A Novel Kind of Smart Monitoring System of Aquaculture

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Abstract. In order to promote the development of intelligent agriculture in our country, this paper puts forward a wireless remote monitoring system of water quality parameters which is based on Android mobile phone platform and GPRS communication technology, the system realizes the remote collection, storage and management of water quality parameters such as the water level, temperature, PH and dissolved oxygen, and also realize the remote control of the control nodes. The 16-bit microprocessor MSP430f149 of TI company is adopted in acquisition part, and also 12 high-precision AD converter is used, the sensor collected data through the GPRS module which is sent to the remote server, and water quality parameters from the servers is sent to the Android mobile phone. The PID control is adopted in the control part, the control commands from the android mobile phone is sent to the server, the server again send it to the lower machine to control the water level regulating valve and increasing oxygen pump. So the Android mobile phone system can complete the monitoring of water quality parameters. After practical testing to the system in Liyang, Jiangsu province, all the indexes can meet the requirements, this system is very suitable for aquaculture.

Introduction

With the progress of modern science and technology and the continuous development of modern high-efficiency agriculture, agricultural automation are increasingly being recognized, it can greatly improve labor productivity and increase labor's comfort and maneuverability, and the application of agricultural automation is a revolution in information perception and acquisition control[1]. Abroad at present, in the field of agricultural ecological environment monitoring, the United States, France and other countries set up agricultural information platform through the advanced sensor technology, data fusion technology and Internet technology, to realize the automatic monitoring of agricultural ecological environment, and to ensure the sustainable development of agricultural ecological environment[2]. For example, the United States has formed the layered architecture of the ecological environment which is information collection-information transmission and processing-information release, the French use communication satellites technology to predict disastrous weather, plant diseases and insect pests. But in water environment monitoring, there are almost no reports about monitoring system based on Android and GPRS[3]; and in our country, for the aquaculture industry, most of the area is still in a relatively backward state, monitoring of water quality parameters in artificial sampling analysis stage, which will bring a series of problems, such as: the operation is inconvenient, time-consuming and the accuracy is not high[4]. Some domestic universities have done related research and made some achievements. For example, Nanjing Agricultural University has developed sampling sensor to monitor the dissolved oxygen concentration, China Agricultural University has designed a remote aquaculture monitoring system based on GPRS and another monitoring system of water quality parameters in Wireless Sensor Networks[5]. The monitoring system described in this paper is combined with the Android mobile phone platform, GPRS communication technology, single chip microcomputer and Internet network, all of these construct a wireless remote monitoring network, and this realize the real-time monitoring of water quality parameters. The system not only makes full use of the existing public cyber source to save the cable

construction and maintenance costs, but also reduce the cost according to GPRS transceiver traffic charges, so that this system can be reliable and economic enough to operate.

General design

The system is mainly composed of a water quality parameter monitoring module, control module, GPRS communication module, site monitoring, remote server monitoring and Android mobile phone client module. Monitoring module includes conditioning circuit and sensors of several water quality parameters such as water level, temperature, PH and dissolved oxygen. The control module comprises a water level regulating valve, air pump and D/A transformation. Site monitoring module is composed of a liquid crystal and keys, and the user could press the corresponding button according to the data displayed in the liquid crystal[6]. The remote server module is mainly used to receive data and communicate with Android mobile phone client via wireless network. And Android mobile phone client mainly completes the data interaction with the server, database management and the network communication function. The system architecture is shown in Fig.1.

System hardware design

This system can be used in continuous data acquisition, the real-time data transmission, data management, and the remote wireless control of the actuators of the water quality parameters. The whole structure of the system hardware design is shown in Fig. 2. The working principle of the system in particular: at first, the AD conversion, filter, computing, storage of the sensor signals are processed by MSP430f149 microcomputer, and then the water quality parameters are sent through the RS485 serial port to the GPRS module, then the data are uploaded to the remote server monitoring center in the form of network packets through the GPRS communication protocol, and at the same time the computer will process, store and display the data. The computer could send control commands to the MCU in the same way according to the requirements, and then the single chip identify and process the instructions so as to realize the wireless remote control of the actuators[7]. Meanwhile the server exchange data with Android mobile phone client, and the mobile phone can also monitor the water quality parameters.

