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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

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station. The remote monitoring station is usually a PC with Graphic User Interface (GUI) for users to evaluate water quality data. The recorded data can be evaluated using various simulation tools for future correspondence and actions.

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.

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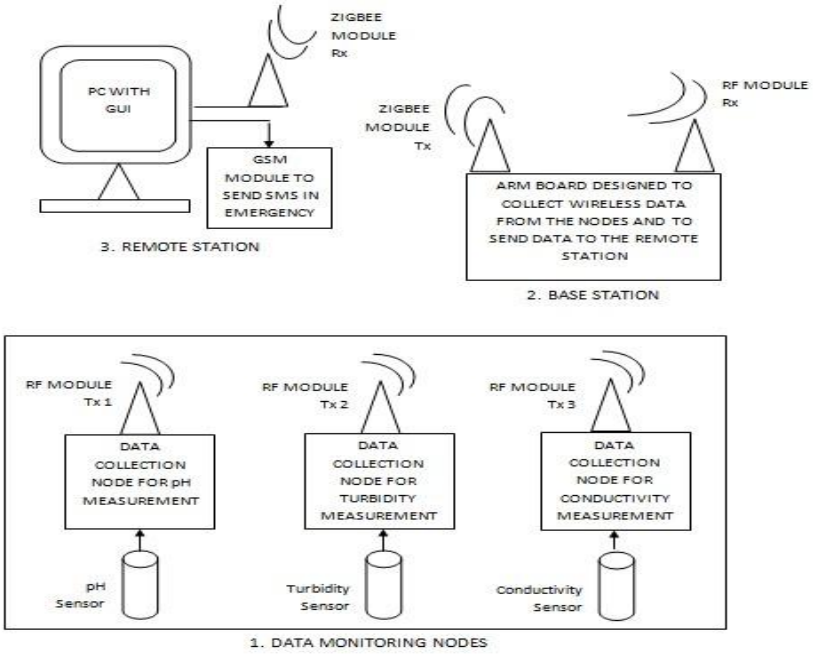

Fig 1: Block diagram of proposed Wireless Sensor Network

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.

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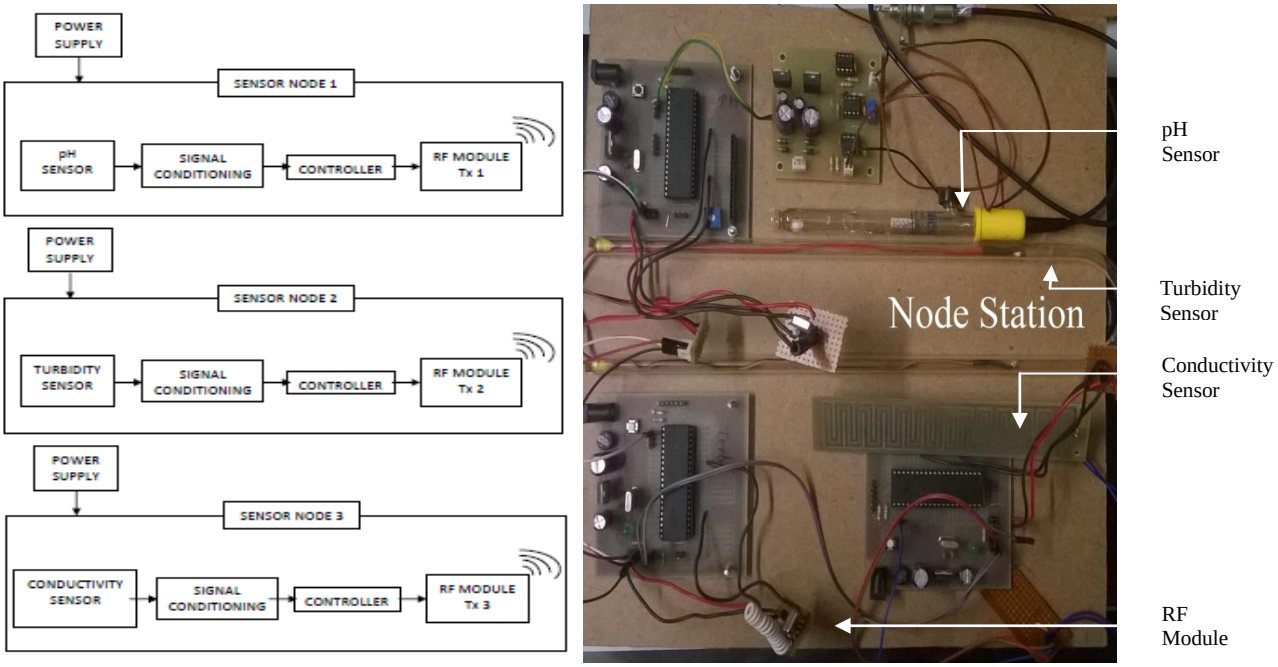

