Real Time Water Quality Monitoring System

Mithila Barabde[1], Shruti Danve[2]

ME Student, Dept. of E&TC, MITCOE, Savitribai Phule Pune University, Pune, India[1]

Assistant Professor, Dept. of E&TC, MITCOE, Savitribai Phule Pune University, Pune, India[2]

ABSTRACT: Water pollution is one of the biggest fears for the green globalization. To prevent the water pollution, first we have to estimate the water parameters like pH, turbidity, conductivity etc, as the variations in the values of these parameters point towards the presence of pollutants. At present, water parameters are detected by chemical test or laboratory test, where the testing equipments are stationary and samples are provided to testing equipments. Thus the current water quality monitoring system is a manual system with tedious process and is very time consuming. In order to increase the frequency, the testing equipments can be placed in the river water and detection of pollution can be made remotely. This paper proposes a Sensor-Based Water Quality Monitoring System. The system architecture consists of data monitoring nodes, a base station and a remote station. All these stations are connected using wireless communication link. The data from nodes is send to the base station consisting of ARM controller designed for special compact space application. Data collected by the base station such as pH, turbidity, conductivity, etc is sent to the remote monitoring station. Data collected at the remote site can be displayed in visual format on a server PC with the help of MATLAB and is also compared with standard values. If the obtained value is above the threshold value automated warning SMS alert will be sent to the agent. The uniqueness of our proposed paper is to obtain the water monitoring system with high frequency, high mobility, and low powered.

KEYWORDS: Continuous monitoring; GSM modem; Real time; Sensors; WSN.

I. Introduction

21st century is century of pollution, global warming, insecurity and vulnerable health factors. Water pollution is the major problem in front of world today, which is nothing but the contamination of water bodies. Water pollution occurs when contaminants are discharged directly or indirectly into water bodies. Water pollution affects plants and creatures living in these bodies of water. Also human health is affected by polluted water.

Water Pollution is a major global problem which requires ongoing valuation and modification of water resource guiding principle at the levels of international down to individual wells. It has been surveyed that water pollution is the leading cause of deaths and diseases worldwide. The records show that more than 14,000 people die daily worldwide. In India predictable 580 people die of water pollution related illness every day. In many developing countries, dirty or contaminated water is being used for drinking without any proper former treatment. One of the reasons for this happening is the unawareness of public and administration and the lack of water quality monitoring system which creates serious health issues. Also natural phenomena such as volcanoes, algae tints, rainstorms, and earthquakes also change the quality and ecological status of water.

As water is the most important factor for all living organisms it is very important to protect it. And water quality monitoring is one of the first steps required in the rational development and management of water resources.

Thus in this paper we describe the design of Wireless Sensor Network (WSN) [1] [2] that helps to monitor the quality of water with the help of information sensed by the sensors immersed in water, so as to keep the water resource within a standard described for domestic usage and to be able to take necessary actions to restore the health of the degraded water body. Using different sensors, this system can collect various parameters from water, such as temperature, pH, oxygen density, turbidity and so on. The rapid development of wireless sensor network (WSN) technology provides a novel approach to real-time data acquisition, transmission and processing. The clients can get ongoing water quality information from faraway. In a system of this kind, there are several nodes, a base station and a remote monitoring station. Each node contains a group of sensors and the nodes are circulated in distinctive water bodies. Data collected by sensor nodes is sent to the base station via WSN channel then to the remote monitoring

II. RELATED WORK

Central Water Commission (CWC) monitors water quality [3][4], by collecting samples from representative locations within the processing & distribution system. These samples are analysed at the well equipped laboratories. At these laboratories samples from raw water, filter water and treated water are taken for analysis. The estimation of water parameters like turbidity, pH, dissolved oxygen, etc is done with the help of meters. So the disadvantages [5] of this existing system are that; there is no continuous and remote monitoring, human resource is required, less reliable, no monitoring at the source of waters i.e. no on field monitoring and the frequency of testing is very low. Due to these disadvantages of the existing system it is required to develop a system that will allow real time and continuous monitoring of water quality [7].