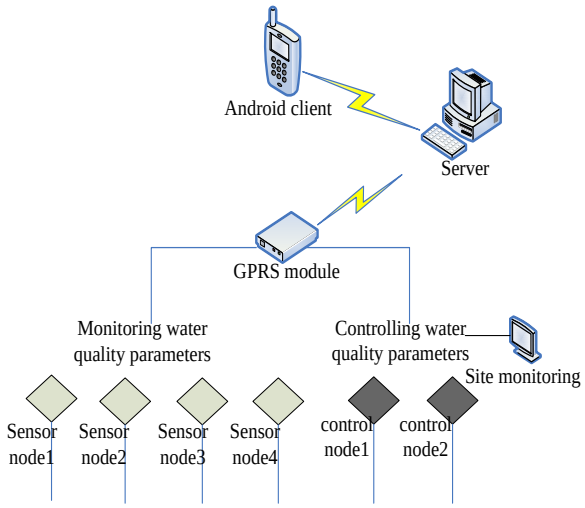

Fig. 1 The system architecture

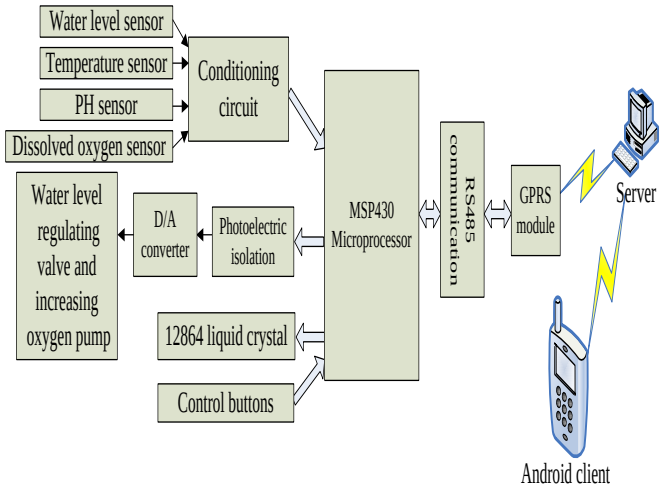

Fig. 2 Whole structure of the system hardware design

System software design

System needs electricity initialization when it starts to run, the initialization procedure is mainly used to initialize the IO port, timer, AD conversion mode, serial port, liquid crystal and key program etc. After initialization, system begins to launch the application. The interrupt of the timer starts based on

parameters configured by initialization procedure of data acquisition. The software design flow chart of the system is shown in Fig.3.

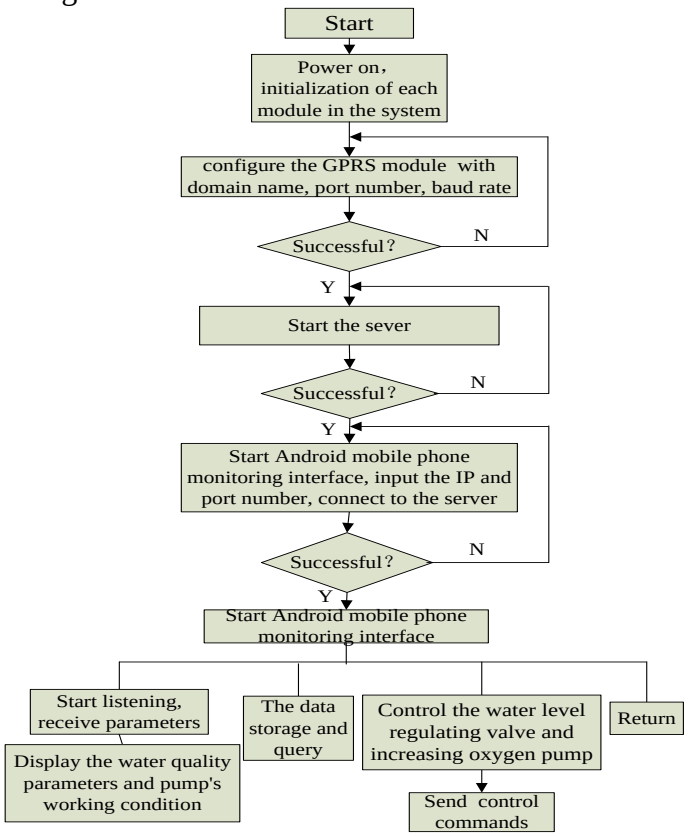

Fig. 3 System software design flow chart

System test results

In May 10, 2014, the test was conducted in the experimental base in Liyang, Jiangsu Province, the experimental fishpond is a semi-enclosed 80m × 80m pond, the actual depth of the pond is about 1.20m. The test was to obtain the real-time water level, temperature, PH value and dissolved oxygen of water quality parameters, at the same time to control the water level and dissolved oxygen. The water level regulating valve and increasing oxygen pump controlled the water level and the dissolved oxygen respectively, and the rated voltage of their motor parameters are 380V, rated power are 2.2kW, and rated speed are 1470r/min. Under closed loop control, the test completed 12 hours of uninterrupted testing on the fishpond. Part of the test data is shown in Table 1.

Table 1 Test data

Time	pH	Temperature/℃	Water level/cm	Dissolved oxygen/ (mg/L)
12:00	7.3	27.0	101	7.5
13:00	7.4	27.2	101	7.4
14:00	8.1	28.0	100	7.3
15:00	8.0	28.1	109	7.6
16:00	8.2	28.1	103	8.0
17:00	8.0	27.6	100	8.2
18:00	8.1	27.8	101	8.0
19:00	7.4	26.0	101	8.0
20:00	7.2	25.0	108	8.1
21:00	7.2	23.0	109	8.1
22:00	7.0	22.6	110	8.0
23:00	7.7	19.0	109	8.0

Conclusions

This system uses the Android mobile phone platform and GPRS communication technology to achieve the remote wireless monitoring on real significance. The pond water quality parameters of the system can be remotely monitored through a mobile phone, it is of low hardware cost and has the high ratio of performance to price. By test, the measurement of water quality parameters of this system is of high precision, the effect of controlling of the water level regulating valve and increasing oxygen pump is good, the water level control precision can be controlled within ±4cm, the dissolved oxygen control precision can be kept within ± 0.4mg/L, the system has the advantages of simple operation, real-time strong, good maneuverability, wide foreground, and it is very suitable for the use of the aquaculture industry.

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