Distributed On-line Water Quality Monitoring System Based on Embedded Web&CAN Bus

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***Abstract*—By combining CAN bus, Embedded web and Ethernet, a kind of distributed on-line Water Quality Monitoring System based on CAN and Embedded web is presented.The system's hardware and software architecture are analyzed,the measuring principle based on spectrophotometry is used in the system,the C8051F040 as a microprocessor is used in water quality monitoring node,the water quality signal is obtained by the optical sensors,the hardware platform of embedded web server based on S3C2410X is constructed，with CAN bus as bottom interface, Subnode use CAN subnet,and also send field data through Internet instantly. The system can achieve the real-time remote water quality monitoring and alarm with CGI technology, and have a good price-performance ratio.**

Keywords-On-line water quality monitoring; Embedded web server; Spectrophotometry; CAN; CGI

I. INTRODUCTION

Automated monitoring system of many water works and water stations[1], its data acquisition nodes usually use microcontroller as the core, they process data and transmit remote data by using PC or industrial computer. With the rapidly development of ethernet and web technology, and its application of network technology and intelligent measurement and control instrumentation, embedded web-based remote monitoring on the basis of the traditional remote monitoring, which include web and embedded technology, it can provide more powerful features than conventional monitor, and also it will become the mainstream of distributed monitoring technology.

According to the fact that monitoring points are scattered, the remote water quality monitoring system based on embedded web and CAN is designed, the measuring principle based on spectrophotometry is used in the system, according to the linear relationship between concentration and absorbance, measuring the concentration of water quality, monitoring stations communication with embedded web server by using the CAN subnet, users can use a web browser to access water quality parameters concentration through internet, such as residual chlorine, total chlorine, ozone, and so on.

the system use the embedded operating system linux, and it can improve greatly system performance and reduce size, power consumption. Users can monitor water quality information by web browser anytime and anywhere. It not only saves the cost of data communications, but also enables the sharing of resources.

II. SYSTEM ARCHITECTURE

There are two kinds of remote monitoring based on web in general, they are PC proxy server and embedded implementations[2]. In this article, the system take embedded microprocessors as the web server, the monitoring node is make up of field devices and a web server, then access to Ethernet, every field device have the embedded Web server, due to the scattered distribution of water points, according to the principles of centralized monitoring[3], its subnet use CAN, the overall block diagram shown in Figure 1.

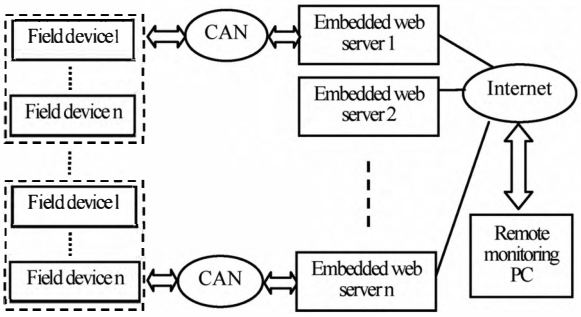

Fig.1 On-line remote monitoring system structure

The characteristics of the system is as follows:

（1）The monitoring terminal is updated real-time by web server;

（2）It is easy to expand function, and the system only need to add new functions to the web server;

（3）Regardless of geographical location and space constraints,any place, as long as the Internet can be connected, the system can monitor data real-time through the web browser;

（4）Forming a network by CAN bus, a web server is make up of many field devices (no more than 110 in theory), and field devices plug and play, more flexibility.

III. THE METHOD AND PRINCIPLE OF WATER QUALITY MONITORING

According to the law of light absorption–Lambert-beer's law[4], in the system, measuring the material concentration from water by quantitative analysis, when a specific wavelength of light irradiates solution, the higher the concentration of material in the solution, the greater the absorbance,according to the linear relationship between concentration and absorbance, the system can calculate the concentration of material in the solution by measuring the absorbance, its mathematical expression is as follows:

$$T = I_t / I_o \qquad (1)$$

$$A = \lg 1/T = \lg I_O / I_t = KCL \qquad (2)$$

Where T is transmittance, I_t is output optical intensity, I_O is input optical intensity, A is absorbance, L is thickness, K is molar absorptivity.

IV. THE DESIGN OF HARDWARE

A. THE DESIGN OF THE FIELD DEVICE NODE

Considering the wide distribution and long distances between the sub-stations, so the monitoring node use the C8051F040 microprocessor with a CAN interface, as shown in Figure 2.

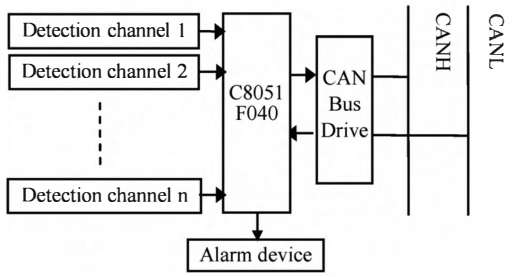

Fig.2 The hardware structure of CAN child node

The hardware circuit diagram of detection channel is shown in Figure 3, including the monochrome LED light source, photoelectric sensor, the sample pool, sampling unit, the signal processing circuit, etc.

