

WATER QUALITY MONITORING AND CONTROL USING WIRELESS SENSOR NETWORKS

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Abstract - The main reason for need of effective and efficient monitoring and control of water quality in lakes, rivers and sea tends to keeping the human resources healthy and sustainable, and to increase population growth and urbanization. Due to climate changes and variability so many huge impacts are caused by the water system to the natural environment. Incredible methods are used by collecting water samples, testing and analyses in water laboratories alone. However, It is not always easy to be captured, analyses and fast dissemination of information to relevant users for making timely and well-versed decisions. In this paper, Water Sensor Network (WSN) system prototype is developed for water quality monitoring in Lakes is presented. These kind of growth was introduced by the assessment of widespread atmosphere that including accessibility of cellular network coverage at the site of process. The system consists of an PIC microcontroller, water quality sensors, and wireless network connection module. It detects water temperature, ph (Potential of Hydrogen), and electrical conductivity in real-time and disseminates the information and these are sent to relevant stakeholders through a web-based portal and can be gain via mobile phone platforms. These Information are specified with the location of the lakes where it has been placed. With the view to complementing the experimental results that shows the system has immense vision and can be used to run in real world environment for monitoring and optimum control of water resources by providing relevant and timely information to stakeholders for facilitate quick action taking and protect themselves.

Key Words: Wireless Sensor Networks, Lakes, Cellular Network Coverage, Mobile Phone Platforms, Sensor Nodes..,

1.INTRODUCTION

The importance of maintaining good water quality is to increasing the need for advanced technology to help monitor the water condition and maintain the water condition. However, In this paper, we are using the lake water for monitoring that provides some important service such as water for drinking, domestic purpose, sites for recreational activity, and important fisheries and also agricultural purpose. If pollution are involved in lake water, then it can reduce the quality of water and so that it is unsafe to drink as well as harm organism that lives in water. The negative collisions of climate change and inconsistency are compounding the accessible challenges. As a result, increasing number of human activities has progressively speed-up contagion and damage to fresh water resources in the lakes. This traditional advance of water quality monitoring based on variety and subsequent analyses in water laboratories is exclusive, time-consuming and has a low promise both in time and space.

Over recent years, wireless sensor networks (WSNs) have received substantial consideration in environmental and industrial monitoring and control applications. A wireless sensor network is a self-configuring network of having a small sensor nodes that are communicating among themselves using some radio signals and deployed in quality to sense, monitor and understand the physical world.

A type of wireless networking which is comprised on number of numerous sensors and they have been interlinked or connected with each other for performing the same function collectively or cooperatively for the sake of checking and balancing the environmental factors. Generally, WSN is used for monitoring the physical conditions such as weather conditions, regularity of temperature, oxygen content also deals in the field of technology related to sound.

In this paper we used different sensors to measure water pH, conductivity, dissolved oxygen (DO) and temperature. In existing paper, they measured pH, Dissolved Oxygen, conductivity, oxidation reduction potential, light and temperature of water. The authors reported that the system cost around US \$1040. However their approach used a computer as the gateway which is costly.

In this paper, a planned WSN water quality monitoring system sample is presented. The system consists of a PIC microcontroller, a set of water quality sensors, and a network connection module. It measures water quality parameters including temperature, Dissolved Oxygen, pH and electrical conductivity (EC) values in immediate. The experimental results showed that the system has great prospect and can be used to operate in real world environment for optimum control of aquaculture environment. Furthermore, the prototype is suitable for long-term outdoor environments and implement low-cost gateway module.

2. PROPOSED SYSTEM

In this paper, the proposed Wireless Sensor Network system prototype was developed as a essential of the Water Resource in Natural Environment. The main reason of proposed WSN system prototype is to evaluate the water quality for the purpose of determining whether it reaches the criteria for drinking and urbanization through the operation and management of water resources in the basin and sample water. The proposed WSN system consists of four major building blocks namely, sensor nodes, WSN gateway node and application software, Zigbee transceiver and mobile phone platforms.

1.1 Sensor Node

For developed WSN system prototype the WSN sensor node is main building block. Wireless sensor node is equipped with sensor and microcontroller units, Global Positioning System (GPS) receiver, power supply and Zigbee transceiver. Several sensors used for detection of water quality parameters and also it is sensor unit consideration. The general characterization of water quality have three sensors for measuring Ph (Potential of Hydrogen),

EC (Electrical Conductivity) and DO(Dissolved Oxygen) in this prototype. Generally, this sensor node is scalable to allowing more sensors depending on needs review the specifications for sensors used in the prototype. **Table 1**

summarizes the specifications for sensors used in the prototype.

The pH, EC and DO sensors are interfaced to the microcontroller using their respective circuits from Atlas Scientific. For their operation the all sensors are powered by Power supply. The Zigbee transceiver transmits sensed parameter values and GPS information to a gateway node. To connect all the sensors to the microcontroller unit, a WaGoSy sensors carrier board can be used. The sensors were calibrate to ensure correct operation and accuracy in the resulting water quality parameter values.

