

RESEARCH ON WATER QUALITY MONITORING BY MEANS OF SENSOR NETWORK

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ABSTRACT

As society develops quickly and people attach more importance to environmental protection, it is of great research significance to intelligently monitor the environment. Based on the sensor network, doing research on live monitor of water quality, first of all, this paper designs data collecting nodes under water, which realize communication and organization by means of sound waves; and then it adds data collecting nodes which automatically form networks by means of Zigbee system form network in every water region; and then it is designed to gather data by wireless network coordinator which are transmitted to servers by GPRS; at last, developed information-alarmed system deal with the data. According to tests, they show that this system is of theoretical meanings and practical value on water monitoring.

Keywords: *Online; Sensor network; Water Quality Monitoring*

1. INTRODUCTION

Water is the source of human life, water environment monitoring is the management and protection of water resources is an important means in our country, the shortage of water resources, water pollution is serious, how efficient, real-time access to water environment parameters, the research and development of new monitoring method of water environment, water environment management and protection has become an important task of water, environmental monitoring is important. As people on the water environment automatic monitoring indicators improve, monitoring environment is increasingly complex background, the Sensor network technology into the solution of water environment automatic monitoring of an ideal scheme. Sensor network is a kind of important network monitoring tools, according to environment independent completion of various monitoring task "smart" system. Wireless sensor network based on the water environment monitoring system has the advantages of: 1, low cost; 2, monitoring points distribution range; 3, network flexible structure; 4, little influence on the surrounding ecological environment etc..

Document [1-4] for underwater sensor network communication technology are studied, and separately from the radio frequency, laser and underwater acoustic communication in 3 ways to demonstrate, radio waves can only realize short distance high speed communication, cannot meet

the long-range underwater network requirements [1,2]; underwater laser communication suitable for short distance high rate data transmission, but a need straight alignment of transmission, short communications, restricting it under water network in the application of [3]; the underwater sensor network using mainly acoustic communication network and [4]. Underwater sensor nodes for data acquisition and network communication, underwater sensor network hardware support, the [5,6] presented with wake-up mechanism in ultra low underwater nodes, the proposed [7] mobile nodes, such as in water environment design of automatic tracing sensor intelligent system to lay the foundation of [8-9] respectively from physics; layer, data link layer, network layer, transport layer and application layer of underwater sensor network protocol study was carried out to study, for sensing network monitoring platform design provides premise; the [10,11] from underwater sensor network information processing technology analysis, solving the water channel low bandwidth, Taka Shinobu and reliability problems.

In order to provide better service for agriculture, water environment, based on the ZigBee platform, based on the above research results, design a set of wireless sensor network intelligent monitoring system of water quality. Based on the foreign existing sensor (temperature sensors, pH sensors, oxygen sensors, copper ion sensor, iron ion sensor) for monitoring node design, underwater

2. MONITORING NODE USING THE ACOUSTIC

communication and networking, and on the surface of the water by adding data collection node, data collection node using the ZigBee system for automatic network, then use the ZigBee coordinator to data collection, from GPRS to the data server, the final development of the information and early warning system for data processing. After the trial, found this system of water environment monitoring is of theoretical significance and practical value. The 1 sensing node and data transmission of wireless network design Water environment monitoring network is divided into four parts, underwater monitoring node, underwater communication network, the communication network, information early warning system. Underwater node communication distance is short, the deployment of a large number of nodes to a designated area, rely on these nodes are self-organized ability, mutual recognition, mutual connection, set up a small sensor network. Underwater sensor network node can through collaboration, real-time monitoring and acquisition within the region of various monitors the information of objects and the processing of information, the real-time monitoring to use acoustic information is transmitted to the surface communication network (Zigbee) data collection node. The water communication network by using ZigBee system for automatic network, and use the ZigBee wireless network coordinator to data collection, and through the GPRS will monitor the real-time information to a data server. The whole process is illustrated in figure 1

