A SENSOR WEB MODEL AND WEB SERVICE FOR DRINKING WATER DISTRIBUTION MANAGEMENT

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Abstract

Population growth, energy demand, and climate change are placing an unprecedented strain on water resources, requiring a fundamental shift in how these resources are managed. Since water distribution systems are highly vulnerable to leakages, improper usage, incidents of contamination, accidental or purposeful intrusions, considerable attention is required for prompt action to save and optimum utilization of natural resource of drinking water. Due to spread out and remote locations of Water supply tanks and Pumps / Valves, both the storage and availability of Water as well as distribution control are difficult. Dependence on Pump attendants makes a mockery of Supply system of this most critical commodity. An approach of Wireless Sensor Network (WSN) application to do real-time data collection at the water supply sources such as water tanks , valves/outlets and etc., to obtain proper required parameters measuring to optimize water resource management . The Sensor Web is an emerging technology that promises to revolutionize the way water information is collected and disseminated. A Sensor Web is a group of interoperable web services, which all comply with a specific set of information models and interface specifications. The Open Geospatial Consortium (OGC) is developing information models and service interface specifications for Sensor Web Enablement (SWE).

I. INTRODUCTION

WSN s have attracted a great deal of interest due to their cost-effectiveness, ability to perform multiple functions simultaneously and make decisions based on information gathered from various sensing elements placed at different locations. Various WSN architectures targeting different applications have recently been reported [1], [2], [3]. The task of measuring and interpreting environmental and process variables is becoming increasingly large and complex. Many proprietary and open technologies are in use for observing, communicating, analyzing and reporting these variables. Although India as a huge fishery country, most domestic water distribution management in terms quality, usage and leakages is still using manual methods that result in a complex detection process. Any error of the steps in the detection process will affect the results of the final data. The manual methods have been unable to meet current water distribution monitoring requirements. Environmental problems involving water quality and security have a wide scope of the entire planet, a daunting complexity at both the microscopic and ecosystem level, and a profound relevance to our daily lives – clean waterways and secure water supply are our best protection from communicable disease and the effects of chemical and biological contaminants either accidentally or intentionally released to our environment.

The proposed WSN has been deployed for monitoring the water distribution in our university campus water tanks distribution., using five different types of sensors, namely, pH, conductivity, temperature, oxidation reduction potential (ORP) and dissolved oxygen (DO) sensors, and experimental results demonstrate the ability of the sensor network to collect the sensor data in real time, store them over a long period of time and display them graphically on a web site. Sensor Web Enablement (OGC-SWE) allows for the integration and analysis of streams of sensor data from multiple and diverse sensors in a standards-based and thus interoperable manner. For instance, observations from water quality sensors can be fused with those from weather instruments and satellite remote sensing instruments. Measurements of anything from process or biophysical variables to higher level indicators such as re-vegetation or landscape function and even social impact potentially can be Sensor Web Enabled.

II. RELATED WORK

The variability in water demand due to changing land use, irrigation withdrawals, and reservoir operations also cause uncertainty in estimates [6]. A

comprehensive review of water resources literature, laws, budgets, and analyses of selected data sets reveal the central role played by the twin factors of diversity of attributes and uncertainty in measurements in our understanding of many water issues (Brands and Rajagopal 2008 a, b, c, Rajagopal et al. 1992b). Enabling our institutions to develop a research infrastructure to manage water laws, science, and technology so as to effectively utilize and combine the diversity of attributes and uncertainty in their measurements at different scales for the protection and management of water resources will be a major challenge in the next two decades (Colaceci et al. 2008, Kumar and Singh 2005, Loucks et al. 2006, Rejman 2007, Vardon and Martinez 2009).

Water management problems are complex because a multitude of factors (natural and anthropogenic – objective and subjective) affect them and it is extremely difficult to identify and isolate a set of cause effect relationships linking particular factors to specific indicators of water distribution measurement. The general aim of a proposed water sensor web mode service is to inform users about the condition of the spatial-temporal aspects of the physical environment. This web-integrated Hydrologic Information System supports any number of data providers, catalogs and consumers. WSNs collection of each tank water quality, tank water level and water leakage data collection activities for benefit of several reasons. Water is a widely distributed resource, and the quality ,usage and movement of water can be affected by things happening at multiple spatial and temporal scales. Sensors to monitor water are expensive and require routine maintenance and cleaning that is difficult with remote installations. Water quality data give us insight in to the suitability of the water for drinking life; and help us understand how chemicals move in our environment, particularly contaminants and pollutants whose transport and persistence in the environment are critical to plans for long term remediation [7].This paper proposes a sensor web service to monitoring drinking water distribution through water tanks to near by water pumps covering our university area. The acquisition nodes are mainly intelligent sensors which are responsible for data collection. The acquisition nodes send the collection data to router node. The router nodes which are responsible for routing selection[8]

