Monitoring water quality by sensors in Wireless Sensor Networks-A Review

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Abstract– Monitoring water quality is critical to human health, hence employing wireless sensor netwoks for such a task requires a system that is robust, secure and has a reliable communication. Water borne diseases have become a major challenge to human health. Around 400 million cases of such diseases are reported annually, causing 6–12 million deaths world-wide. Access to safe drinking water is important as a health and development issue at national, regional and local level. The population in rural India mainly dependent on the ground water as a source of drinking water. The main problems at the time to effectively implement sensors are that, on one hand, there is a lack of standards for contamination testing in drinking water on the other hand, there are poor links between available sensor technologies and water quality regulations. In this paper the application of WSN in environmental monitoring, with particular emphasis on water quality. Various WSN based water quality monitoring methods suggested by other authors are studied and analyzed, taking into account their coverage, energy and security concerns.

Keywords-- Water quality monitoring, Remote, Wireless Sensor Network

I. INTRODUCTION

Recent advances in MEMS-based sensor technology, low-power analog and digital electronics, and low-power RF design have enabled the development of relatively in- expensive and low-power wireless micro sensors that are capable of detecting ambient conditions such as temperature and sound. Sensors are generally equipped with data processing and communication capabilities [1][2]. The sensing circuitry measures parameters from the environment surrounding the sensor and transforms them into an electric signal. Processing such a signal reveals some properties about objects located and/or events happening in the vicinity of the sensor. Each sensor has an onboard radio that can be used to send the collected data to interested parties. Such technological development has encouraged practitioners to envision aggregating the limited capabilities of the individual sensor in a large scale network that can operate unattended. Numerous civil and military applications can be leveraged by networked sensors. A network of sensors can be employed to gather meteorological variables such as temperature and pressure. One of the advantages of wireless sensor networks (WSNs) is their ability to operate unattended in harsh environments in which contemporary human-in-the-loop monitoring schemes are risky, inefficient and sometimes infeasible. Therefore, sensors are expected to be deployed randomly in the area of interest by a relatively uncontrolled means, e.g. dropped by a helicopter, and to collectively form a network in an ad-hoc manner. Given the vast area to be covered, the short life span of the battery-operated sensors and the possibility of having damaged nodes during deployment, large population of sensors are expected in most WSNs applications.

In most part of the world, ground water is the only and important supply for production of drinking water, particularly in areas where water supply is limited. Groundwater quality will directly affect human health [3]. A sensor is the electronic device that can detects and responds to the external stimulus from the physical environment. The external stimulus can be temperature, heat, moisture, pressure in the environment. The output of the sensors is generally a signal which can be converted into human readable form. Sensors may be classified as analog sensors and digital sensors. Analog sensor senses the external parameters (wind speed, solar radiation, light intensity etc.) and gives analog voltage as an output [4]. A digital sensor is an electronic or electrochemical sensor, where data is digitally converted and transmitted. A base station is responsible for capturing and providing access to all measurement data from the nodes, and can sometimes provide gateway services to allow the data to be managed remotely. The importance of maintaining good water quality highlights the increasing need for advanced technologies to help monitor water and manage water quality. Sensors in Wireless sensor networks offer a promising infrastructure to municipal water quality monitoring and surveillance. In this paper we suggest some parameters for drinking water quality and proposed model and methods for water quality [5][6].

II. SENSORS

Sensors are electronic devices that can be used for monitoring physical and environmental condition such as temperature, vibration and sound. Sensors are defined as the sophisticated devices which aids to detect and respond to electrical or optical signals. It converts the physical parameters like temperature, blood pressure, humidity, speed into a signal that can be measured electrically. Sensors can be classified based on the following criteria and conditions:

a. Primary Input quantity
b. Transduction principle
c. Material and Technology
d. Property Applications

Figure 1 represents another category of sensors.

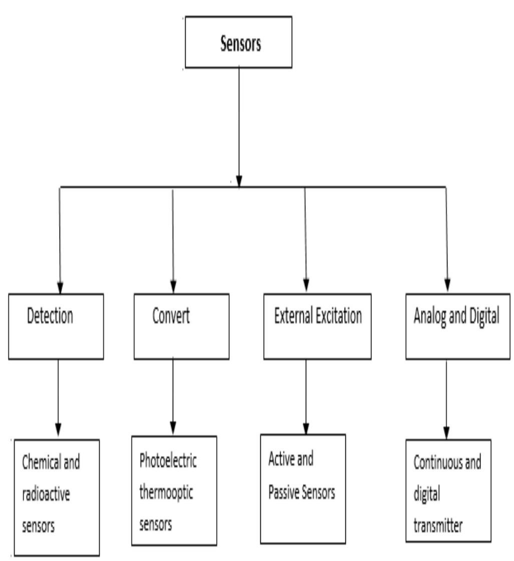

Figure 1. Classification of Sensors

III. CHALLENGES OF MONITORING WATER QUALITY

Access to safe drinking water is important as a health and development issue at national, regional and local level. The population in rural indie mainly dependent on the ground water as a source of drinking water. As India is a developing country and it has wide-spread emerging technologies, there is a need for system for timely help and to monitor water pollution on the total state of the water system [7] [8]. Monitoring of water quality is very important for good health. Wireless sensor networks can help for control quality of water by using some methods but there are some challenges of monitoring water quality are:

(a) Sensors Costs and Specifications
(b) Low energy of sensors
(c) Security
(d) Connectivity
(e) Sensor location

(a) Sensors Costs and Specifications

Site specific installation cost projections need to be developed. Typical cost components in the total cost of a sensor installation at each potential location include:

1. Land purchase
2. Construction of the vault in which the sensors and connections to the distribution piping will be located
3. Installation of the sensors and RTU
4. Supplying power to the site
5. Installing the communications equipment and upgrading/installing equipment at the central control room
6. Design and bidding the construction and installation work
7. Access to site

(b) Low energy of sensors

In Wireless Sensor Networks, Energy is a scarcest resource of sensor nodes and it determines the lifetime of sensor nodes. These are battery powered sensor nodes. These small batteries have limited power and also may not easily rechargeable or removable. Long communication distance between sensors and a sink can greatly drain the energy of sensors and reduce the lifetime of a network. In

Wireless Sensor Networks, energy of sensors is a major issue to be considered [9].