Fig 2: Data Monitoring Nodes

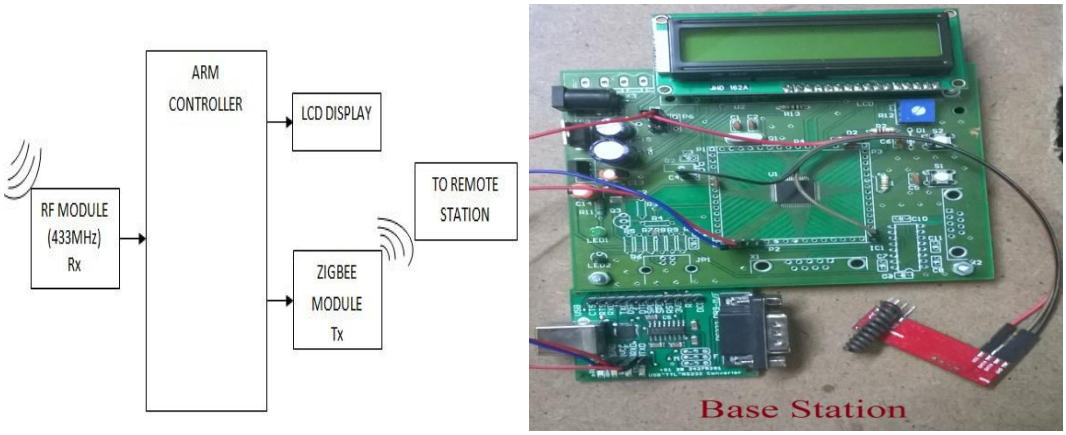

Fig 3: Data Base Station

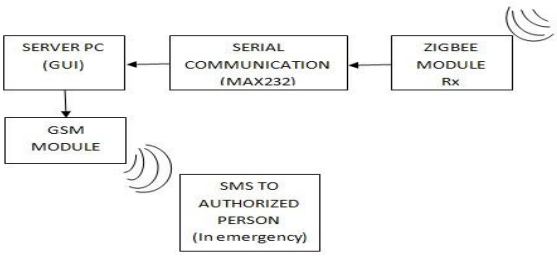

Fig 4: Remote Monitoring Station

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B. *Software Design:*

Software design approach for water quality monitoring system is based on three parts, first is PIC programming, ARM programming and GUI design in MATLAB. PIC programming is done in MPLAB IDE version 8.92 and ARM programming is done in Keil uVision4 IDE software. Embedded C is used as the programming language. The GUI platform is successfully developed using the MATLAB software which is able to interact with the hardware at the remote monitoring station.

Detailed flowchart for the working of whole system as well as software design is shown in figure 5.