Thus various advanced technologies for monitoring water quality have been proposed in the recent years. In [8] the structure of the wireless sensor networking in which a number of sensor nodes are located in a lake is proposed. A much smaller number of UAVs also watch the lake and they are controlled by the central monitoring station (CMS). The sensor nodes and UAVs are both movable whereas the CMS is fixed. The CMS collects the information from the sensors and process them. In [9] a framework for monitoring water quality by incorporating bacterial contamination of water for open water bodies using WSN (consisting of sensors for sensing parameters of interest), UV Light to probe the contamination of water and Fluorescence as a monitoring tool is proposed. [10] presents a web based wireless sensor network [1], [2] for monitoring water pollution by means of Zigbee and WiMax technologies. This system would have a local Zigbee network that will be capable of measuring various water quality parameters, a WiMax network and web based monitoring with the help of a controlling computer. The system is intended to collect and process information, thus making decisions in real time via a remote web server. The data is directed through the Zigbee gateway from sensor nodes to the web server by means of a WiMax network, thus permitting users to distantly monitor the water quality from their place instead of gathering data from the scene. Experimental results revels that the system is capable of monitoring water pollution in real time [11].

III. PROPOSED SYSTEM

The main aim here is to develop a system for continuous monitoring of water quality at remote places using wireless sensor networks with low power consumption, low cost and high detection accuracy. pH, conductivity, turbidity level, etc are the parameters that are analysed to improve the water quality. Following are the objectives of idea implementation [12]:

- To measure water parameters such as pH, dissolved oxygen, turbidity, conductivity, etc using available sensors at remote place.
- To collect data from various sensor nodes and send it to base station by wireless channel.
- To simulate and analyze quality parameters for quality control. (Graphical and numerical record using MATLAB)
- To send SMS to an authorized person automatically when water quality detected does not match the preset standards, so that, necessary actions can be taken.

The detailed block diagram of water quality monitoring system is shown in Figure 1.

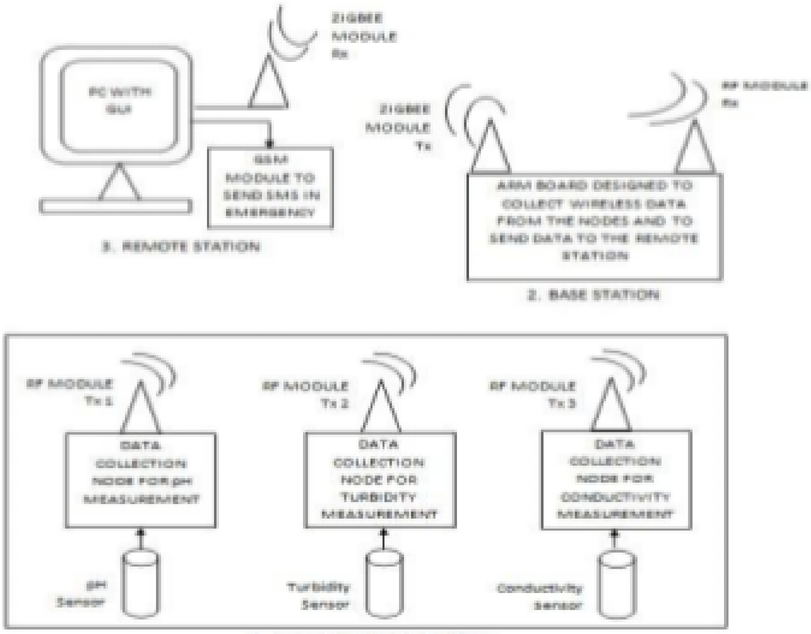

Fig 1: Block diagram of proposed Wireless Sensor Network

A. *Hardware Design:*

The proposed water quality monitoring system based on WSN can be divided into three parts:

- Data monitoring nodes
- Data base station
- Remote monitoring centre

(a) Data Monitoring Nodes

Figure 2 illustrates the data monitoring nodes which consist of sensors (pH, turbidity and conductivity), signal conditioning circuit, a controller and RF module. The data sensed by the sensor will be passed through a signal conditioning circuit in order to manipulate the analog signal in such a way that it meets the requirements of the next stage for further processing. Then the manipulated data will be given to the controller (PIC16F877A). The inbuilt ADC will convert the analog signal to digital signal for further processing. With the help of the RF module the manipulated sensed data will be sending to the data base station as shown in figure 1.

