Feature Article

U-20AQ Series : Remote Monitoring System of Water Quality Data

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Water pollution is a serious global environmental problem. However, measurements of pollution used to be started only after it revealed. One of the reasons is that water quality analysis requires substantial facilities. In addition to the analytical equipment, each measuring point requires a building to house the equipment, establishment of telemetry devices with dedicated line networks and works for water sampling, all costing around tens of millions of yen in capital investment. We have realized a system of low cost continuous monitoring of water quality at multiple points with its U-20AQ Series Remote Monitoring System. It is composed of the U/W-20XD Series Water Quality Monitoring System that can make simultaneous analyses of 13 parameters, and a solar powered remote monitoring device with wireless transmitter.

Introduction

Water is an important resource of all life. Such important water resources are under threat by common global problems of eutrophication and pollution by chemical substances[1]. It is important for resolving these problems to analyze and gain a wider understanding of water quality. For this purpose we have developed the U/W-20XD Series Water Quality Monitoring System that can make simultaneous analyses of 13 parameters[2][3]. Combination of this system and a solar powered remote monitoring device with wireless transmitter enabled easy and automatic real-time measurement. We introduce here the structure and features of this U-20AQ Series Remote Monitoring System of Water Quality Data and report the field testing results.

Structure and Features of the U-20AQ Series

Conventional water quality monitoring points required water suction and discharge facilities, automatic water quality monitoring and telemetry devices with dedicated line networks and buildings to protect the equipment. They also required much work and cost to operate and maintain such as calibration facilities. The system has been used for water quality monitoring for lakes and rivers where there are limitations for establishing measurement space and cables for communication using kind of telephone lines. It has been one of the reasons of difficulty of timely introduction of facilities despite their importance because of cost and difficulties of installation. The U-20AQ Series Remote Monitoring System of Water Quality Data enabled reduction of initial cost, load of maintenance and setting problems. It combines the compact U/W-20XD Water Quality Monitoring System with solar cells and battery. The existing cellular phone network was applied for communication.

The appearance of the U-20AQ Series and a diagram of the communication system are shown in Figure 1 and Figure 2, respectively.

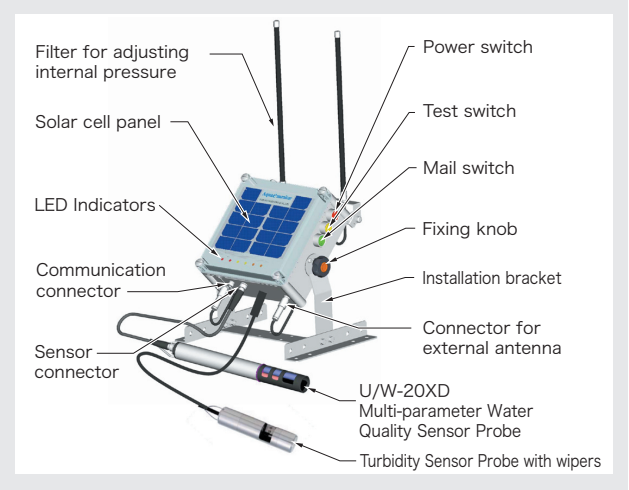

Figure 1 The Appearance of the U-20AQ Series

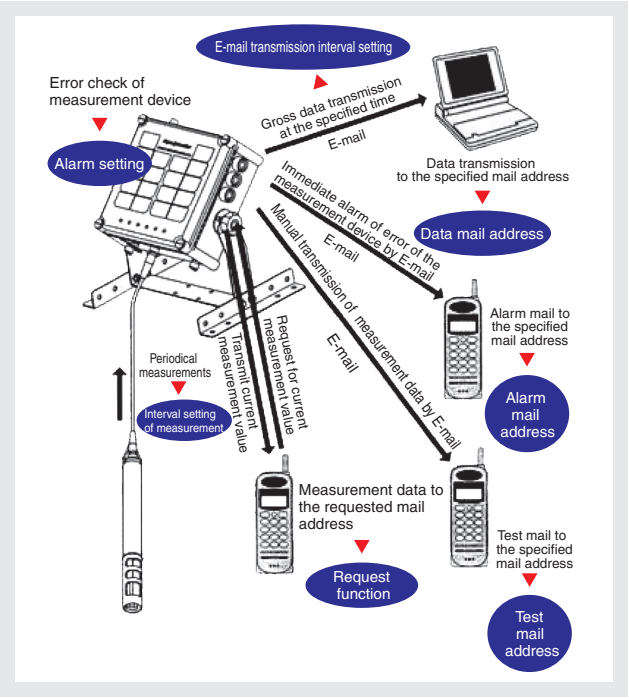

Figure 2 Diagram of U-20AQ Series Communication System

The Remote Monitoring Device has a solar cell panel on the front and it should be installed facing south with an elevation angle of 45 degrees. Its operation is very simple. Five LED status indicate: power source check, solar cell operation, measuring, and communication. Three switches can operate power on/off, test mail transmission or mail transmission, and receiving or sending E-mail. The system starts up at the specified time automatically, then measures the water quality, inputs the data into the memory and transmits whole data at the specified time. When any measurement out of range is detected, alarm is transmitted immediately.