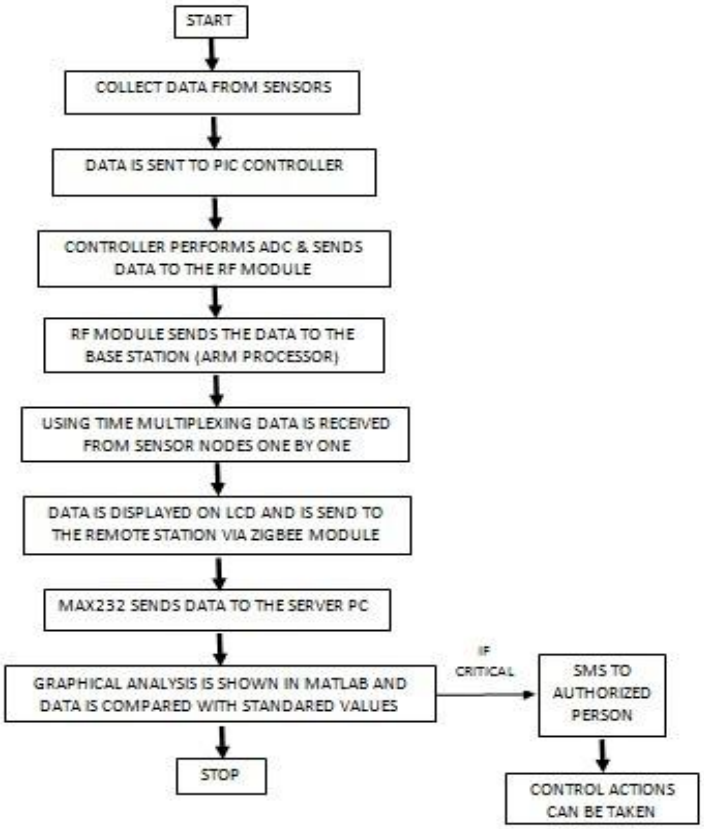

Fig 5: General Workflow of Water Quality Monitoring System

IV. SIMULATION RESULTS

The graphical user interface using MATLAB, displaying results is shown in figure 6. Water parameters are collected from the nodes as shown in figure 2. Then this data is displayed on LCD as shown in figure 3. Collected data is forwarded to the server PC with GUI shown in figure 4. From prior testing, a threshold value (range of values) is defined for the monitoring of pH, turbidity and conductivity of water. Depending on whether the average of the values obtained is less than or greater than the defined threshold, we get to know whether the water is acidic or basic, conductivity is high or low, is the water pure or impure and hence if it is suitable or not for the specific purpose.

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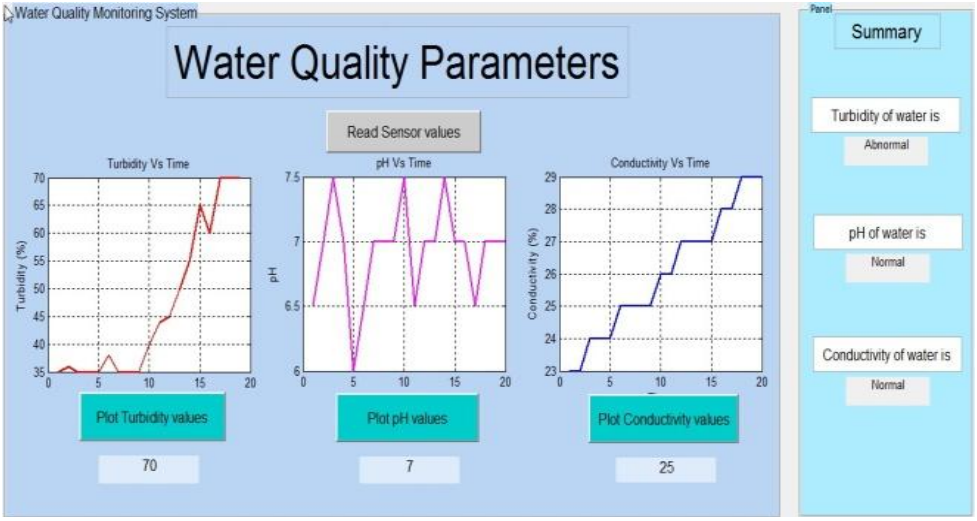

Fig 6: Snapshot of GUI of results displayed on PC.

V. CONCLUSION AND FUTURE WORK

The paper addresses about developing an efficient wireless sensor network (WSN) based water quality monitoring system, which examines "water quality", an important factor as far as, irrigation; domestic purposes; industries; etc are concerned. Water pollution can be easily detected by this system, which will help in controlling it. Overall the proposed execution of high power Zigbee based WSN for water quality monitoring system offering low power utilization and low cost is presented. Another important fact of this system is the easy installation of the system that is the base station can be placed at the local residence close to the target area and the monitoring task can be done by any person with very less training at the beginning of the system installation. Performance modelling is one important aspect in different environment to be studied in the future as different kind of monitoring application requires different arrangement during system installation.

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