewage treatment abroad are mainly used for effective water quality control through the joint use of recycled water and reverse osmosis seawater desalination. Literature [10] also proposed a technology that can effectively treat polluted wastewater. This brand-new technology can effectively evolve wastewater with a pollutant concentration of 300,000 pm, and its actual input cost is less than half of the previous chemical treatment. This new technology is one of the simplest and easy to use sewage treatment methods. Based on this, this article proposes an effective single-chip water quality monitoring method based on wireless communication, using sensor modules to realize the function of water quality monitoring and uploading to the mobile phone APP.

2. Overall scheme design of water quality monitoring method
The hardware of the water quality monitoring system mainly uses STM32 series single-chip microcomputers as the main internal expansion circuit of the system. The specific hardware composition includes PH sensor control circuit module, temperature sensor circuit module and other different components. Moreover, the wireless water quality monitoring system can realize the real-time detection of water temperature, PH value and turbidity. The PH sensor in this system uses the Shanghai Raymag E-201-C electrode to realize real-time monitoring of the pH value in the water. The sensor uses the TSW-30 probe to complete the relevant monitoring of the actual turbidity in the water, and the last temperature sensor is the DS18B20 to realize the detection of the water temperature. Then the wireless water quality monitoring system transmits the data through serial communication with the WiFi module through the minimum system of the single chip microcomputer. The overall design of the system is described in detail below. The system design process is shown in Figure 1. below.
### 3. Hardware design of water quality monitoring system

| Table 1. The main control chip STM32F103C8T6 and the smallest peripheral system |
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| **1. Minimal system** |
| ![Minimal system diagram] |
| **2. Liquid crystal display circuit** |
| ![Liquid crystal display circuit diagram] |
| **3. ESP8266** |
| ![ESP8266 diagram] |
| **4. PH detection circuit** |
| ![PH detection circuit diagram] |
### 3.1. STM32F103C8T6 minimum system design

The minimum system of the single-chip microcomputer is usually composed of crystal oscillator circuit, power circuit, reset circuit and debugging circuit. Below we will give a specific description of the minimum system of the single-chip microcomputer. The minimum system is shown in 1 in Table 1, and the interface circuit between OLED and MCU is shown in 2 in Table 1.

#### 3.1.1. Power Module

The 5V and 3.3V power supplies are used in this system, so the design of the system power supply is a very important module, and the stability of each part of the power supply is related to the performance of the entire system. The realization of 5V power supply can be realized by various kinds of voltage regulator chips, and there are many types of voltage regulator chips to choose from, such as LM2940, LM7805, AMS1117-5V, etc. Considering the performance and price of voltage stabilization, the STM32 main control chip is selected as the 5V voltage stabilizing chip of the system. The wireless module in the system needs a 3.3V power supply. The methods to achieve a stable output of 3.3V power supply mainly include series resistor divider and dedicated voltage regulator chip. Considering from the aspects of voltage regulation performance and price, the main control chip is selected as the 3.3V voltage regulator chip in this system.

#### 3.1.2. Crystal oscillator circuit

We can divide crystal oscillators into two types: active and passive crystal oscillators. The active crystal oscillator is more stable and more expensive than passive crystal oscillators, but it needs to be connected to a power supply. The precision of passive crystal oscillator is basically sufficient, convenient, flexible and cheap. Here we choose the passive crystal oscillator according to the principle of system device selection. The passive crystal oscillator requires an external start-up capacitor and two capacitors to be used in parallel. The size of the capacitor is determined by the crystal used. Generally, 20~22pF is used.

#### 3.1.3. Reset circuit

STM32 has three reset methods: power reset, system reset and backup domain reset. The reset method
selected in this system is power reset. The principle is that when the NRST pin is lowered, an external reset will be generated and a reset pulse will be generated to reset the system.

### 3.1.4 Decoupling capacitor

The function of the decoupling capacitor is to filter congestion and keep the pin voltage stable. When drawing the picture, it should be noted that the capacitor is close to the relevant pins of the chip and distributed around the chip.

### 3.1.5 Debug download circuit

When BOO1=X and BOO0=0 in the MCU system, it is turned on in the user's flash memory, which is a normal state. When BOO1=0, BOO0=1, it will be turned on in the system memory. This is the procedure that the manufacturer completes the setting. When BOO1=1 and BOO0=1, it is turned on in the built-in SRAM, which is a debug mode.