Major specifications of the U-20AQ Series are as follows:

Measurement Items

The system can measure water temperature, water depth, conductivity, salinity, dissolved oxygen, pH, turbidity, ORP, TDS (total dissolved solids), sea water density, three types of ion (select three ion types from nitrate, calcium, chloride, fluoride, potassium and ammonia), internal case pressure, case temperature, battery voltage and solar cell voltage (for remote monitoring system).

Measurement Function

Interval measurement is available to store data measured for one year in the case of every one hour measurement.

Transmission Function

The system transmits data regularly by E-mail (with an attached file of CSV format) to 20 places as maximum, connecting to the Internet by wireless packet transfer communication using MobileArk by NTT DoCoMo.

Alarm Function

When any measured data out of range is found, an alarm message is immediately transmitted to the cellular phone. (Setting of upper/lower limit values or abrupt change values for major measurement items is possible with commands sent via E-mail.)

Features of the U-20AQ Series

The features of the Remote Monitoring System U-20AQ Series for Water Quality Data are as follows:

(1) Small size, and portable. Easy and low cost installation is possible without special construction.

(2) Three sensor probes (Figure 3(a)) can be connected for simultaneous measurement. It is possible to monitor water quality at different depths, for example water near the bottom and surface of lake at the same point can be measured simultaneously. Furthermore continuous measurement of turbidity is available by connecting wipers to the turbidity sensor (Figure 3(b)).

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(a) Sensor Probes

U-21XD, U-22XD and W-22XD

W-23XD sensor probe
(with ion sensors)
without the sensor guard
(sensors are visible).

(b) Turbidity Sensor with Wipers

Windows for light source
and detector are cleaned by wipers

Figure 3 Sensor Probes and Turbidity Sensor with Wipers

(3) Solar power system with solar cells and battery require no external power source. Battery replacement maintenance is also eliminated.

(4) The remote monitoring device has an IP67 waterproof (that is waterproof under the condition of 1 m depth for 30 minutes determined by IEC Standards) and can be used outdoor environments without special modification for protection.

(5) The maintenance required is periodic cleaning of the sensors and some simple calibration only.

(6) The wireless transmission function using MobileArk by NTT DoCoMo (with a bandpass frequency of 800 MHz) is used and the system enables communication to any location in Japan. The communication cost is low because of a packet transfer communication protocol that depends on the quantity of data to be transmitted. An example of an e-mail received from the U-20AQ Series and a result of data processing are shown in Figure 4.

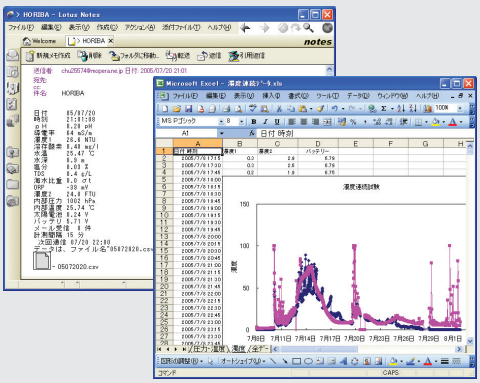

Figure 4 An Example of an E-mail Received from the U-20AQ Series and a Result of Data Processing

Results of Field Testing

An ocean field test of the facility was carried out for about 3 months (Figure 5).

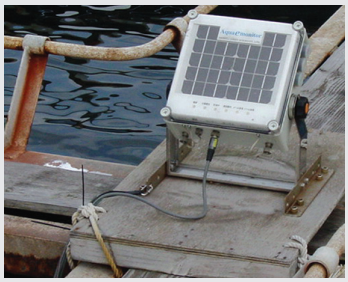

Figure 5 View of the Ocean Field Testing

The measured results of water temperature, dissolved oxygen, salinity, pH, water depth and turbidity are shown in Figure 6 and 7.

The internal temperature of the device, voltage of solar cells and battery are shown in Figure 8.

