Water quality monitoring system based on Internet of Things

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***Abstract*—Aiming at the problems of the current water quality detection system, a new type of real-time online water quality monitoring system solution based on the Internet of Things is proposed. This solution integrates the design of STM32 single-chip microcomputer, sensors, WiFi wireless transmission and remote water quality management. The system uses sensors to monitor water quality turbidity, pH value, temperature and other parameters, and uploads the data to the management center through wireless communication. According to the analysis results, the water environment quality was measured, and water quality problems were pre-warned to prevent further spread of pollution, improve the scientificity and efficiency of water quality monitoring and management, and provide relevant departments with response strategies and management measures. This system has good real-time performance and strong practicability, and can be promoted and used in the future to promote the development of water environment monitoring.**

Keywords-Internet of Things; Water quality monitoring; Remote management;

I. INTRODUCTION

In recent years, with the rapid development of society and economy, The pure pursuit of economic interests by human beings is seriously polluting the water environment. The discharge of industrial sewage and urban and rural domestic sewage far exceeds the self-purification capacity of ecosystems. Whether for drinking, household, food production or recreational activities, safe and readily available water is needed for public health. Once the water source is polluted, people's life and health will be seriously threatened [1-3]. According to statistics, the total amount of renewable groundwater resources in China is 870 billion cubic meters, accounting for only 31% of China's water resources. Among these 31% of groundwater resources, better water bodies only account for 40%, and 60% of the water quality is not optimistic [4-5]. In order to strengthen people's awareness of water environmental protection, various countries around the world have begun to pay attention to water quality improvement. China has also proposed a series of laws and regulations on water quality improvement, and given guidelines for sewage discharge and related standards. Therefore, it is of great significance to establish a scientific and perfect water quality monitoring system and improve the level of water quality monitoring.

In the past, water quality monitoring usually used manual sampling and recording. The work was complicated, the real-time performance was poor, the monitoring cycle was long, and the water sample analysis and statistical process required high-precision instruments and equipment, which caused excessive monitoring costs. Therefore, this paper proposes a simple, convenient and practical water quality monitoring system. The system uses water quality sensors to collect water quality data in real time. The core controller STM32 is responsible for data processing, and then transmits to the remote management platform in real time via WIFI for related staff to query.

II. OVER PLAN

The system adopts a modular design concept as a whole, which is mainly composed of a main controller, a sensor and a wireless communication module. The water quality parameters collected by the sensors are transmitted to the main controller, and the main controller detects the water quality information according to the water quality parameters, and uploads the water quality data to the remote management platform through WiFi wireless transmission. Users can access the server through mobile phone applications or web clients, receive or query monitoring data, set alarm thresholds, the server will periodically push water quality data information to the mobile phone, and send abnormal water quality information to mobile terminals in the form of alarm text messages, So that users can check the water quality problems in a timely manner.

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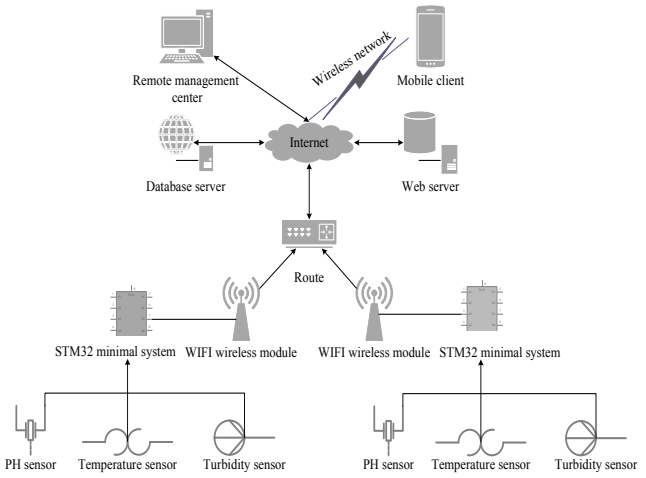

Figure 1. Overall structure design of the system.

