Design and Implementation of an Online Water Quality Monitoring System Based on IOT

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ABSTRACT

In response to the increasing emphasis on environmental protection and the public demand for water quality information, an online monitoring platform for water quality based on IOT and Hadoop was designed and implemented. The platform used the wireless detection sensor to gather water quality data, and stored the collected water quality data in the Hbase of the server, which can realize real-time online access and data analysis of the water quality data. The practical application showed that the platform can provide decision support and event warning for the department by analyzing real-time and historical water quality data. ¹

INTRODUCTION

Water resources are the basis for human survival and development. Water shortage and water pollution are two major problems facing the world's water environment, so the protection of water resources has become a global environmental problem, and has been receiving more attention all over the world [1, 2]. In order to better protect water resources, water quality needs to be monitored. A lot of water quality testing instruments have been developed, and various types of water quality detecting sensors such as electrode type, biological water quality and optical water quality have appeared [3]. Water quality monitoring has also evolved from initial manual monitoring to current instrument monitoring and automatic monitoring. However, most of the current water quality monitoring systems only collect the monitored water quality data, and don’t analyze the gathered data. We

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also fail to fully understand the potential resource attributes of water quality monitoring data, and have not fully exploited their shared characteristics and application value in decision-making behavior [4, 5]. So, combined with the modern Internet of Things and big data technology, we designed a water quality monitoring platform in which sensors were used to collect the monitored water quality data, and the gathered data was stored in a Hadoop database in the cloud. The gathered water quality data will be analyzed by using the big data technology, and the results will be graphically displayed to the users. So the users can clearly understand the water quality data, and provide support for enterprise operation and administrative decision-making.

SYSTEM DESIGN

The whole system is mainly composed of three parts: measurement sensing layer, data transmission layer and application layer. The measurement sensing layer monitors the water quality in real time through each sensor node, and collects the raw monitoring data of water quality. The data transmission layer is responsible for the transmission of the data from the sensing layer to the application layer. The application layer’s task is to store the gathered data, analysis the stored data, and display the results by using HBase storage, Mysql cache, and Hadoop big data processing technology. The structure of the water quality monitoring system platform is shown in Figure 1.

HARDWARE SELECTION

There are many factors influencing the water quality. The platform mainly tests the parameters such as TU, PH, temperature, and some heavy metal. We chose a
single-line digital thermometer DS18B20 as a Temperature sensor, a GE sensor TS type as a Turbidity sensor, and other heavy metal detectors made by LIHERO Technology. In the future, the corresponding sensing nodes can be added to gather specific indicator data according to actual needs.

In the program implementation of data acquisition, the main purpose is to convert the temperature values, PH values and TU turbidity values. Firstly, obtain the converted voltage value of the A/D analog-to-digital converter. Then, the voltage value can be calculated by the formula. The conversion of PH value and TU value is based on a linear function relationship, the relationship is calibrated according to the standard buffer solution. The conversion formula for pH and TU turbidity values are given in equations (1),(2),(3), where ‘num’ represents the voltage signal of the physical quantity collected by each sensor

\[ ADC\_Voltage = num \times 500/255 \]  
\[ PH = -5.296 \times ADC\_Voltage + 2025.872 \]  
\[ TU = -0.5388 \times ADC\_Voltage + 461 \]

There are four commonly used data transmission methods: mobile air network, cable transmission, traditional Internet and short-range wireless transmission. We chose a pair of CC1101 wireless transmission modules. The advantage of this module is that it works in the 433M ISM frequency band, which can realize wireless communication between the MCU and the MCU, and configure the spring antenna which is cost-effective. The monitoring data acquisition and transmission process is shown in Figure 2.

![Diagram of the database structure.](image)
SOFTWARE DESIGNING

The application layer mainly includes three parts: the home page, the data analysis module and the management module. The home page includes modules such as system introduction, real-time monitoring (water quality and trend graph), and etc. The management module includes users management module (add users, Edit user information), map mode management module (displayed as map, click on the map to display the water situation), water and monitoring points management module (add and edit water and monitoring point information), the system settings module and other modules.

Water quality monitoring data processing is performed by using Hadoop related data processing methods. Hadoop is a platform for distributed storage and computing for big data. It is suitable for large files, streaming data access, and one writing and multiple reading [6]. The water quality monitoring data collected from each sensing node is submitted to the WEBAPI for processing. WEBAPI stores the data in HBase. The database structure is shown in Figure 3. The data analysis module directly extracts data from HBase for analysis. It calls the corresponding API and graphically displays the processing results through the Echart plugin. Some analysis results are shown in Figure 4.

CONCLUSIONS

In order to make good use of the water quality monitoring data and fully explore its application value. Combining with Hadoop and related big data processing technology, we designed an online water monitoring platform by using IOT technology. The collected monitoring data is wirelessly transmitted to the upper computer, and then saved to the Hbase database in the cloud. The Hadoop big data processing platform is used to analyze the gathered data for supporting
administrative and decision-making. In the future, other types of sensing nodes can be added to collect other indicators parameters of the monitoring waters, and designed the mobile software to display the water quality data processing results for providing real-time warning and decision support.

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