Test Bed For Real-Time Monitoring of Water Quality Using Wireless Sensor Networks

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Abstract— **Water bodies across the globe are known by the quality of water they maintain. Due to increasing interferences from various extraneous factors, the quality of water is deteriorating at an alarming rate. The conventional mechanism (discrete and mechanical) adopted to monitor quality of water is time consuming, costly and less effective under many hostile situations. Hence, technology intervention is required to keep a constant vigil on different parameters determining the quality of water. In this context, the paper proposes a solution based upon the use of wireless sensor networks to design a generic test bed for Real Time Monitoring of Water Quality. The parameters to be monitored in real time include pH value, conductivity, dissolved oxygen, turbidity, temperature, ORP/Redox and would be transmitted to a based station or control/monitoring room over a TCP/IP network for further action.**

Keywords— **Wireless Sensor Networks, Water Quality Monitoring, Under Water Sensors, Data Acquisition, Automated Water Quality Monitoring (AWQM).**

I. INTRODUCTION

The motivation of this work stems from the deteriorating conditions of the world famous Dal lake in Kashmir valley[1]. The world famous Dal Lake, Srinagar is regarded as a nerve centre of Kashmir Tourism. It is a multi-basin lake surrounded by mountains on its three sides. A large number of gardens including world famous Moughal Gardens & Orchards have been laid along its shore. It is believed to be fed by a number of underground springs but the main source is the Telbal Nallah.

The water quality of Dal Lake has deteriorated considerably in the last two decades. With the increase in the number of house boats, a large number of residential buildings, restaurants and hotels coming up along the lake front, the authorities are finding it difficult to monitor and keep a check on the raw sewage discharge entering Dal Lake from different directions. The polluted water has resulted in excessive weed growth, reduction in water clarity, enrichment of waters and high microbial activity. Both central and the state Govt. of J&K have taken the issue very seriously and lot of efforts are being made to improve the lake environment by using both physical and biological approaches.

This paper focuses on a solution for monitoring the water quality of the Dal Lake in real time. The parameters of water quality[4] proposed to be monitored include pH value, Conductivity, Dissolved Oxygen, Turbidity, Temperature, ORP/Redox. For this purpose wireless sensor network with appropriate underwater sensors shall be used. The solution is supposed to leverage the advantages of wireless sensor networks in terms of cost and size, fault tolerance, easy deployment, wide coverage, remote connectivity and self healing.

II. PROPOSED SOLUTION

Recent advances in wireless communications and electronics have enabled the development of low-cost, low-power, multifunctional sensor nodes that are small in size and communicate unattended in short distances.

The wireless sensor network shall be built around crossbow motes like MicaZ. Such motes operate on TinyOS an open source operating system suitable for embedded applications. These motes can create adhoc network using XMesh networking protocol a propriety protocol of Crossbow. These tiny and generally simple sensor nodes consist of sensing units, data processing, and communicating components[2]. A large number of such nodes deployed over large areas can collaborate with each other to monitor various physical parameters including the ones determining the water quality. They also support Tiny DB Database which is an appropriate database for acquisition of data by sensor networks.

The actual architecture[3]will be built around a host of underwater sensors to be interfaced with data acquisition system and sensor network. A generic block diagram of data acquisition system is given in fig. 1. The underwater sensors to be used for sensing pH value, Conductivity, Dissolved Oxygen, Turbidity, Temperature, ORP/Redox shall give current output in the range of 4 ma to 19 ma proportional to the physical parameters indicated above. Care will be taken to use sensors which are completely encapsulated in marine grade appoxy within a stainless steel housing. As the monitoring is intended to be carried out in an unattended area with limited access, signal or data from the sensor unit will then be transmitted wirelessly to the base/monitoring station.

With proper signal conditioning circuits, the current output from the underwater sensors shall be changed to appropriate voltage levels to be fed to ADC channel of a data acquisition board like MDA320. Data acquisition board MDA 320 supports upto 8 channels of 16 bit analog input with single ended 0 to 2.5 volt inputs or 4 differential 0 to 2.5 volt ADC channel. It also supports 8 digital 0 to 2.5 volt IO channels,

64K EEPROM for sensor calibration data, 200Hz counter channel and external 12C interface.

