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Continuous Water Quality Monitoring System for Water Resources at Remote Places

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Abstract—The current water quality monitoring system is a manual system with tedious process and is very time consuming. Thus to overcome the problems caused by the manual monitoring, a real time water quality monitoring system for water resources at remote places is proposed. 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. This approach brings several advantages over current monitoring systems in terms of cost, portability, and applicability.

Keywords— Continuous monitoring, real time, wireless sensor network, pH sensor, turbidity sensor, conductivity sensor, zigbee technology.

INTRODUCTION

Water quality monitoring is an essential question in the whole world today. At present, for remote checking, satellite is generally used to screen the water quality for waterways, lakes, oceans and seas. In any case, satellites just offer a full scale perspective of the water quality. When it comes to a specific locale of interest, the precision of the satellite surveillance may not meet our prerequisites. With the advancement of correspondence innovation and sensor innovation [1][2], particularly the idea of remote sensor system and Cyber-Physical System (CPS), numerous endeavors have been made toward building new water quality observation advancements taking into account remote sensors conveyed submerged. Sensors have been produced for submerged environment that have the capacity to gather precisely a few water quality parameters, for example, temperature, chemical substances, pH, turbidity and so forth. These sensors can be outfitted with enhanced correspondence capacity, for occasion, transmitting information. Utilizing remote correspondence system, it is presently possible to arrange sensors as an independent sensor organize that gives ceaseless, exact water quality measures in moderately huge water body, for example, lakes. Submerged sensors system can serve as a promising and a reciprocal methodology with satellite surveillance for an exact remote detecting of water quality.

In this paper we describe the design of Wireless Sensor Network (WSN) 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 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.

LITERATURE SURVEY

Central Water Commission (CWC) monitors water quality [3][4], by collecting samples from representative locations within the processing & distribution system. These samples are analyzed 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 [12].

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 analyzed to improve the water quality. Following are the objectives of idea implementation [11]:

- 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.

(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 center

(a) Data Monitoring Nodes

Figure 1 illustrates the data monitoring nodes which consist of a number of sensors (pH, turbidity, dissolved oxygen, conductivity, etc), 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. 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 as shown in figure 2. 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 Center

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 3. 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.