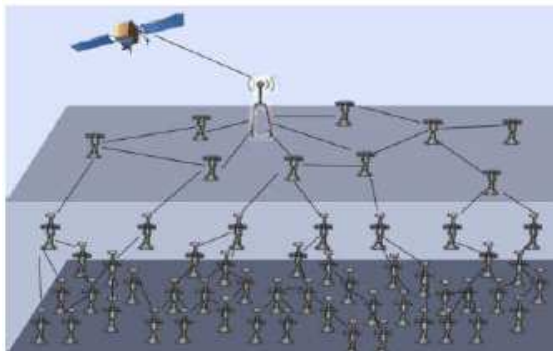


Fig 1 Structure Diagram Of Water Environment Monitoring

2.1 Underwater Sensor Node

Underwater sensor networks deployed in underwater, underwater acoustic communication. Mainly consists of sensors, float, amplifying circuit,

A/D conversion, memory, the microprocessor, the signal conversion module, as shown in figure 2. The sensor module comprises a temperature sensor, pH sensors, oxygen sensors, copper ion sensor, iron ion sensors and other components; underwater buoy is mainly used to control the depth of a node; the sensor monitoring data for low frequency analog signal, amplified and converted into digital signals need, such that the microprocessor can identify. As a result of in wireless sensor networks, energy consumption is the largest in the information transmission process, so the microprocessor receives a new data acquisition and memory last data comparison, if the same to the LPCZ138 chip (Network) to send a "0 " (with the same number according to said, reducing network transmission data), if not the same to LPCZ138 chip to send the relevant data, and the replacement of the data in the memory. Signal processing modules: mainly signal collection and processing, including the modulation and demodulation function, and the corresponding digital signal through an underwater acoustic transducer into suitable for underwater transmission of analog signals, in fact, used in underwater wireless radio frequency only at low frequency (30HZ-300HZ), and requires a higher transmit power, unlike the electromagnetic wave signals that have a higher transmission attenuation, but there is a large scattering. Therefore, the underwater wireless sensor networks are based on the acoustic signal of wireless communication requires the use of electrical signal and sound signal conversion of underwater acoustic transducer.

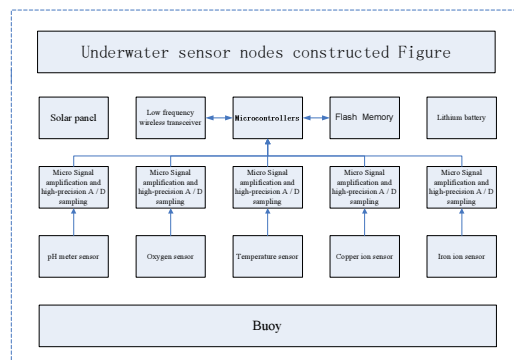


Fig 2 Underwater Sensor Nodes Constructed Figure

The signal processing module, the data to be sent according to the acoustic transducer bandwidth requirements are assembled into a frame, based on FPGA and D/a converter to achieve the intelligent DDS is transmitted to a power amplifying module, and then by the acoustic transducer sends out. The acoustic sensor signals received through a power amplification module, shaping amplification, into

the signal processing module, an A/D converter for converting a digital signal, and then based on the realization of the FPGA DSP of signal processing, detection of receiving data. Among them, D/A converter by using TLV5639 chip, A/D converter by using ADS7800 chip.

2.2 The Surface Of Sensor Node

The sensor network will be the main wireless sensor nodes deployed to the surface of the water, using radio communication and network, this network has fast transmission speed, low energy consumption, high transmission reliability. Deployed on the surface of the wireless sensor network node using solar energy storage power supply, using GPS precise positioning, direct and satellite communications. Wireless sensor network is mainly responsible for the surface and underwater sensor network information transmission, and the automatic network, and the associated data transmission ZigBee coordinator, then by the GPRS transmit data as shown in figure 3.

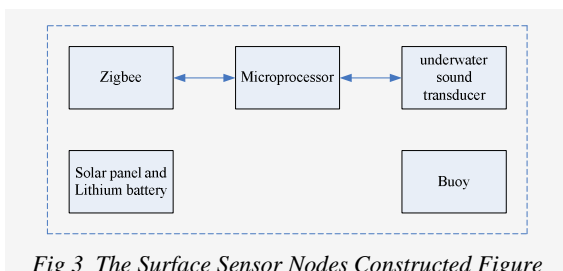


Fig 3 The Surface Sensor Nodes Constructed Figure

Fig 3 the water sensor node structure diagram Figure 3 shows that the surface of sensor nodes is composed of power supply, transducer, microprocessor, Zigbee. The microprocessor, the microprocessor MSP221.11C1611 with TI.

