Remote Water Quality Monitoring in Wide Area

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Summary

A water quality monitoring technology in a wide area is developed to detect water pollution in streams, rivers and coastal areas. A wireless sensor network (WSN) technology is used to cover wide measuring area without any communication infrastructures. The water quality sensor module is used to measure the water pollution data such as DO, pH, conductivity, turbidity, depth of water, and temperature. Such a water pollution data from a water quality sensor modules are transmitted between the field servers with the sensor modules and finally, to the base station (BS) through a designed self-organizing autonomous wireless sensor network. Here a field server consists of a water quality sensor module to collect the water quality data, an ATmega128 microcontroller for data processing and control, and a wireless sensor node for the transmission of the water quality data.

Keywords: Water quality monitoring, water quality sensor, self-organizing WSN, water polluting

System Configuration

Fig. 1 shows the conceptual architecture of a self-organizing water quality monitoring system. The self-organizing water quality monitoring system is designed based on a WSN. Some of the integral advantages of this configuration are: lower implementation cost compared with wired networks; improved mobility and no hassle of cables; ideal for unreachable places such as across a river or mountain or rural areas; and ideal for temporary network setups. The properties of improved mobility and scalability of a WSN are the main reason for adopting a WSN in our application.

In this study, “self-organizing” denotes the autonomous self-organized routing of the sensed water quality data from the deployed sensor nodes to the BS in a WSN field. The water quality sensor in the field server appropriately measures the water quality data, such as DO, pH, conductivity, turbidity, depth of water, and temperature (Table 1). The routing protocol of a multi-hop communication is predefined and programmed in the sensor nodes by the network engineer before testing, and the routing path is automatically optimized in the form of a self-organizing network by the OS programming of all the wireless sensor nodes in the field.

Experimental Results

The field servers are positioned at a range of 10 m from each other for the practical testing of the designed WSN as shown in Fig. 2. Each field server consists of a water quality sensor module for collecting the water quality data, a sensor node for wireless data transmission, a flash memory for the data averaging process, an interface between the sensor node and the water quality sensor module, and a battery charged using solar cell panels.

The water quality data are measured every 1 min from the water quality sensors connected to the sensor module, and the measured water quality data are stored in a flash memory buffer every 5 min. The averaging calculation is performed on a wireless sensor module every 5 min. The averaged data are transmitted to the BS through the flooding routing protocol. This averaged data transmission technique applied to each of the field servers, where the sensor data are obtained, is a method to compress the data size for transmission and, consequently, to reduce the data traffic considerably in the WSN. The data traffic reduction in the WSN can increase the data transmission reliability with a very low data packet loss.

This real time monitoring software on the server PC monitors the measured water quality data obtained from the distributed nodes of the different field servers in the WSN. We can choose a specified field server among all the deployed field servers in the WSN, as displayed on the screen of the server PC, to monitor the environmental data of the spot. In addition, an alarm and warning message service are provided in the window box of the program when the measured value exceeds the threshold value, indicating the pollution status.

Reference

[1] K. S. Chen, M. M. Crawford, P. Gamba, J. S. Smith, Remote sensing for major disaster prevention, monitoring and assessment, IEEE Transactions on Geoscience and Remote Sensing, Vol. 45, No.6-1, 2007, pp.1515-1518; doi: 10.1109