Usage of crossbows mote works software along-with XMesh protocol, XServe, XSnifer, Mote Config, PN2 and Mote view platform shall enable the development of custom sensor application by making use of open source Tiny OS operating system and NesC as a programming language.

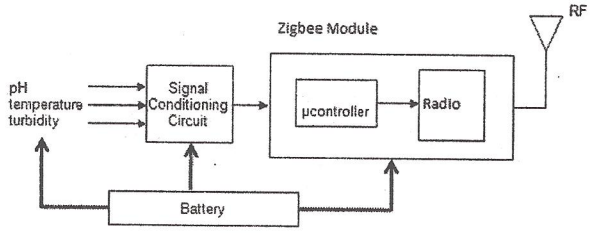


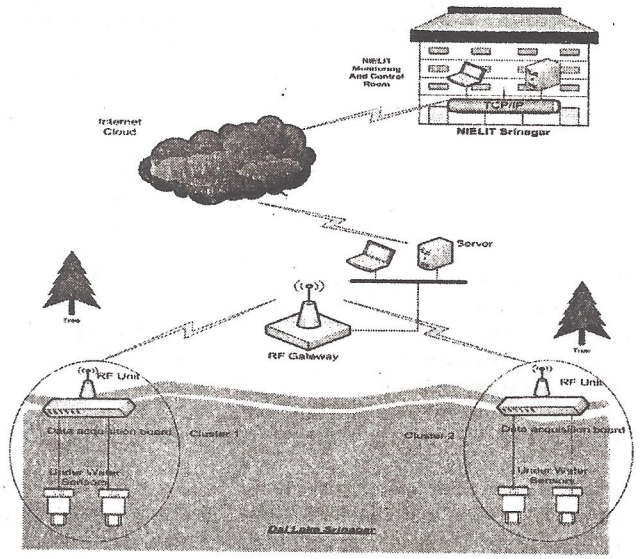
Figure 1: Block diagram of data acquisition

The data acquisition board shall be integrated with processor and radio platform like NPR 2400 CA based on Atmal Atmega 128 L. The Atmal Atmega is a low power microcontroller which runs mote works from its internal/memory. The radio is IEEE 802.15.4 compliant and offers a speed of 250kbps with hardware security (AES 128).

The sensor node would be connected to a Base Station/Ethernet gateway like MIB 600 to create a wireless sensor network. MIB 600 gateway will provide an Ethernet (10/100 Base-T) connectivity to sensor nodes for communication and in system programming. The MIB 600 allows remote access to sensor network data via TCP/IP. The MIB 600 serial server connects directly to a 10 Base-T LAN like any other network devices. It will be used to bridge wired and wireless components of sensor network and shall be programmed as a coordinator that receives the data sent from the sensor nodes wirelessly. The two separate ports offered by the gateway shall be used for in system mode programming and data communication over Ethernet. Application server shall be connected to gateway using either Ethernet or USB interface. For remote transmission, a TCP/IP link will be created between the onsite test bed and a control room to be established initially at NIELIT Srinagar. Mote view software will be used on the client side to display the sensed data for monitoring purposes. The sensed data will also be logged in the corresponding Postgress database located in the remote station.

III. Conclusion

The proposed test bed for Real Time Monitoring of water quality is under implementation at National Institute of Electronics & Information Technology (NIELIT) Srinagar/Jammu. Experimentation as proof of concept related to acquisition of data using Data Acquisition Board and transmission of sensor data to the base station/gateway wirelessly using IEEE 802.2.15.4 complaint radio has been carried successfully. The sensor data has been successfully visualized on Mote view platform and also logged in the Postgress database. Simultaneously simulation is being carried out using TOSSIM, TinyViz, Octopus to generate and analyze various scenarios.



The actual test results would be published once the test bed is successfully deployed at the designated site.

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