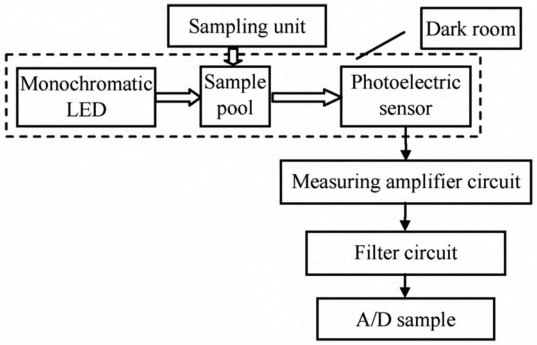

Fig.3 The hardware block diagram of detection channel

Firstly, the monitoring node collect water samples by the sampling system, the treated sample solution is injected into the sample pool, the monochromatic light from monochromatic LED irradiate the sample pool, and light signal is received by the photoelectric sensor, then convert into electrical signals, and it is processed through the amplifier and filter circuit, the data is processed by the microprocessor, finally, the monitoring node get the concentration of water solution and send the data to the embedded web server by CAN bus.

B. THE DESIGN OF HARDWARE BASED ON EMBEDDED WEB SERVER

The system can not only realize the field device data acquisition by embedded web server, but also send data to the Internet, a comprehensive price and performance of processor comparison.Embedded web server use embedded processor S3C2410X from the SAMSUNG company,the chip integrates a large number of function expansion unit, such as LCD controller, touch-screen interface, USB interface, and so on, and also extend RS232, CAN, Ethernet interface, the processor provide different communication mode,it is suitable for monitoring in different environments and conditions.

ARM micro-controller as the core control module, the Ethernet controller chip AX88796 access Ethernet by the coupling filter FC-518LS, and RJ45,then CAN bus interface is extended,CAN bus protocol is compiled, the equipment of the CAN control sub-line access into the Ethernet[5]. Because the S3C2410X has not the CAN controller,this system use MicroChip the Company's independent CAN bus controller MCP2510 be extended to the microprocessor and Philips Corporation's CAN transceiver TJA1050. Figure 4 shows the hardware block diagram of embedded web server.

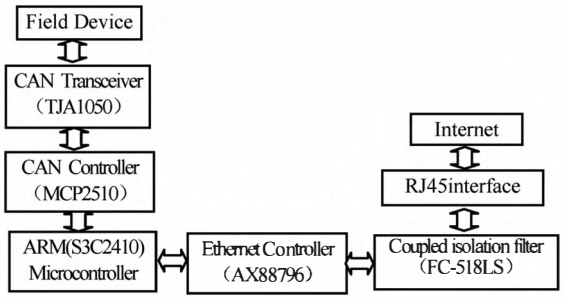

Fig.4 The hardware architecture based on embedded web server

To achieve the embedded web server, although the CAN controller doesn't be integrated , it can be extended through the SPI interface, interface circuit is simple, and it is easy to implement interface circuit. CAN-bus interface circuit mainly uses the SPI interface with the independent CAN controller MCP2510, CAN bus transceiver TJA1050 and other equipment.Independent CAN controller MCP2510 fully supports the CAN2.0A and CAN2.0B protocol. MCP2510 as the slave device is connected to the SPI0 of S3C2410X. TJA1050 bus transceiver is interface chips between CAN controller and the physical bus, it can enhance the capability of bus drive.the optocoupler 6N137 is joined between the MCP2510 and the TJA1050, it can

enhance anti-jamming capability and stability for system, and resolve level compatibility, the MCP2510's TXCAN and RXCON are connected to the TXD and RXD. the terminal resistor (120Ω) as a matching resistor to eliminate the reflected signals, and it can effectively improve the system anti-jamming capability.

V. THE DESIGN AND IMPLEMENTATION OF SOFTWARE BASED ON EMBEDDED WEB SERVER

The program is presented in this paper, the application software of monitoring system includes the coordination of multiple tasks, HTTP service is responsible for the water quality status information is generated that contains web pages, web server communicate with CGI through the environment variables, it send data to the web server through CGI, the page file is generated by writing C code. The system use B/S （Browser/Server）structure[6], including the Windows PC of the outer layer(as the customer), boa web server and embedded device hardware platform, as shown in Figure 5.