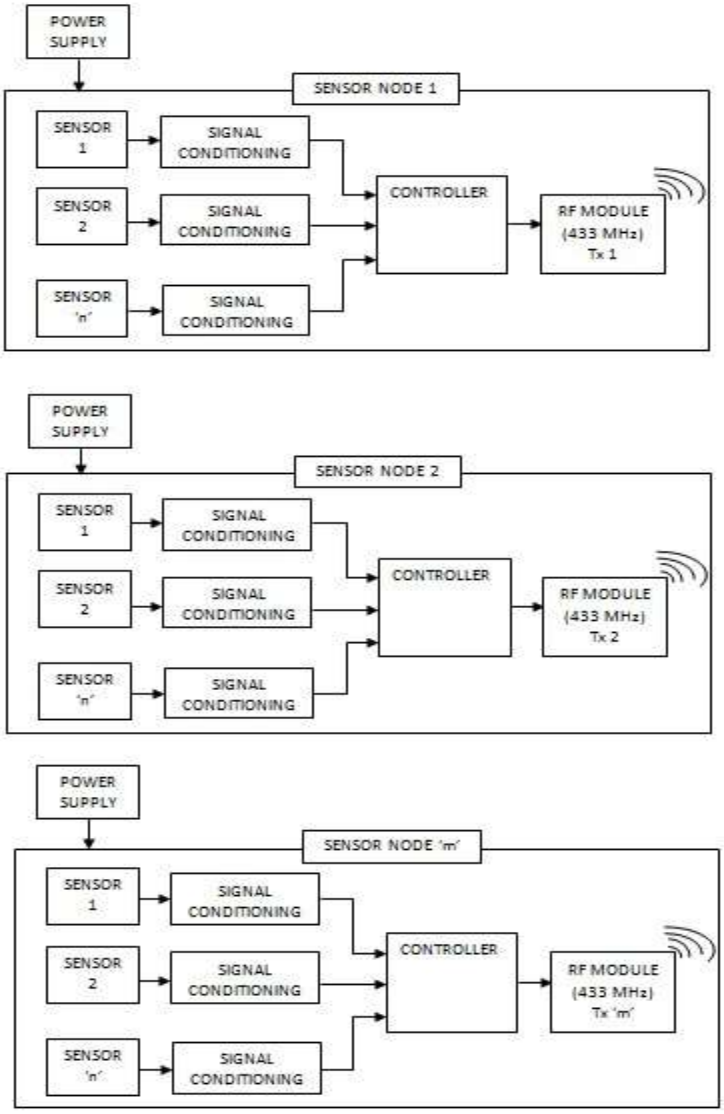

Figure 1: Data Monitoring Nodes

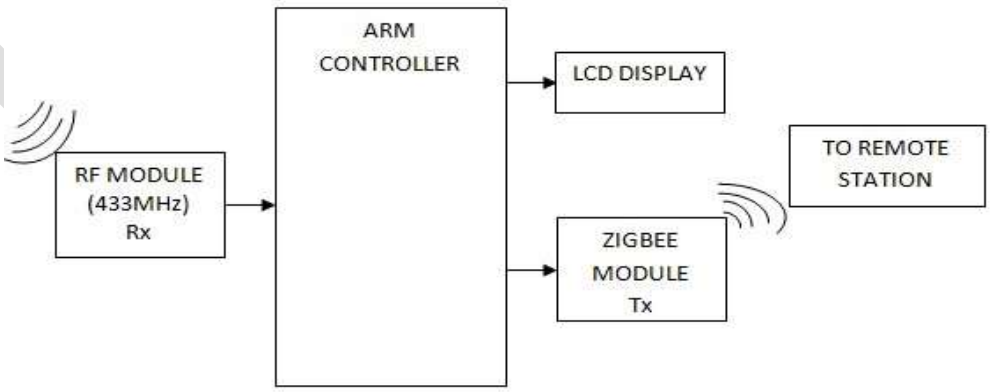

Figure 2: Data Base Station

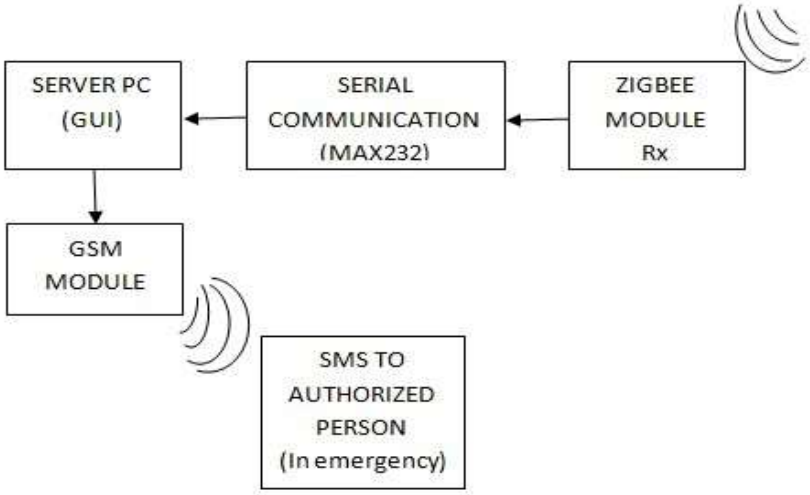

Figure 3: Remote Monitoring Station

(A) 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. The layout design of the front end of the GUI is shown in figure 4.