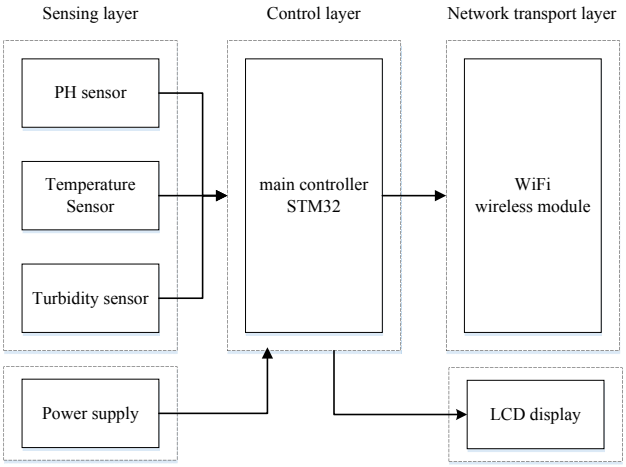

Figure 2. Overall framework of hardware.

III. SYSTEM HARDWARE DESIGN

A. *Overall hardware design of the system*

The water quality monitoring system based on the Internet of Things is generally composed of three parts, the sensing layer, the network transmission layer, and the application layer [6].

The sensing layer mainly collects water quality data by pH sensors, turbidity sensors, temperature sensors, and then provides them to the microcontroller unit with the STM32 embedded microcontroller as the core through the amplifier circuit (signal conditioning circuit). The module will convert the analog signal into a digital signal for further processing. In addition, the LCD screen is used to display data in real time with a dynamic connection. The system also includes an alarm device to notify users of deviations in water quality parameters.

The control layer uses STM32F103 core controller. Due to its abundant on-chip resources, the smallest system can meet the system requirements without requiring too many peripheral interface devices. The processor module is used to coordinate the normal work of each module and control the reading, receiving, processing and transmission of sensor data.

The network transmission layer mainly uses the WIFI module to send the data processed by the controller to the cloud remote management center through the internal communication function.

B. *Perceptual layer lardware design*

The sensing layer is responsible for collecting and processing the signals of the sensors. The data sensing module includes a pH sensor, a turbidity sensor, and a temperature sensor. The data sensed by the sensor will be transmitted to the next stage through the amplifier circuit (signal conditioning circuit).

The monitoring node is powered by a battery. The power module is mainly responsible for converting the battery power voltage to the DC power required by the node and providing working power for other modules. The data acquisition module mainly refers to the bus interface circuit and sensor module. The data is transmitted to the core controller for processing.

C. *Network transport layer hardware design*

The ESP8266 WiFi module is a standalone SOC with an integrated TCP/IP protocol stack, allowing any microcontroller to access your WiFi network. ESP8266 can host applications or offload all Wi-Fi network functions from another application processor [7]. Each ESP8266 module is pre-programmed with AT command set firmware. The Wi-Fi module provides a connection between hardware and software.

IV. SYSTEM SOFTWARE DESIGNN

The system software part consists of a data monitoring terminal, a cloud server, and a mobile APP / Web client. The hardware terminal is mainly responsible for data collection and forwarding to the server. The user writes the alarm threshold to the server through the client. The server forwards the data to the monitoring terminal and reaches the alarm threshold set online.

A. *Cloud platform database design*

The data collected by the sensor layer is processed and transmitted to the cloud server. The system platform mainly monitors pH, temperature, turbidity, etc., and sets alarm values for each monitoring data to form alarm records. The system

uses a SQL Server database with strong security and strong concurrency control to organize, store, and manage data, and establish a historical database and an interactive database through the SQL Server database. The historical database mainly stores water quality data collected by sensors, and there is at most one piece of data in the interactive database. The information collected by the sensors will be updated to the interactive database in real time. The interaction database is mainly used as an intermediary between the cloud server and the web page. The web client reads information from the interactive database through the HTTP protocol and presents it to the client. Through these database functions, the safe and stable operation of the water quality monitoring system is guaranteed.

B. Design of remote management monitoring functionn

The upper computer part adopts the form of WEB webpage, which is convenient for users to check the water quality situation online in real time [7]. The software functions of the water quality monitoring and monitoring system mainly include water quality status, statistical charts, and abnormal alarms.

1) Real-time water quality. It can monitor the information of each point in real time, including the real-time data of each water quality sensor, and the geographical location of water quality monitoring. Users can set water quality alarm thresholds online, water quality monitoring start time, water quality monitoring end time, and equipment operation status to grasp the current water quality status in real time.