(b) Data Base Station

The data from all the nodes is collected at the data base station consisting of ARM processor (LPC2148) as shown in figure 3. The data from each node is collected one after another i.e. using time multiplexing. This obtained data is displayed on a LCD display. Also, this data is forwarded to the remote monitoring station via zigbee module.

(c) Remote Monitoring Station

The remote monitoring station consists of a zigbee module which will receive the data sent by the data base station. This data will be fed to a server PC consisting of Graphic User Interface (GUI) via serial communication as shown in figure 4. The obtained data will be represented graphically with the help of MATLAB and will be saved for further reference. Also the obtained data is compared with the standard values of the water parameters. If the obtained water parameters do not match the preset values then SMS will be sending to an authorized person in order to take preventive measures.

The distribution of rainfall, and other related hydrological variables such as river flow and recharge, is determined by the prevailing climatic regime.

3. THREATS TO SUSTAINABILITY OF WATER RESOURCES:

Here, we would like to emphasize three main threats to the sustainability of any water resource: climate change, water pollution, and the adverse impacts of water resource management practices. These threats are identified based on the definition of sustainable water resources that has been introduced in the previous section.

- It is necessary to study and analyze the impacts of subsidies (on water, energy, and other relevant inputs) on water use. Subsidies that inhibit water use efficiency or cause negative effects on the environment should be reduced.
- Our traditional water management approaches and systems were both sustainable and accountable. These need to revived and invigorated. Policies must recognize and build on these.
- Principles of reuse and recycling of water resources must be incorporated into water management plans and strategies. There must be incentives for water conservation[7].

PUBLIC EDUCATION AND AWARENESS

- Public awareness and education on the importance of protection of the coastal and ocean environment helps to meet social and economic needs and aspirations of the country in the long run.
- Awareness campaigns on existing regulations for management of coastal areas need to be conducted. Education and communication material on the need for conservation and protection of rare and endangered species need to be developed.
- Research findings on marine resources, their development and management have to be demystified. The educational and communication material targeted at the public has to be developed in local languages.
- Opportunities for interactions between communities, policy makers, regulating agencies, NGOs, scientists, etc. need to be increased.
- Appropriate strategies and decision making tools that would enhance the capabilities of professionals, Government, and non government organizations to take up local and community level action programmes need to be developed[8].

DEFINITION OF SUSTAINABLE WATER RESOURCES

We define a sustainable water resource as a **flux of water** that is **managed** with the objective of maintaining **the availability and quality** of water for as long as the **current climate** prevails.

In presenting this definition, we would like to highlight four related issues:

First, we emphasize that a sustainable water resource is a flux of water that reflects the natural rate of replenishment of the water resource through the hydrological cycle. A sustainable water resource is not a stored volume of water. This distinction is particularly important when considering groundwater aquifers, natural lakes, and man-made reservoirs. The value of any groundwater aquifer as a water resource system is directly proportional to the rate of recharge to the aquifer. Here, the hydrologic concept of the aquifer as a water reservoir is indeed more relevant than the geologic concept of the aquifer as a water holding formation. Similarly, the inflow to natural lakes and man-made reservoirs is the important variable to consider in evaluating the corresponding sustainable water resource.

Second, in assessing sustainability of a water resource the quality of water is an important consideration. Water quality is as relevant as water availability. However, these two issues are not independent from each other. For example, pollution of an aquifer may limit the value of the abundant recharge to the aquifer. On the other hand, excessive pumping from an aquifer may result in degradation of the water quality to the extent of limiting the usefulness of the water resource.