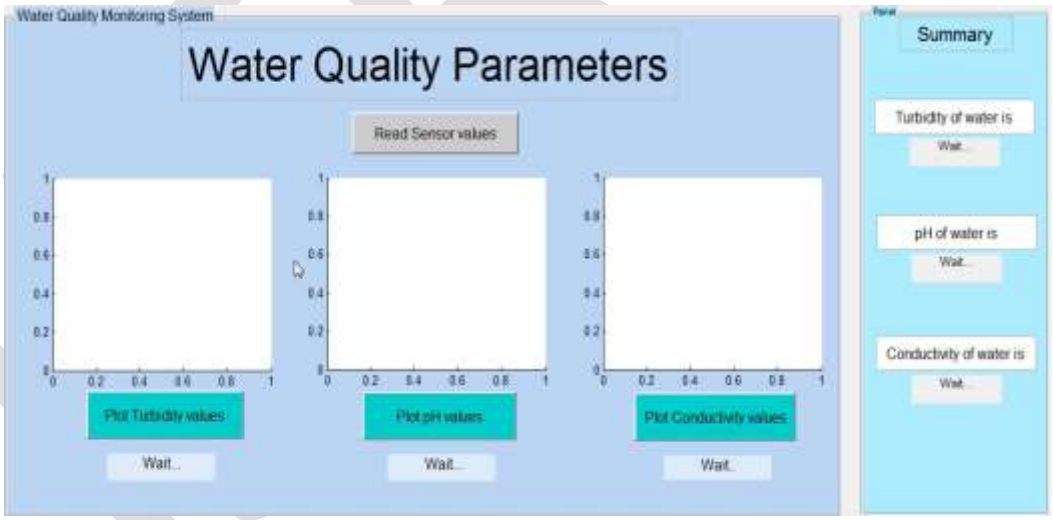

Figure 4: Layout design of the front end of the GUI

Once the sensor node is turned on, the conductivity, pH and turbidity sensors immersed in water start sensing the respective data. A push button named “Read sensor values” is provided for reading the conductivity, pH and turbidity values. Once the user clicks on this push button of the panel the zigbee transceiver on the receiver side sends a signal to the zigbee transmitter on the transmitter side demanding the corresponding data values to be sent. The push buttons named “Plot turbidity values”, “Plot pH values” and “Plot conductivity values” plots the different values that are obtained at the receiver side. Once the values are plotted, it is inherently saved and stored in MS Excel Database. These values are also displayed in the textbox continuously, shown in Fig.4.

RESULTS

The graphical user interface using MATLAB, displaying results is shown in figure 5.

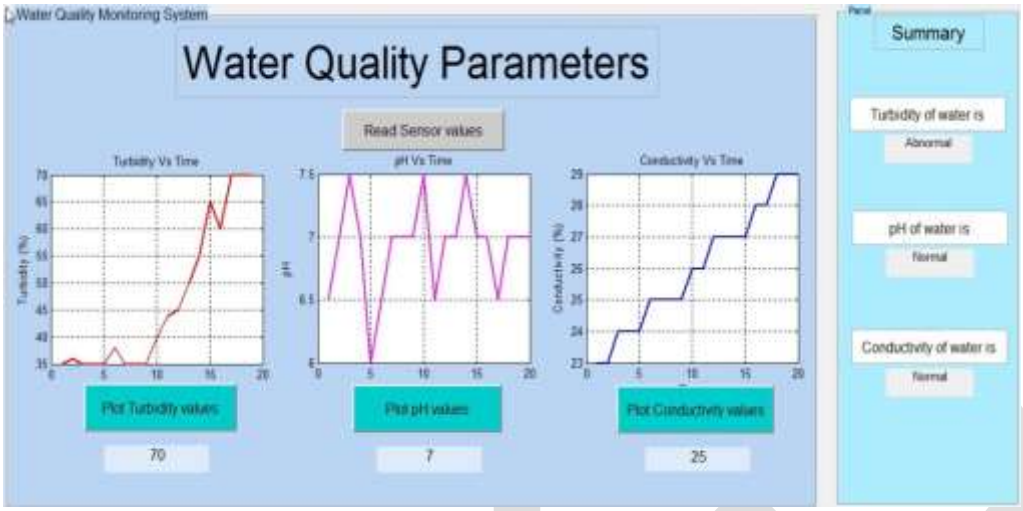

Figure 5: Snapshot of GUI of results displayed on PC.

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.

CONCLUSION

The project 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. Overall the proposed implementation of high power Zigbee based WSN for water quality monitoring system offering low power consumption and low cost is presented. Another important fact of this system is the easy installation of the system where 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 minimal training at the beginning of the system installation.

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