The microcontroller and a software programme consist by microcontroller unit and it determines the behavior of the WSN sensor node. PIC16F877A microcontroller, an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software was used to acquire and process sensor data. However the GSM data is captured and sent to the gateway in preset time interval and not continuously to reduce power consumption.

Table -1: Summary of Architecture of the Sensor Nodes

S/N	SENSOR	MANUFACTURE	MODEL	RANGE
1	pH	Atlas Scientific	ENV-40-Ph	0-14(Na ⁺ error at>12.3 pH)
2	DO	Atlas Scientific	DS18B20	0 - 20 mg/L

1.2 Gateway node

Generally the Gateway nodes provide the communication device that gives remote network with connectivity to a host network. Gateway serves as the entry and exit point of a network. All data routed inward or outward must first pass through and communicate with a gateway in order to use routing parts. In proposed system the WSN system gateway is one of the most essential and unique block. From multiple sensor nodes the gateway node collect all received information. The developed gateway is equipped with microcontroller unit, Global System for Mobile Communication (GSM) module, Zigbee transceiver and power supply. Through the Zigbee transceiver PIC16F877A microcontroller is used to acquire and process received sensor data from WSN sensor nodes. The GSM module residing on top of the gateway node is used to communicate with the cellular network to forward the Short

Message Services (SMS) data to specified stockholders. This is quad-band low power consumption Global System for Mobile Communications (GSM)/GPRS module. In these it needs a user SIM to transmit the resulting values.

1.3 WSN Zigbee Transceiver

The WSN based on Zigbee transceiver was implemented for the purpose of lower cost and low power consumption and high performance. The data rate provided by the ZigBee transceiver is of 250 kbps at 2.4 GHz. The physical range of a zigbee is to 10 to 20 meters. Zigbee can be used for coordinator, router and sleeping device. It is integrated into IEEE 802.15.4-2003 PHY and MAC layer. In this, ZigBee 32 bit ARM cortex and M3 processor can be used. It allows small, low cost devices to transmit quickly the small amount of data such as sensor readings. The specification is a packet based radio protocol intended for low cost, battery operated devices. The protocol allows devices to communicate in a variety of network topologies and can have battery life lasting several years. It provides ability to run for years on inexpensive batteries for a host of monitoring and control applications. In this the Zigbee can act as both transmitter and receiver. For that there are two Zigbee one on the microcontroller and the other on the PC. First all the three sensors were dipped into the water. Then the sensor can sense the purity in the water and send the values to the PC. This can be done through the microcontroller and the Zigbee. First the sensor sends the values to the microcontroller then the microcontroller transmits the sensed values to the PC through the Zigbee transceiver. Finally, the sensed values sent to the mobile phones through GSM.

A. Transmitter section

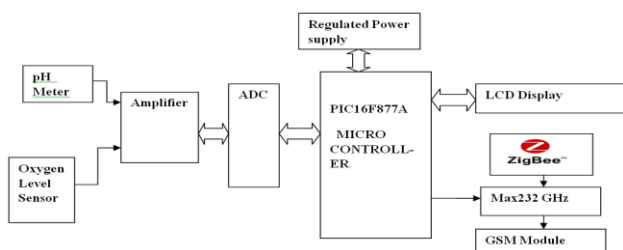


Fig -1; WSN Transmitter Section Architecture

B. Receiver section

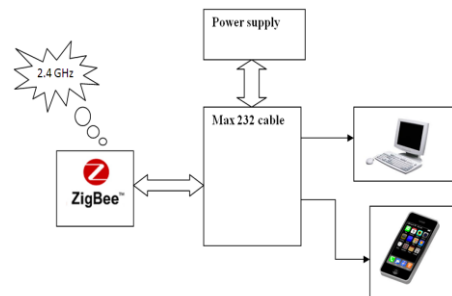


Fig -2; WSN Receiver section architecture

1.4 WSN Power Supply

In a Wireless Sensor Node system for water quality monitoring, where sensor nodes are presented through the connectivity of Microcontroller Unit, power supply is an extremely important issue to deliberate. The only important method to power the sensor nodes in WSN application is to use battery. The advantages are obvious, but the usage batteries have limited lifespan and cannot stand for a long time. Replacing depleted batteries regularly is difficult. To avoid unnecessary work and make the system more flexible to deploy, different energy harvesting schemes like solar panel can also be used to re-charge the battery.