Third, the sustainability of any water resource is largely a function of how we manage it. Water management practices that utilize the water stored in any reservoir without considering the corresponding rate of replenishment are not sustainable. Sound management practices should seek to maintain the quality and availability of the water resource indefinitely. This represents the only pathway towards sustainability. Any other pathway would result in compromising the quality and/or availability of water for future generations.

Fourth, the direct relationship between sustainability of water resources and climate is emphasized. One of the most important impacts of climate change is the potential for changing the distribution of sustainable water resources. A water resource that is sustainable in the current climate may not continue to be sustainable if climate changes.

WATER CONSERVATION

Water conservation can be defined as:

1. Any beneficial deduction in water loss, use, or waste.
2. A reduction in water use accomplished by implementation of water conservation or water efficiency measures; or,
3. Improved water management practices that reduce or enhance the beneficial use of water a water conservation measure is an action, behavioral change, device, technology, or improved design or process implemented to reduce water loss, waste, or use. Water efficiency is a tool of water conservation. That results in more efficient water use and thus reduces water demand. The value and cost-effectiveness of a water efficiency measure must be evaluated in relation to its effects on the use and cost of other natural resources.(e.g. energy or chemicals)[1]

GOALS

The goals of water conservation efforts include:

- Sustainability- To ensure availability for future generations, the withdrawal of fresh water from an ecosystem should not exceed its natural replacement rate.
- Energy conservation- Water pumping, delivery, and wastewater treatment facilities consume a significant amount of energy. In some regions (e.g. California[2]) of the world over 15% of total electricity consumption is devoted to water management
- Habitat conservation- Minimizing human water use helps to preserve fresh water habitats for local wildlife and migrating waterfowl, as well as reducing the need to build new dams and other water diversion infrastructure.

CONSERVATION TECHNOLOGIES

Process of conservation may be synonymous of preservation against loss or waste. Briefly stated it means putting the water resources of the country for the best beneficial use with all the technologies at our command. Water conservation basically aims at matching demand and supply. The strategies for water conservation may be demand oriented or supply oriented and/or management oriented. The strategies may vary depending upon the field of water use, domestic, irrigation or industrial use.

1) Rainwater harvesting- Rainwater harvesting essentially means collecting rainwater on the roofs of building and storing it underground for later use. Not only does this recharging arrest groundwater depletion, it also raises the declining water table and can help augment water supply. Rainwater harvesting and artificial recharging are becoming very important issues. It is essential to stop the decline in groundwater levels, arrest seawater ingress, i.e. prevent seawater from moving landward, and conserve surface water run-off during the rainy season[3].

Advantages

1. Provides self-sufficiency to water supply
2. Reduces the cost for pumping of ground water
3. Provides high quality water, soft and low in minerals
4. Improves the quality of ground water through dilution when recharged
5. Reduces soil erosion & flooding in urban areas

6. The rooftop rainwater harvesting is less expensive & easy to construct, operate and maintain. In desert, RWH only relief.
7. In saline or coastal areas & Islands, rainwater provides good quality water

2) Better Irrigation Practices- Conservation of water in the agricultural sector is essential since water is necessary for the growth of plants and crops. A depleting water table and a rise in salinity due to overuse of chemical fertilizers and pesticides has made matters serious. Various methods of water harvesting and recharging have been and are being applied all over the world to tackle the problem. In areas where rainfall is low and water is scarce, the local people have used simple techniques that are suited to their region and reduce the demand for water.

For crop irrigation, optimal water efficiency means minimizing losses due to evaporation, runoff or subsurface drainage. An evaporation pan can be used to determine how much water is required to irrigate the land. Flood irrigation, the oldest and most common type, is often very uneven in distribution, as parts of a field may receive excess water in order to deliver sufficient quantities to other parts. Overhead irrigation, using center-pivot or lateral-moving sprinklers, gives a much more equal and controlled distribution pattern. Drip irrigation is the most expensive and least-used type, but offers the best results in delivering water to plant roots with minimal losses[4].