(c) Security

Underwater wireless sensor network is a novel type of underwater networked system. Due to the characteristics of Underwater Wireless Sensor Network and underwater channel, Underwater Wireless Sensor Network are vulnerable to malicious attacks. The existing security solutions proposed for WSN cannot be used directly in Underwater Wireless Sensor Network. Moreover, most of these solutions are layer wise. In figure 2 all sensors sense the data under water and send these data to the base station. Different types of sensors can be used under the water for monitoring quality of water [10].

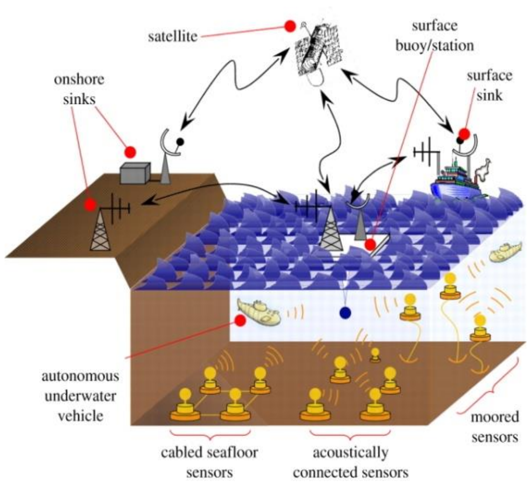

Figure 2. Underwater Wireless Sensor Network

(d) Connectivity

The most fundamental problem in underwater sensor network is network connectivity. The connectivity problem reflects how well a sensor network is tracked or monitored by sensors. An underwater wireless sensor networks is the emerging field that is having the challenges in each field such as the deployment of nodes, routing, floating movement of sensors etc. For the connectivity of nodes use DFS (Depth first search) algorithm and for coverage use distributed coverage algorithm [11] [12].

(e) Sensor location

Sensor nodes are addressed by means of their locations. The distance between neighboring nodes can be estimated on the basis of incoming signal strengths. Relative coordinates of neighboring nodes can be obtained by exchanging such information between neighbors. To save energy, some location based schemes demand that nodes should go to sleep if there is no activity. More energy savings can be obtained by having as many sleeping nodes in the network as possible.

IV. QUALITY RANGE OF SUGGESTED PARAMETERS FOR DRINKING WATER

Parameters examined by US environmental protection agency, resolved that both chemical and biological waste has an adverse effect on many water monitoring parameters such as pH, ORP, Turbidity, Nitrates, Dissolved Oxygen, Water temperature, Fluoride, Chlorine, Oxygen. In order to detect the water contamination or impurities, it is enough to determine the changes in the suggested parameters (Table 1).if there is any deviation when compared to that of the drinking water standards recommended by WHO or Central pollution control board, India, then the water is not safe for drinking [13].

Table 1: Quality range of suggested parameters

Sr.	**Parameter**	**Units**	**Quality range**	**Measured Cost**
1	pH	pH	6.5-9.0	Low
2	ORP	mV	650-800	Low
3	Turbidity	NTU	0-5	Medium
4	Nitrates	mg/L	<10	High
5	Dissolved Oxygen	mg/L	0.2-2	Medium
6	Water temperature	C	<10	Low
7	Fluoride	mg/litre	<0.05 –0.2	Medium
8	Chlorine	mg/litre	0.2–1	Low
9	Oxygen	mg/l	1-2	High

V. PROPOSED MODEL FOR WATER QUALITY

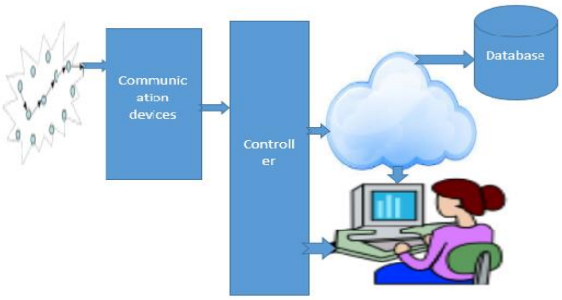

Figure 3. Proposed model for monitor quality of drinking water

Proposed model (Figure 3) for monitor quality of drinking water is very effective for monitor ground water. In this proposed model all sensors sense the data and collect data then stored these data in local-controller. Once the local-controller receives the data, it then transferred to the cloud for analyzing the data. Cloud storage work as a mediator between data transmission layer and database management layer. After analyzing data by cloud storage data transferred to end-user. Domestic water supplied form Municipal Corporation or directly takesn from the ground water are mainly used for drinking and cooking purposes.

Traditional water supply management involves<storing the pool of water at various locations and distributing the same through water head tanks and domestic pipelines.

VI. CONCLUSIONS

The main objective of this paper is to show the role of sensors for the betterment of water quality in order to obtain a hygienic environment. In this paper we study the challenges of monitor quality of drinking water and parameters required for monitor drinking water. According to the study, drinking water obtained from both groundwater and surface water must satisfied the standards for safe drinking water. This paper gives a clear view about what is a sensor, parameters to identify quality of water, and stages to create online water quality management system.

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