III. SENSOR WEB MODEL ARCHITECTURE

The goal of the current study is the investigation of the various sensing technologies and to implement them in wireless sensor networks, as a start of an integrated water distribution management. To that extent, moisture, water purity ,water level and leakage detection sensors were utilized and interconnected using WSN. At first, an experimental setup was used at the premises of the University water distribution tanks. The laboratory setup consists of four wireless nodes placed at specific locations along the experimental water distribution system model, to collect and reliably transmit sensor data to a base- station which is located within the sensor web lab area of university. The deployed sensors are tasked with monitoring water purity ,tank water level and water leakage,. Figure 1 depicts the aforementioned basic wireless sensor network architecture and its deployment. The system is based on the Mica2 433 MHz motes (Mica) enclosed in waterproof package for outdoor monitoring. Soil volumetric water content is measured by the Decagon Ech2o dielectric sensors (Decagon) attached to sensor nodes using an MDA300 data acquisition board (Mica). Water purity is measured from various locations at 0.5m and 1.0m below the level of the water pipe network. Water level is measured using the widely deployed KENT V100 (PSM) meters (Elster)., It is tobe integrated to the MDA300 data acquisition boards. Finally, a Zonescan-800 leak noise logger from Gutermann is used for leak noise detection. The Tiny OS operating system installed at each mote was used as the software platform for data acquisition, processing and efficient low-power communication (TinyOS). The communication of the motes to the base station provides the functionality equivalent to a data logger where the data acquired from all sensors are stored in a specifically designed database. The motes communicate with a Stargate (Hunaidi and Chu 1999) gateway which is responsible for sending the acquired data to the remote base-station via a GPRS link. The Stargate gateway is also used to update the.All data is collected and stored on the Base Station Controller, through a Gateway Station. Data is classified on a relational database and uploaded on a sensor web page using OGC Standard Schemas which offers users the opportunity to check, in real time, the wireless nodes, their readings and the condition of the pipe network. The webpage (Figure 2) shows information for

all inspection points, with textual or graphical information on daily, monthly and yearly.

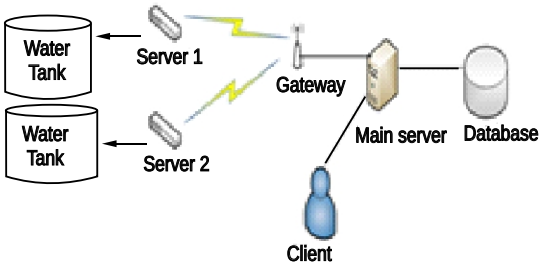

Fig. 1 Basic flow of communication in water sensor

Water distribution monitoring system software can pre-process, display and analyze the data from wireless sensor network, then make the corresponding decisions. The system collects water level, pH, and detecting leakage sensor signals by sensor module, via wireless transport module transmit data, and combines with system software to achieve real-time monitoring and control. The system based on users demand, can monitor the water distribution data each tanks wise data at any time. It provides scientific evidences to automatic monitoring of water quality,level and leakage.

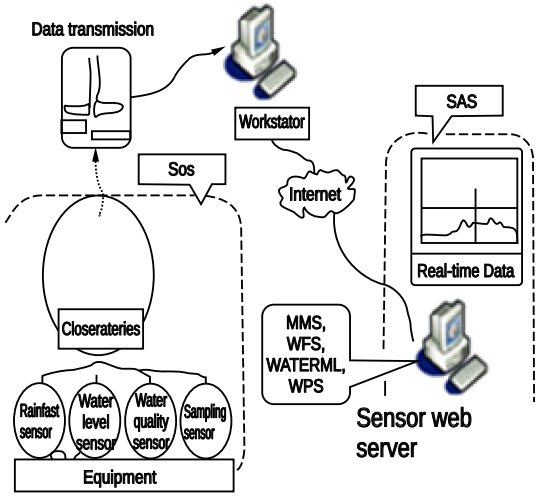

Fig. 2. Sensor Web Architecture Model

IV. IMPLEMENTATION

Web monitoring and data management two different programs needed to be implemented, which were: a data retrieval and a web monitoring .The data retrieval was responsible for retrieving data from sensor networks and recording them to the database. A web monitoring was responsible for translating the collected data from the database to the relevant format and presenting them via web interface.

In this software architecture, the software hierarchical structure has three-layers: display layer, logic layer and data layer. Data acquisition and device control layer is related to the wireless sensor network hardware of the system architecture. The entire software modules achieve the various monitoring and control functions which allow users to real-time monitor and manage aquatic water quality conveniently and efficiently. Implentation of layers of senses web server is shown in fig. 3.

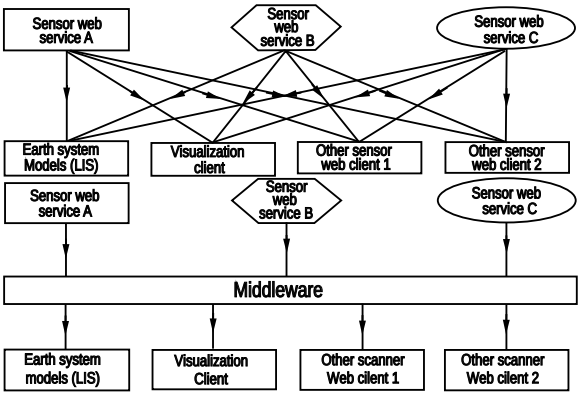

Fig. 3. Implementation of layers of sensor web service

V. CONCLUSION

The manuscript describes the framework of the projects; research projects aiming the development of an integrated management system for water distribution networks. In this paper, we demonstrated how advances in wireless sensor networks, communication and sensing technologies could provide much needed increase in spatial and temporal resolution of hydraulic and water quality data for better understanding and monitoring large scale water supply and sewer systems. The real-time monitoring of the water quality data of aquaculture is based on the water quality parameters correlation between each other by adding data fusion functions and fuzzy control model. It will greatly improve the accuracy of the system monitoring.

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