3) Use of Saline Water for Irrigation- Saline water is widely available but rarely used for agriculture because it restricts plant growth and yield. Salt resistant varieties of crops have also been developed in recent times.

4) Mulching, i.e., the application of organic or inorganic material such as plant debris, compost, etc., slows down the surface run-off, improves the soil moisture, reduces evaporation losses and improves soil fertility.

5) Fog and dew contain substantial amounts of water that can be used directly by adapted plant species. Artificial surfaces such as netting-surfaced traps or polyethylene sheets can be exposed to fog and dew. The resulting water can be used for crops.

6) Contour farming is adopted in hilly areas and in lowland areas for paddy fields. Farmers recognize the efficiency of contour-based systems for conserving soil and water.

7) Tippy Tap for water conservation: - Tippy Tap is a simple device which dispenses a limited amount of water slowly and facilitates a thorough hand wash. In case of piped water supply, every time the tap is opened for a hand wash, an average of 300 - 500 ml of water is utilized. Using Tippy Tap it is possible to have a good hand wash with only 60 to 80 ml of water

8) Propagation of Dry Garden / Eco Lawns- As a step towards water conservation and propagation of native plant species, drought resistant plantation (plants requiring less water) should be carried out.

9) Soak pit construction- Water run offs and water logging are combated by constructing soak pits near water points like hand pumps. This is a sanitation measure and also helps in recharge of ground water.

10) Tree plantation in water catchments area/riverbanks and clean-up drives near water bodies are some of the other initiatives taken up to preserve our water resources.

11) Desalination- To augment the depletion of fresh water resources in coastal areas due to excessive abstraction, desalination like distillation, electro-dialysis and reverse osmosis are available. Selection and use of these processes is site specific.

12) Long Distance Transfer of Water- Transfer of water from surplus basins by creating storage at appropriate locations and inter-linking various systems is yet another strategy for increasing the benefits considerably[5].

MEASURES OF WATER CONSERVATION

Water conservation measures in industries should include: (i) review of alternate production processes and technologies from water consumption point of view; (ii) ensuring sound plant maintenance practices and good house keeping, minimizing spills and leaks; and (iii) optimization of treatment to achieve maximum recycling. Another established technique for maximum water recovery is the water pinch analysis technique. However, this technique only focuses on maximizing freshwater and wastewater reduction via reuse and regeneration[6].

WHAT WE CAN DO TO CONSERVE WATER?

- Use only as much water as you require. Close the taps well after use. While brushing or other use, do not leave the tap running, and open it only when you require it. See that there are no leaking taps.
- Use a washing machine that does not consume too much water. Do not leave the taps running while washing dishes and clothes.
- Install small showerheads to reduce the flow of the water. Water in which the vegetables & fruits have been washed - use to water the flowers & plants.
- At the end of the day if you have water left in your water bottle do not throw it away, pour it over some plants.
- Re-use water as much as possible
- Change in attitude & habits for water conservation
- Every drop counts!

IMPROVE WATER MANAGEMENT

- The close link between forests and water, and the traditional relationship between agriculture and water, need to be recognized and protected to ensure sustained productivity.
- National water management policies should take account of the impact of trade in water-intensive goods on water availability and ecosystems integrity. For example, in water scarce regions, people should grow crops with low water requirements, or of high value compared to the water used. Options for improving the water balance by importing water intensive goods from water-rich regions should be explored, where appropriate and cost-effective.
- The potential of rainwater harvesting for augmenting rural and urban water supply is increasingly becoming recognized. This alternative should be further explored and utilized.
- Proper water pricing must be an integral part of water policies. However, care must be taken to ensure that the poor and socially disadvantaged are not denied access. Moreover, there must be adequate monitoring and control of market mechanisms.