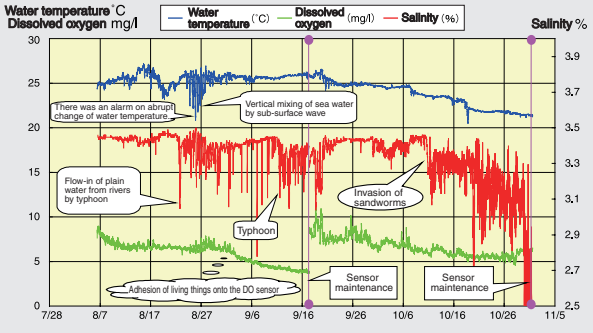

Figure 6 The Measured Results of Water Temperature, Dissolved Oxygen and Salt Content from the Ocean Field Testing

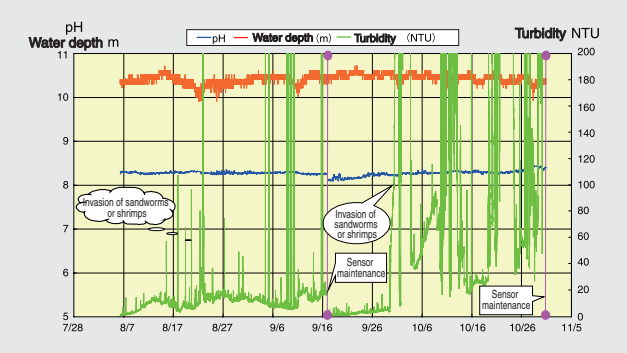

Figure 7 The Measured Results of pH, Water Depth and Turbidity During Ocean Field Testing

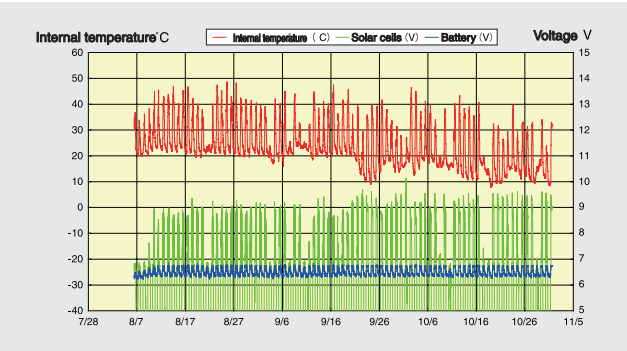

Figure 8 Internal Temperature of the Device, Voltage of Solar Cells and Voltage of Battery

Results of Ocean Field Testing

Throughout the field testing, we demonstrated that the facility is sustainable even though its internal body temperature goes up 50 degrees centigrade under the temperature difference of 30 degrees centigrade between daytime and night time caused by direct exposure of sun light in summer.

Although a typhoon hit the testing site, the periodic measurement every 10 minutes and periodic transmissions of E-mails and alarm mails every hour were sent without trouble. Minor problems of stains on the U/W-20XD's turbidity sensor and an invasion of microbiologies during testing were solved by wiper cleaning.

Conclusion

Blue oceans, beautiful clear rivers and lakes. Water is an important resource for all life. Such important water resources have been polluted by discharges from various human activities such as domestic wastewater, industrial effluent or agricultural drainage. Widespread environmental destruction has been caused by eutrophication and pollution by chemical substances. As this is a global problem, we, manufacturers of analytical instruments have very important role to provide tools for real-time measurement and control of water quality.

The U-20AQ Series Remote Monitoring System of Water Quality Data can measure important parameters of water quality for long periods by solar powered wireless transmission. We expect that this energy saving and compact system will be widely adopted and will contribute to solve enviromental problems.

We consider that it is necessary to develop such a system that enables remote monitoring anywhere in the world. Further, we need to establish technologies for easy analysis to measure items (such as sodium ions, chlorophyll, nitrate, hormones in aquatic environment) which are given attention as indicators of environmental problems in addition to existing equipment. We would like to contribute to solve environmental problems by establishing of sensor technologies for water quality measurement.

Reference

[1] Water Resources Management , by Chris H.D. Magadza, *Readout,* 27, 54-59 (2003).

[2] The U-20 Series Multi-water Quality Monitoring System, by Tsuyoshi Kobayashi, *Readout*, 18, 32-36 (1999).

[3] Water Quality Observation of Lakes and Marshes, and Portable Water Quality Monitor, by Yasuaki Yamashiki and Tsuyoshi Kobayashi, *Readout*, 21, 61-65 (2000).

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