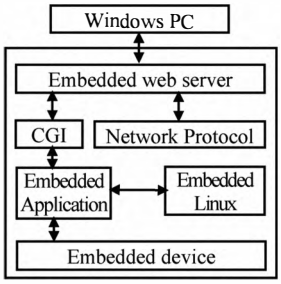

Fig.5 System Architecture

A. *The Construction of HTTP Server*

Porting Linux operating system to the board based on S3C2410X processor, the system use boa as the embedded web server, the remote online monitoring system is established, the boa server is a single task and small HTTP server, open source, performance excellence, and it particularly is suitable for use in embedded systems. If two users will access it at the same time, one must wait for a moment, it creates a separate process to handle CGI programs, so it take up less system resources.

the main migration process of the boa server is as follows:

（1）Downloading boa source code, and unziping it;

（2）Compiling code and generating executable file boa;

（3）Configuring the boa server. To run the boa web server on the target platform, it need to modify configuration files boa.conf, the main settings include the boa port number, server root directory, log files, html and cgi files directory and Readable/Writable temp directory attributes, after the completion of above configuration, you can run the boa server.

B. *The Function Realization Based On Embedded Web Server*

Various web resources are stored in external EEPROM memory, it communicate with the remote monitoring host through the Ethernet, and the system has achieved the function of web server and achieved web dynamic page by CGI technology, the full name of CGI is "Common Gateway Interface"[7], the program provide the interface for the web server with client-side HTML page.

Embedded web server send the client information to the CGI program, the client submit information through the HTML document, the form provide an interactive interface for the user, the information is entered by the user constitute a form data sets, and it is transmitted to the web server as a part of the HTTP request message,the web server receive the client request information, and then it send the form data set to the CGI-related applications. There are two ways to submit the form: they are GET and POST, To use a different request attributes, it uses different environment variables.

The CGI program communicate with the boa server through environment variables, command-line parameters and the standard input, etc. The form coding information is used in the design, they are transfered through the environment variable QUERY_STRING, which return the implementation result and send the result to the client browser, its implementation process as shown in Figure 6.

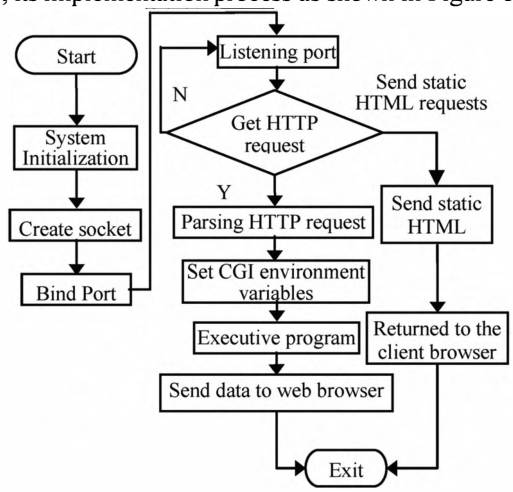

Fig.6 The work flow of web server

VI. RESULTS

On-line water quality monitoring system based on Embedded web, when users access an embedded web server by web browser, it is necessary for authentication, when passing the validation, the web server send data to the web browser,the sub-station collect data, on-site alarm and other functions. the remote host display real-time data, and query historical data, it can display dynamic data and other functions, and by monitoring the home page determine monitoring status whether it is normal, it play a role in early warning. Its concrete realization steps are as follows:

（1）Copying CGI program cgi-test.cgi on the directory of /var/www/cgi-bin, copying index.html on the directory of /var/www,compiling and downloading the code to the target platform;

（2）running boa, setting the target board IP address 192.168.0.105 through the ifconfig command in the target board;

（3）Opening IE browser and entering the server IP address, you can visit the web page on the client through IE

browser, and you can login the system and monitor the remote data, as shown in Figure 7.

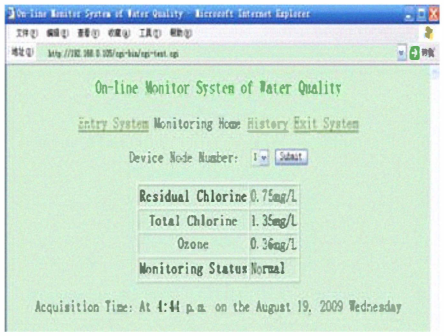

Fig.7 The interface of the browser client

VII. CONCLUSIONS

In this article,on-line water quality monitoring platform based on Embedded web&CAN bus is designed,the system monitor the water concentration by using spectrophotometry, it is feasible and convenient, and it will don't cause seconary pollution, the embedded web technology is used in the on-line water quality monitoring system, which can replace the traditional proxy project based on PC, the system can continuously collect water quality parameters from many points, and display on the web browser, while exceeding the threshold monitoring points, the system can display its status information,and it play a role in early warning.

The system consists of a remote customer terminal and monitoring sub-stations,the monitoring sub-stations consists of the embedded web server and field devices, the remote computer communicate with the sub-station through receiving data and sending commands to the sub-station. Field devices of monitoring Sub-station attache to the server by using CAN control sub-networks, plug and play, more flexible. the monitoring program of the water quality based on embedded web server is designed, and water quality parameters is collected ,analysed and tested in this program, it is feasibility to be verified through the experiment, the system based on embedded web server compares with monitoring system based on PC, it has the advantages of high performance-price ratio, little space occupation and the convenient installation and maintenance.

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