Biological pollution online monitoring system

Youfeng Zhang¹, Yulin Yuan² and Yunhong Zheng²,*
Xiamen University of Technology, Xiamen, China

*Corresponding author e-mail: zhengyunhong@xmut.edu.cn

Abstract. With the improvement of people's living standards, the industrial system has begun to develop rapidly, and the problem of water pollution has also increased. Based on the above background, this paper designs an online monitoring system for biological pollution, this system can automatically or manually perform sufficient pretreatment of the water quality to be measured, it can graphically display the dissolved oxygen value and temperature data of the water quality in real time. The software part of this system uses the MK60N512VMD100 microcontroller of the Free scale Kinetis K60 series as the main control chip, and the IDE used is CodeWarrior for MCU 10.5. it is based on the underlying components of the MCU, the software design of the MCU is completed. The upper computer uses Lab Window/CVI 9.0 of NI Company, which connects the equipment terminal to the Internet through SIM900A module, thus completing the communication between the upper computer and the equipment terminal. The hardware part of the biological pollution on-line monitoring system is designed to be portable. Its main purpose is to be convenient for users to carry and suitable for on-site and field operation. The system uses MCU-K60 as the control chip and realizes on-line monitoring on the hardware circuit platform. It is suitable for the determination of water dissolved oxygen and other parameters by departments such as tap water source monitoring, aquaculture farms, environmental protection, sewage treatment plants, beverage industry and scientific research units.

1. Introduction

With the rapid development of society and the improvement of people's living standards, water environment issues have been paid more and more attention. Water quality is related to many factors such as social living areas, living habits, economic conditions and so on. There are also differences in drinking water quality requirements. The research and development of instruments, instruments and other equipment to detect water quality is of great significance to protect the water environment. The oxygen content in the water can show the degree of self-purification of the water to a certain extent. For example, for biological treatment plants using activated sludge, the oxygen content detection in the aeration tank is particularly important.

The most common method of water pollution monitoring is to analyze and monitor through physical and chemical means. The change of aquatic biological behavior is the fastest among all environmental organisms. Although physical and chemical monitoring is already a very advanced means and method, regular testing and sampling are still required in most cases. The result is that it can only reflect the average concentration of pollutants for a certain period of time.

This work mainly detects parameters such as the oxygen content of water in various environments, and displays the oxygen content value through a display module for output. This system has two
modes of manual control and automatic control, and it can use the wireless communication SIM900A module for switching control. In other words, the system can control the working mode and related working process through the wireless communication SIM900A module, and it can also obtain the monitoring parameter data of the system

2. Hardware circuit design of biological pollution online monitoring system

2.1. Hardware system design content

The hardware design and development of this system mainly includes a main controller module part, a display module part, an operational amplifier circuit building part, a relay drive control part, a power supply part, and a wireless communication part. The main controller module is mainly the design of the oscillation circuit, reset circuit and power supply circuit. The display module part is the establishment of the relevant data path and the power supply circuit design for the display screen. The operational amplifier circuit module is mainly composed of two operational amplifier components, A and B. In the physical platform model diagram, 1 is the oxygen meter, 2 is the detection tube, 3 is the device switch, 4 is the stir bar, 5 is the magnetic stirrer, 6 is the TFT touchable color screen, 7 is the Inlet valve, and 8 is Drain valve, 9 is an aerator, 10 is an integrated module, as shown in Figure 1.

![Physical platform model diagram.](image)

The relay drive control module part is a drive of the relay itself. In the design of the power circuit, an independent 5VDC is given to drive the relay components. The control end is controlled by the CPU in the main controller module. The power circuit part mainly includes the power supply of each component module in the system, which is mainly driven by the relay, the power supply of the CPU module is 3.3VDC, and the schematic diagram of the electrical connection relationship is shown in Figure 2.
Figure 2. Electrical connection diagram.

2.1.1. Power module

In this design system, the power supply voltage of the main controller MCU is 3.3VDC, then other related signals during the data interaction with the main controller, that is, the 3.3VDC voltage that the main controller can withstand shall be used for transmission control. The power supply of the entire system is mainly provided by the city power. The city power is converted into a relatively stable 12V DC power through a step-down circuit and a voltage stabilization circuit, that is, from 220VAC to 12VDC. 12VDC can output 5VDC power supply voltage through step-down conditioning chip LM2596 and related hardware circuits.

The main controller part is powered by 3.3VDC, so the system also needs a suitable power source that can be used by the main controller part. In this design system, it is only necessary to further perform the proper step-down conditioning on the 5VDC that has been converted before.

At the same time, in order to enable the controller to effectively identify various data and amplify related signals to drive subsequent controlled objects, or to obtain a reliable transmission identification function, a relatively stable reference level is required. This reference level is also determined by 5VDC is converted to 3.3V, but it is more stable. This article has designed a reference level processing path as shown in Figure 3:

Figure 3 Reference level processing circuit
2.1.2. Main controller module

This controller module is a circuit mainly based on Freescale K60 series MK60N512VMD100 chip, which mainly includes clock oscillation circuit, power supply circuit, system reset circuit, etc. The signals of the entire system are collected and the control results are output to the controlled object through related arithmetic algorithms. For example, the data display of the TFT color screen needs to be processed by this main controller before being sent to the display module for real-time data display output.

