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REMOTE MONITORING AND INTELLIGENT ANALYSIS PLATFORM FOR WATER QUALITY IN LAKE RESERVOIR

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ABSTRACT:

As for a relatively backward situation in monitoring of water quality and prediction and early-warning of algal bloom in lake reservoir, an intelligent information platform integrating monitoring and analysis of water quality, and prediction and early-warning of algal bloom is developed. Lower data acquisition instrument is based on main ARM controller, adopting WinCE OS, and integrates serial-port communication technology, GPS technology and GPRS remote data communication technology, so as to collect and transmit information on water quality; upper analytical system is established using C++, and combines key technologies like network communication, geographic information system and SQL2005 database, so as to analyze data on water quality collected by instrument and realize functions like real-time monitoring and history inquiry of information on water quality. In addition, high-precision prediction and early-warning to algal bloom in lake reservoir are realized through grey-BP neural network model, providing an effective information decision-making platform for environment protection bureau to prevent and treat algal bloom in lake reservoir.

Keywords: *Remote Monitoring Of Water Quality; Intelligent Analytical Platform; Neural Network; Prediction And Early-Warning*

1. INTRODUCTION

As the economy and society develop rapidly, the problem of water pollution has severely impacted or even posed threats to human health. In particular, water eutrophication and the formation of algal bloom have raised great concern. For pollutions in rivers and lakes, eutrophication is the most general and dangerous problem in water environment. The aggravation of water eutrophication leads to algal proliferation, reduces water transparency, deteriorates water quality and severely damages ecological environment, having bad implications for natural water and human lives [1]. Research and development of information monitoring and intelligent analysis system for water quality in lake reservoir is an important aspect in future research on water environment [2-4].

Urgent needs for water environmental monitoring and analysis, we have developed the water quality of lakes and reservoirs in remote monitoring and intelligent analysis platform, The platform consists of the lower water quality of the information collection instrument and upper intelligent analysis system, the instrument can be placed in different locations of the lakes and reservoirs, remote water quality monitoring information and GPS geographic coordinate information collection, and the collection of data information to the host system through a wireless network transmission, released or SMS to mobile terminals. Upper intelligent system receiving lower instrument transmission in real-time water quality monitoring data, to achieve real-time data display, fast inquiries, data comparison function, and water bloom prediction

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model based on neural network systems integration, to achieve the forecast and early warning capabilities of blooms, lakes and reservoirs, water environment monitoring and water bloom control decision-making platform provide effective information for the environmental protection department.

2. DESIGN OF INTELLIGENT ANALYSIS PLATFORM

Refer to Figure 1 for overall structure diagram of remote monitoring and intelligent analysis platform.

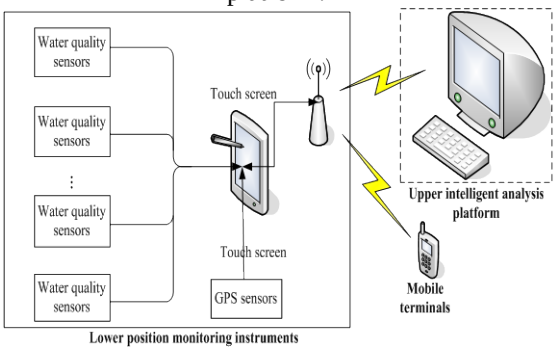

Figure 1. Overall Structure Diagram Of Remote Monitoring And Intelligent Analysis Platform Of Water Quality

The intelligent platform consists of two parts: lower water quality monitoring instrument and upper intelligent analysis system. The instrument includes three modules: GPS module, YSI data acquisition module and data transmission module. Data collected by GPS and YSI is transmitted through GPRS to upper the computer. Upper intelligent analysis system is developed based on Visual Studio 2010 software system. Location of monitoring point and parameters of water quality are displayed in real-time on GIS graph, historical data of water quality is inquired according to time and space, real-time and historical curves are drawn, data comparison is conducted. Besides, data on water quality can be analyzed by calling backstage grey-BP neural network model, so as to achieve prediction and early-warning of algal bloom.