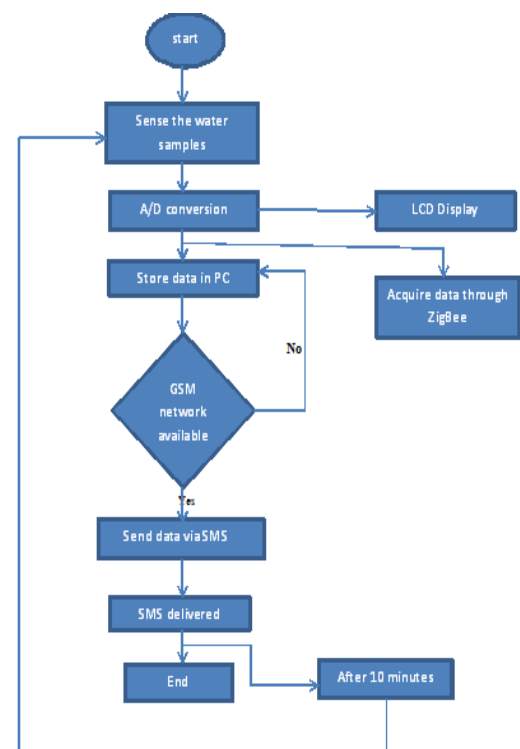


Fig -3; Flowchart of Data Processing at the Gateway Node.

In the Existing prototype, they used 3.7 Volt 6 AH rechargeable polymer lithium ion batteries to power the WSN nodes. This battery has longer life and excellent long-term and self-discharge rates. However it provide less than 5 V required by most components on the WSN sensor nodes and gateway node .A 10 Watt power supply was used to provide continues battery charging in day time when the current is not present. The weight of the battery that we proposed is having 7.4 kg . The capacity of the battery is higher.

1.5 Application Software

The Wireless Sensor Network system software contains some system database management that is used to store the acquired data and to display the Information. These module includes some visualization that allows users to exhibit, and compare water quality parameters and includes locations in text format representation. In this paper, The Software module was developed using languages as Dotnet, Embedded C, My SQL and Java scripts .For Database Management alone we can use My SQL language.

3. RESULT AND DISCUSSION

The wireless sensor node plays a vital role in the proposed system prototype. During evaluation, the sensor can acquire the resulting values and send it to PC. This can be done through the microcontroller unit and zigbee transceiver. A software programme was developed and uploaded into the microcontroller to allow the wireless sensor nodes to measure water quality constraints. However, GSM transmit data at time interval of 10 minutes. The respite of the time, the sensor nodes are in rest condition to safeguard the battery power. Once the information are captured, the WSN sensor nodes capture the data through the Zigbee transceivers and send the values to the PC. Then the Zigbee transceiver again fetches the values and transmits to the mobile phone through GSM to the relevant stakeholders. The experimental values are sending simultaneously to the mobile phone after 10 minutes. In this paper we proposed a solution for facilitate the ability to measure water quality parameters in lakes at specified sites continuously. Because instead of using computers Mobile phones gives the efficiency for the stakeholders for analyzing and detecting.

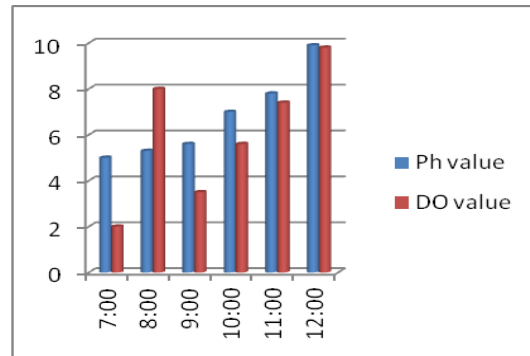


Fig-4; Values of pH and DO sensors.

In this graph, we are displaying the resulting Sensed PH and DO values. It continuously senses the values of PH and DO but the resulting values are displayed to the mobile after 1hour. So, in this paper we compare the number of the mobile users and the PC users. The below graph shows that the mobile users has a high range in comparison to the PC users.

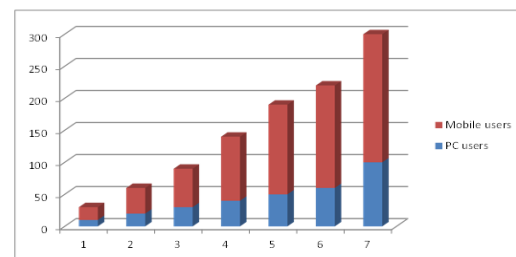


Fig-5; Comparison of users in Existing and Proposed system

4. CONCLUSIONS

In this work, the development and protest of a low cost, continuous water quality monitoring WSN system prototype is described. The system uses low cost sensors and open source hardware aiming at providing continuous water quality measurements at substantially reduced cost. The system has capability to continuously measure water quality parameters and transmit them to a database in real-time. The resulting values can finally send to the mobile phone device by 10 minutes. With the use of mobile phones platforms, the values of measured parameters are displayed in easy-to-comprehend as text message format anytime and anywhere. The result can send to the mobile phone via GSM as normal and abnormal water based on their suitable values.

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