3 . THE DEVELOPMENT OF EARLY WARNING SYSTEM OF INTELLIGENT INFORMATION

The system mainly serves the water environment of water, pH, oxygen content and heavy metal ions such as real-time information collection, storage, display, alarm, dynamic analysis and dynamic tracking. Eventually to water environmental information real-time monitoring, provide the basis for emergency treatment. In order to make the data can be shared, software system in architecture, based on the SOA services architecture thought, dynamic data and content integration. The whole system is divided into data acquisition and data analysis module, a specific architecture as shown in figure 4.

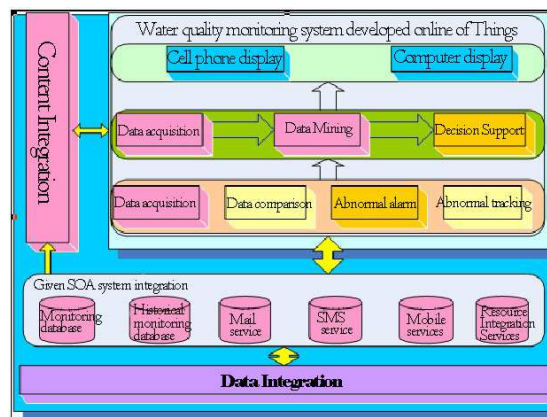


Fig 4 Water Quality Monitoring System Developed Online Of Things

Data acquisition and storage module is responsible for collecting data from the nodes, and automatic storage, the system realizes the automatic unattended data collection. A data acquisition module of real-time detection module through the multithreading technology to real-time detection from the TCP/IP protocol, RS232 interface to transfer data, once the detection to the data, the data acquisition subsystem is responsible for parsing the data format; generate the corresponding text files, stored in the computer corresponding to the directory. Because of the water environmental system, collection frequency than change frequency data is much larger, more data when essentially no change, in the data received by the first time, to determine whether the data effectively, such as whether if the specified data format, or the transmission process of missing data, confirm the valid data, in contrast to the former one data, if in the specified unit of time (for example: 2 minutes) the same data is collected once only, do not repeat the same store too much data, saving storage space. The data storage module through the multithreading technology to real-time detection of computer data storage directory, once found to generate a text file, then the call data storage module for data storage, once the data storage, deletes the current generated text file.

In the data storage module stores the data at the same time, the abnormal data comparison module for real time data analysis, once the real-time data over a warning threshold, call anomaly data storage module, at the same time call warning module to the website, mobile phone, mail carrier for early warning data display. Data analysis module is provided for the same data type of different time trend analysis, through the image of report display data in different site, different time contrast. Data prediction module through the data mining

technology, in view of a large number of historical data mining analyses, prediction of water quality data may happen to. Regional information maintenance: the module is the main function of the test area information maintenance, the regional name, code maintenance, can also upload area map, to area of number, fuzzy query, and to the region to modify information maintenance. Recipient management: This module mainly is provided the recipient's mobile phone and email address, in order to facilitate the early warning information transmission. The main interface is mainly to all recipients to query, create, and delete function. Click the "new " to the new recipient, the recipient of the " Edit " button, to maintain the recipient 's personal information, click " profile " button, the recipient can be configured to the corresponding observation point, corresponding to the type node, if the node set type than the early warning information, automatically send text messages and e-mail, alarm.

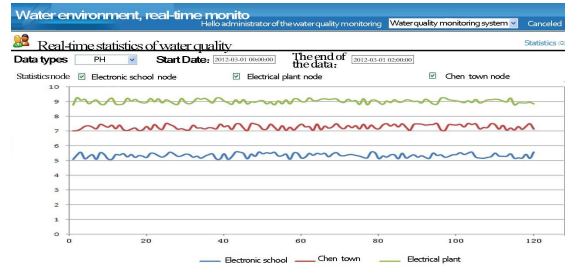
4 FIELD TESTING SYSTEMS

In order to test the performance of the whole system, the nodes are divided into three parts for testing, but on three local water pH, oxygen,