2.1. Design of Lower Instrument

With many advantages like low voltage, lower power consumption and high integration density, the powerful ARM9 series processor is adopted in remote monitoring instrument, so as to rapidly yet accurately process large amounts of information about water quality. Using serial-port communication technology, information on geographic coordinates and water quality are collected respectively by GPS and YSI sensor to LCD touch screen, and transmitted to upper computer system using GPRS/3G wireless remote transmission technology. Refer to Figure 2 for the appearance of remote monitoring instrument.

WinCE is adopted in the software system of remote monitoring and analysis instrument to build a user-friendly interface, and RS-232 serial port is used in MFC-based multithreaded application for communication. GPS and YSI data are received using serial-port communication technology and stored in database files for system inquiry and calling. The system can realize real-time display of parameter data on water quality and GPS location. In addition, the instrument can transmit data to upper software system as well as mobile phone terminals of superior leaders and workers in environment protection bureau, thus realizing real-time monitoring and management of water environment.

Figure 2. Appearance Of Remote Monitoring Instrument

2.2. Design of Upper Intelligent Analysis System

Upper intelligent analysis system is developed based on Visual Studio 2010 software platform. Based on GIS platform, real-time transmission of information on water quality is realized through GPRS remote wireless transmission, and data transmitted by lower instrument through GPRS is received by Socket control. The system stores real-time monitoring data and large amounts of historical data in database established by SQL2005, can display real-time data from lower monitoring point and changes in water environment through intuitive graphs. Plus, it can display real-time location of monitoring point and parameters of water quality on GIS graph, conduct historical inquiry according to time and space, draw real-time and historical curves and perform

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data comparison. Figure 3 is the display of real-time monitoring state and historical inquiry state[5].

Icons of monitoring points will be displayed in real-time on corresponding places in the figure. By placing the cursor on top of monitoring point in the figure, it'll display related information on water quality in a list; meanwhile, historical inquiry is done by choosing date and period of time in the calendar at the left side of the interface. The system can also compare data from different monitoring points at variable time span. By choosing data collected within certain period of time from two or more monitoring points for comparison, the changes of water quality can be displayed on the same interface intuitively through curve graphs.

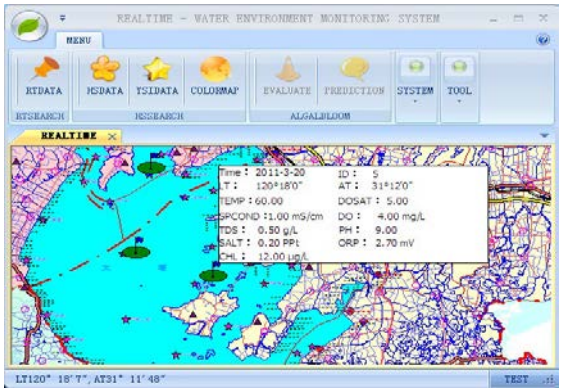

Figure 3. Real-Time Monitoring Display And Historical Data Inquiry Interface

3. PREDICTION AND EARLY-WARNING OF ALGAL BLOOM THROUGH INTELLIGENT ANALYSIS PLATFORM

Lake reservoir system is a complex system with multiple levels, factors and targets, while water quality information system has obvious level complexity, dynamic changes at any time, and incomplete and uncertain index data. As for these features of algal bloom in lake reservoir, grey theory and neural network are adopted in intelligent analysis platform to predict the time for the outbreak of algal bloom. Refer to Figure 4 for detailed modeling procedure:

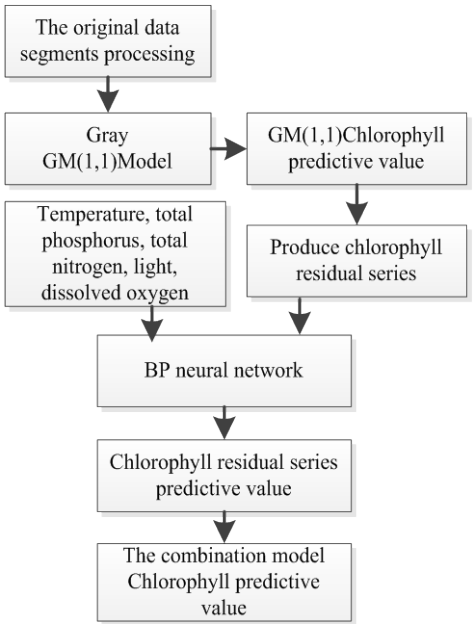

Figure 4. Modeling Procedures For Grey-BP Neural Network

Separate chlorophyll parameter values into many time series, and establish $GM(1,1)$ model to get predicted value of chlorophyll. Deviation between predicted value and actual value, and correlations among series, are taken into account in neural network model. Deviation value of next moment or longer predicted by $GM(1,1)$ model acts as an input to neural network. Figure 5 is the prediction simulation result for algal bloom (prediction period is 30 days). The hybrid grey-BP neural network model can effectively predict outbreak of algal bloom with a precision of over 90%[6,7].

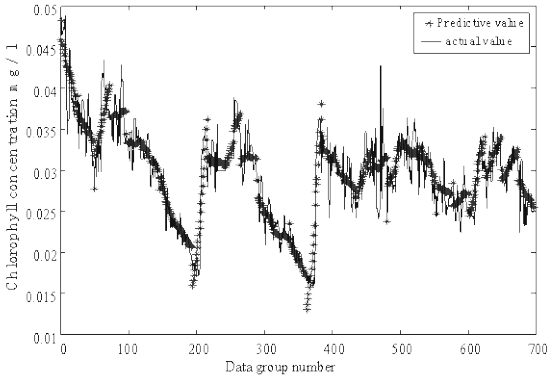

Figure 5. Prediction Result Of Algal Bloom In 30 Days

4. CONCLUSION

The remote monitoring and intelligent analysis platform for water quality can realize remote

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monitoring and transmission, analysis and treatment of information on water quality, prediction and water-warning of algal bloom, etc. It includes lower water-quality monitoring instrument and upper intelligent analysis system. Lower instrument system adopts WinCE OS based on ARM main controller, and integrates serial-port communication technology, GPS geographic positioning technology and GPRS remote data communication technology; upper intelligent analysis system is integrated with network communication system, GIS graph display technology, SQL2005 database technology, etc. This intelligent analysis platform provides a solution for current monitoring of water quality and prediction and early-warning of algal bloom, as well as an effective information platform for automatic monitoring of water quality and high-precision predication of algal bloom in lake reservoir. But the platform is also inadequacies, due to the the water emergency treatment of Chinese decision-making mechanisms and decision-making method is still being studied and is not mature enough, so there is no decision-making system of the emergency management of water bloom on the platform. The platform will achieve this function when the next time is ripe.

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REFERENCES

[1] Liu Zaiwen, Lv Siying, etc. Research on Predication Method of Algal Bloom in Rivers and Lakes. Water Resource Protection, 2008, 24(5): 42-47

[2] Dai Jun, Liu Zaiwen, Wang Xiaoyi, Xu Jiping. Water Environment Monitoring and Algal Bloom Early-Warning System based on Wireless Communication Technology. System Simulation Technology and Its Application, 2010, 12: 504-507.

[3] Qiu Jianhua, Peng Zhihao.. Realization of Serial-Port Communication Technology in Visual C++. Software Engineer, 2010: 94-95

[4] Zhou Changzheng, Yang Jie. Design of GPRS Real-time Monitoring System for Ships,Journal of Wuhan University of Technology (Information and Management Engineering section), 2006, 28(11): 149-152

[5] Jin Hailiang, Liu Huijie, Miao Baoliang, etc. Secondary Development of Basic Functions of GIS Application Software based on MapX Control. Computer and Digital Engineering, 2011, 01(19): 26-29.

[6] Liu Zaiwen, Wu Qiaomei, Wang Xiaoyi, etc. Algal Growth Model based on Optimization Theory and Its Application in Prediction of Algal Bloom. Journal of Chemical Engineering, 2008, 59(7): 1869-1873.

[7] Liu Zaiwen, Lv Siying, Wang Xiaoyi, etc. Research on Predication Method of Algal Bloom in Rivers and Lakes. Water Resource Protection, 2008, 24(5): 26-29.