2) Statistic chart. The statistical chart function is to form the collected sensor data into a chart form, so that the user can view it more intuitively and at a glance. The user can check the data of any monitoring point for any period of time through the search box, and can accurately predict the trend of water quality and water regime change through the change of historical trends, and conduct multi-parameter comparison analysis and correlation analysis to facilitate users to make accurate Decision. At the same time, users can download historical data such as historical daily reports, monthly reports, weekly reports, etc. The report will give the maximum, minimum, average, and TP90 (90% of the data is higher than the set water quality) in a certain period of time. Parameter threshold value), TP99, TP999 and other data, combined with statistical data, gives an assessment of the water quality in this area. For the reference of relevant staff, check the situation of pollution sources.

3) Abnormal alarm. The abnormal alarm function mainly monitors the alarm function of water quality parameters exceeding the standard and the operation of instruments and equipment. When environmental pollution accidents occur in the monitoring waters, the system will immediately display abnormal water quality parameters and take corresponding measures. First, the system sends abnormal indicator information to water quality monitoring personnel via SMS so that relevant personnel can take effective measures in a timely manner. At the same time,The system will record the specific conditions of the alarm equipment and provide effective water quality information for further troubleshooting, querying and analysis. When the relevant instrument of the water quality monitoring system fails, the system will immediately alert the abnormal state of the instrument and equipment, and send fault information to the water quality inspection personnel through the wireless communication network for equipment maintenance and troubleshooting. The parameters that trigger the alarm are: water quality PH value, temperature, turbidity higher or lower than the standard set value, sensor abnormality, database abnormality, battery failure, communication abnormality, etc.

V. SYSTEM FUNCTION TEST

This test takes a water quality sample of domestic water, inserts a water quality sensor into the sample, and queries the water quality information online in real time. The field test accurately collects water quality information, the data transmission is stable, the remote control is clear and reliable, and it runs continuously for a period of time. No abnormal conditions occurred.

In order to test the accuracy of the sensor, the system collects water quality information every 20 seconds, and the mobile phone terminal can display specific water quality data in real time. This system takes the PH value and turbidity as examples. The specific data is shown in the figure below.

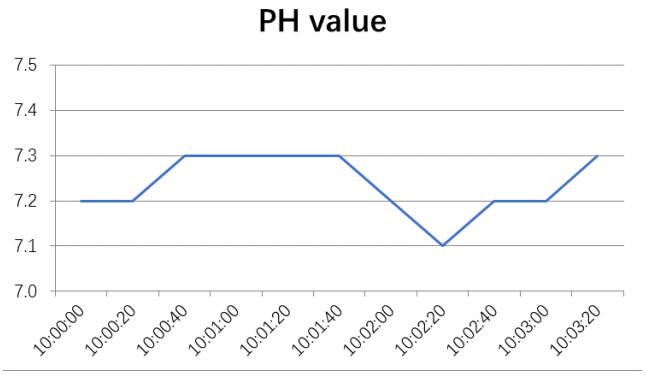

Figure 3. pH test data.

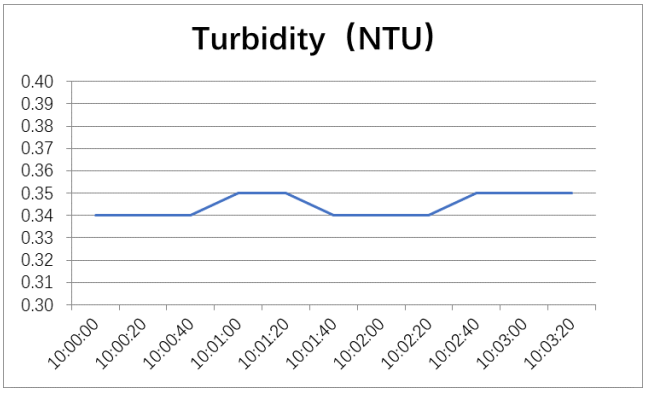

Figure 4. Turbidity value test data.

VI. CONCLUSION

This article designs a water quality monitoring system based on the Internet of Things. The system plan is reasonable, the structure is rigorous, and the functions are perfect. A new type of low-cost, energy-saving, low-power consumption, flexible, easy-to-expand, and convenient operation and management monitoring system has been implemented. The system has functions such as real-time monitoring of water quality, statistics of water quality data, abnormal alarms, and online query of mobile terminals. The test results show that the entire system runs stably and provides significant support for the realization of water quality monitoring technology.

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