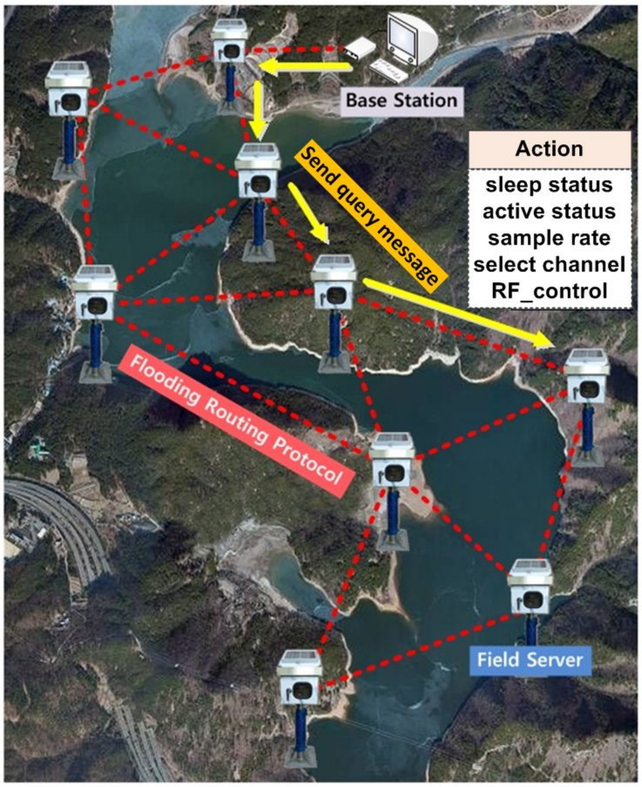

Fig. 1: Concept of water quality monitoring system.

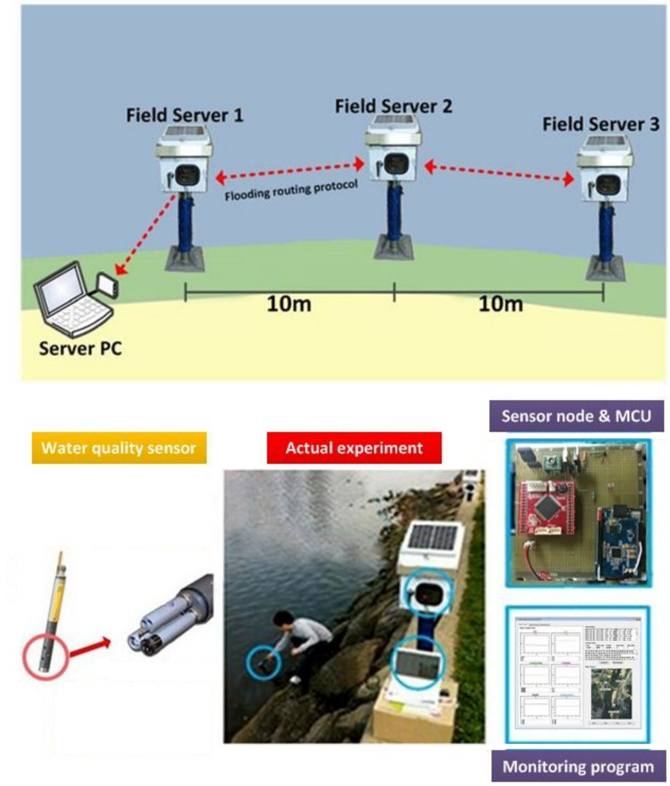

Fig. 2: Test-bed architecture and practical experiment.

Tab. 1: Specifications of used water quality sensor module.

	Range	Resolution	Accuracy
DO	0 ~ 500 %	0.1 %	0 ~ 200 % :±2 % of reading 200 ~ 500 % : ±6 % of reading
	0 ~ 50 mg/L	0.01 mg/L	0 to 20 mg/L :±0.2 mg/L 20 to 50 mg/L :±6 % of reading
pH	0 ~ 14 units	0.01 unit	±0.2 unit
Conductivity	0 ~ 100mS/cm	0.001 ~ 0.1 mS/cm (range dependent)	±0.5 % of reading + 0.001 mS/cm Whichever is greater
Turbidity	-999 ~ +999mV	0.1 mV	±20 mV
Depth	Shallow 0 ~ 9.1m	0.001 ft, 0.001 m	±0.02 m
Temperature	-5 ~ +50℃	0.01 ℃	±0.15 ℃