### 3.2 Wireless sending/receiving module

In recent years, wireless technology is developing rapidly, especially popular technologies such as WiFi, Bluetooth, and 5G technology. Since the system needs to monitor water quality parameters and real-time wireless data transmission, the cost-effective and highly integrated WiFi micro-control unit, ESP8266 wireless module, is selected from the aspects of system requirements, ease of implementation and price to further realize data transmission. As shown in 3 in Table 1.

### 3.3 Sensor module

The system needs to monitor the water temperature, pH and turbidity of the water source, and the sensor selection is particularly important. Combined with the actual demand analysis, the PH sensor uses the E-201-C composite electrode, the turbidity sensor uses the turbidity sensor detection module, and the temperature sensor uses the DS18b20 to detect the water temperature. As shown in 4, 5, 6, in Table 1.

### 3.4 Dual-channel analog-to-digital conversion voltage compatible module design

In the design process of electronic products, DIY development, etc., we often use the function of the A/D converter (ADC), and often encounter signal circuits that do not match the sensor output signal level of the control system A/D converter. Ping the problem. For example, the output signal range of some sensors is in the range of 0~5V, and the reference voltage of STM32 series MCU A/D conversion is 3.3V. At this time, the problem of level signal compatible conversion will occur. For this reason, a dual-channel analog-to-digital conversion voltage compatible module is selected. This dual-channel analog-to-digital conversion voltage compatible module can realize linear and proportional conversion of 0~5V voltage signals to 0~3.3V voltage signals. The module is plug-and-play and supports two-way voltage conversion. Connect the circuit to be tested to the output of the module, and the voltage in the range of 0~3.3V can be obtained at the corresponding output. It can be directly connected to the single-chip system for collection. Development brings great convenience. As shown in 7 in Table 1.

### 4. Software design of water quality monitoring system

In the software design, for the purpose of simplifying the plan and clarifying the task. The system software adopts modular design, which not only has good readability, but also is easy to expand and upgrade the system later. In this design, the main design of the program includes: AD conversion module and its wireless data sending/receiving module and other different system modules. The detailed process is shown in Figure 2. and 3. below.
The wireless module first performs the initialization operation, sets the microcontroller I/O and SPI related registers to communicate with the ESP8266, and configures the frequency through the SPI bus to enter the correct working mode. When the wireless module transmits data, first set the ESP8266 to the transmit mode, and then write the target address and data of the data to be sent from the transmitter into the wireless module buffer, and transmit the data after a delay. The transmitter flow chart is shown in Figure 4. The receiving end flow chart is shown in Figure 5.

Figure 2. Schematic diagram of system data acquisition flow
Figure 3. Schematic diagram of system data receiving node flow

4.1. Program design of wireless transmitting/receiving module
The wireless module first performs the initialization operation, sets the microcontroller I/O and SPI related registers to communicate with the ESP8266, and configures the frequency through the SPI bus to enter the correct working mode. When the wireless module transmits data, first set the ESP8266 to the transmit mode, and then write the target address and data of the data to be sent from the transmitter into the wireless module buffer, and transmit the data after a delay. The transmitter flow chart is shown in Figure 4. The receiving end flow chart is shown in Figure 5.

Figure 4. Transmitter program flow chart
5. Conclusion
The main content and achievements of this article are as follows:

- Select the hardware components of the wireless water quality monitoring system, including sensor modules, specific parameter monitoring tools, and the smallest single-chip microcomputer system, etc., and modularize the system hardware according to the specific requirements of each function of the wireless water quality monitoring system, and carefully analyze and study The concrete realization of each hardware function module can solve the problems of data processing in practical applications in life.

- The specific parameters in the water quality monitoring system are displayed: the water quality temperature monitoring range is -55~+125℃ and communicates to the smallest single-chip microcomputer system through a single bus. The pH value monitoring range is 0-14PH, and the output voltage signal is through the sensor A/D The conversion module is converted into a digital quantity and sent to the microcontroller, and then sent to the mobile phone APP through wireless communication. The turbidity output 0~5V analog signal is converted to 0~3.3V by the voltage conversion module and sent to the minimum system of the single-chip microcomputer, and sent to the mobile phone APP terminal through wireless communication.

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