2.1.3. Display module

In this design, the final terminal interface is a TFT touch screen. In addition to being a display device or a man-machine interaction interface, the module can use the touch function of the module to control the on or off of system parameters or corresponding actual switching devices.

2.1.4. Operational amplifier module

The operational amplifier module consists of two discrete op amp components. In this design system, the main function is that the sensor sends out voltage and current signals, which are converted into voltage signals by resistance, and then the voltage signal is amplified so that the main controller can accurately identify the signal and perform subsequent data processing.

2.1.5. Wireless communication SIM900A module

In this design, the main function of the wireless communication SIM900A module is to enable the user to perform a remote control of the design system and remote transmission and acquisition of some data based on the wireless communication network with the widest coverage. This module can support all 2G network communications except telecommunications, and the transmission rate based on GPRS can reach 85.6kbps, and has high transmission security and reliability. Software design of biological pollution online monitoring system

3. Experimental verification

3.1. Overall process

The operator turns on the upper computer and sends the corresponding SMS to the sim card number in the system, and the system will turn on the automatic mode. The operator only needs to pay attention to the test results on the display. If there are special requirements or an accident occurs in the system, the manual mode Start / stop each process separately to achieve your own needs, The overall process is shown in Figure 4:

![Figure 4. The overall process](image)

3.2. Scheme design

The biological pollution online monitoring system studied in this paper can realize the online monitoring function of protecting water quality and the real-time monitoring of water quality data. The online monitoring function is to detect water quality information through the sensor module, measure dissolved oxygen, temperature and other data as needed, and then send the measured data to the microcontroller through the serial port. The microcontroller then sends the received data to the
terminal host computer through the GPRS module. On the server, the upper computer analyzes and sorts out these data, and then displays it intuitively in the form of a graph curve on the control interface of the upper computer, which is convenient for managers to monitor the water quality. The automatic water quality monitor has the best on-site use effect. It can automatically and continuously monitor the water quality, and the data can be automatically transmitted remotely. The water quality data of the set site can be inquired at any time. The upper computer monitoring interface is shown in Figure 5:

![Graph Curve](image)

**Figure 5.** Data display chart

3.3. Finished physical test platform

After the system is built, as shown in Figure 6 (a), the overall frame is made of acrylic board. After the system is turned on, it will display the functions of the system, as shown in Figure 6 (b):

![Overall Picture](image)  ![Display Interface](image)

(a) Instrument overall picture  (b) TFT display interface diagram

**Figure 6**

3.4. Data Test

After the system is configured with the server IP and port, it will enable the GPRS function, and the data can be received in the upper display or saved locally. The finished product saves the received data
in TXT format, as shown in Figure 7. In addition, the host computer will automatically save the data in the background.

(a) The dissolved oxygen of texted water  
(b) The temperature of texted water

Figure 7. Test data

4. Conclusion
Aiming at the problem of water pollution, this work proposes and designs a portable biological pollution online detection system. This system involves technologies such as communication, k60 and so on. As a result, the amount of dissolved oxygen and temperature of the water body can be detected in real time. It is different from the traditional large-scale sewage detection device that only uses physical or chemical means. The system has the advantages of small size and high environmental applicability, and the system has remote communication capabilities, which does not require regular manual inspections.

5. Acknowledgments
Project Supported by Guiding Project of Fujian Science and Technology Department.

References
[1] State Environmental Protection Administration. Water and Wastewater Monitoring and Analysis Method (Fourth Edition) [M]. Beijing: China Environmental Science Press, 2002.
[2] Zhiqiang Wang, Wenxun Xiao, Long Yu. Design of Switching Power Supply (3rd Edition) [M]. Electronic Industry Press, 2010-06-01C.
[3] Wanfeng Wu, Lizhong Xu, Hong Xu. Summarization of Automatic Water Quality Monitoring Technology [J]. Water Conservancy and Hydrology Automation, 2004.3 (1): 14-18.
[4] Texas Instruments Incorporated. Manual《MSP-FET430FLASH Emulation Toll(FET) User’s Guide》.2004
[5] Xavier Lagrange. GSM Network and GPRS. Electronic Industry Press, 2002
[6] Bai Xiang Ren, Qing Ren, Gui Yun Si, et al. An Online Monitoring System Installed to Alarm on Pollution Incidents in Douhe Reservoir in Tangshan, China. 2015, 3727:223-227.
[7] Zhang Gaosheng, Chen Linlin, Liu Yuedan, et al. A new online monitoring and management system for accidental pollution events developed for the regional water basin in Ningbo, China. 2011, 64(9):1828-34.