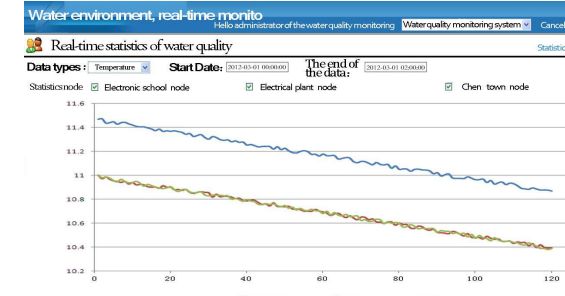
temperature test, in which each part consists of 3 nodes, 1 underwater monitoring sensor node, 1 surface sensor for receiving contact, 1 ZigBee forwarding point coordinate. Electronic school node environment for electronic school sensor network lab, the test content for a plastic barrel water; when needing to change a value, through standard acid solution; and boiling water, ice change monitoring; mechanical and electrical factory node environment through electrical plant sewage back outlet, and water quality is detected by the environmental protection departments after reaching the standards; Chen node environment for Chen town farm pond, pond within the normal growth of fry.

(1) Real-time data monitoring

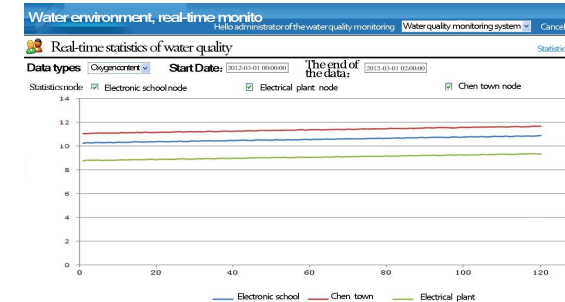
In the module, can be based on node type, test point selection, time interval, and display the real-time data. In order to obtain the related data, and data from outside the intervention condition, project group at 12 p.m. on March 1, 2012 on the data collection, and 2 end points, data related to a in Figure 5, B, C shows. A pH B



a PH value



b temperature value



c oxygen Oxygen content

Figure 5A longitudinal coordinate values for pH, abscissa for minutes, from March 1st 24 to March 2nd 2 points within 120 minutes of the pH value changes.

From the graph it can be found in the electronic school node pH value is between 5-6, less than 7 of normal value, reason is the electronic school node monitoring solution for tap water, which contains an alkaline substance; mechanical and electrical factory node pH value is between 8.7-9.2, with a certain degree of acidity, reason is mechanical and electrical plant related solution is the result of chemical solution after the release, which contains acidic matter; Chen node for natural water, close to neutral. The above related to monitor the situation is consistent with the fact. Figure 5B ordinate for temperature value, scale is 0.2 degrees, the coordinates of time in minutes. From the graph can be found in the electronic school node temperature higher than the other two temperature, due to the electronic school node is in the interior, and a plurality of working computer in the room, so the temperature to 1 degrees; from the results we can



find from 24 to 2 temperature in the decline stage, and the actual situation conform to.

Figure 5C ordinate value mg/mol for oxygen content (mg / mol), scale is 0.2 mg, horizontal coordinates of time in minutes. From the chart we can find Chen node by measuring oxygen content is highest, mechanical and electrical factory node by measuring oxygen content and the lowest, with less time increases, oxygen content value increase. Analysis of results: Chen node monitoring for farm pond, there are green plants can be decomposed into oxygen, so oxygen content value is high, and the electrical and mechanical factory node monitoring for sewage outfall, there are large numbers of microorganisms, need to consume oxygen, so the oxygen content of water environment value is low; the quantity of oxygen in the high, low and atmospheric pressure the temperature, there is a certain relationship between the standard atmospheric pressure, oxygen content, with the decrease of temperature rise. The monitoring value is consistent with the fact. (2) Early warning data

In order to detect whether the system can alarm, electronic school node data for testing, and the solution is added with standard acid solution; and boiling water, ice. The module is able to exceed the alarm limits of the data to be recorded, and related to the warning information, as shown in figure 6.

5. CONCLUSION

This system integrated the use of embedded system development technology, wireless sensor network technology, to build wireless communication technology, distributed intelligent information processing technology and object oriented software development technology, based on the oxygen content in water, pH value, heavy metal ion content of automatic measurement, water quality monitoring, data on abnormal automatic warning, for each year data comparison and makes predictions about the future and other functions. The system has good scalability; little improvement can be applied in the Yangtze River Basin water environment monitoring. After the experimental monitoring the system has certain practical value and popularization value

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