Water Quality Monitoring System

Rajnikant Bhandare, Mayur Chhajed, Suyog Sonavane

***Abstract*— Good water quality is essential for the health of our aquatic ecosystems. Continuous water quality monitoring is an important tool for catchment management authorities, providing real-time data for environmental protection and tracking pollution sources; however, continuous water quality monitoring at high temporal and spatial resolution remains prohibitively expensive. An affordable wireless aquatic monitoring system will enable cost-effective water quality data collection, assisting catchment managers to maintain the health of aquatic ecosystems.**

In this project, a low-cost wireless water physic-chemistry sensing system is presented. The results indicate that with appropriate calibration, a reliable monitoring system can be established.

This will allow catchment managers to continuously monitoring the quality of the water at higher spatial resolution than has previously been feasible, and to maintain this surveillance over an extended period of time. In addition, it helps to understand the behaviour of aquatic animals relative to water pollution using data analysis. [1]

***Index Terms*—About four key words or phrases in alphabetical order, separated by commas.**

I. INTRODUCTION

The problems of water scarcity are being felt more and more with every passing day. Changing weather patterns (due to global warming) and the pollution of fresh water bodies, have resulted in an inadequate supply of water for human use. It is important that our water resources be monitored and maintained to ensure that they are not being polluted by effluents from industries or domestic sewage. Maintaining good water quality in rivers and streams benefits both humans and aquatic ecosystems. Water is the essential element for humans to live. Equally, this principle applies to amphibians and aquatic animals. Any imbalance in water quality would severely affect the health of the humans and simultaneously affect the ecological balance among species. Hence, it is of prime Importance to protect the quality of water pollution remains a key factor contributing to declining ecological health in aquatic ecosystems worldwide. In Australia, the state of Victoria is facing a major challenge in maintaining water quality in the freshwater systems. Nearly 80% of waterways in Victoria are in poor to moderate condition and there has been little improvement from previous years. Remediation efforts are hampered by the difficulty of diagnosing the causes of environmental degradation. Currently, low-resolution water quality monitoring is conducted, and water samples are collected at regular periods for chemical analysis in the laboratory. The disadvantages of this approach are:

(a) Data collection is patchy in space and time, so sporadic pollution events can easily be missed;

(b) It is time-consuming and expensive for personnel to collect water samples, return to laboratory to test and repeat the same procedure for different water resources;

(c) There are certain biological and chemical processes such as oxidation-reduction potential that need to be measured on-site to ensure accuracy;

(d) Laboratory testing has a much slower turnaround time compared with on-site monitoring;

(e) Interpretation of data collected across different seasons is difficult, as the data is sparse both in space and time.

Water pollution occurs when pollutants are discharged directly or indirectly into water bodies without adequate treatment to remove harmful compounds. Water pollution affects plants and organisms living in these bodies of water. In almost all cases the effect is damaging not only to individual species and populations, but also to the natural communities. Water covers over 70% of the earth's surface and is a very important resource for people and the environment. Water pollution affects drinking water, rivers, lakes and oceans all over the world. This consequently harms human health and the natural environment.

II. LITERATURE SURVEY

A *Automated water monitoring system for west and Rhode Rivers, USA*

The application of high spectral and spatial resolution airborne remote sensing has developed to an almost operational level. We investigate the role of remote sensing especially coupled to the two other available water quality assessment tools: in situ measurements and ecological water quality modeling data. In USA, they implemented an automated water monitoring system for west and Rhode Rivers. They developed a multi-sensor heterogeneous real time water monitoring system using the parameters like ph, temperature, conductivity, turbidity and dissolved oxygen. Monitoring air pollution using zigbee based wireless sensor network with the help of GIS technology. [2]

B. *The 2nd UN World Water Development Report, March 2006*

According to the United Nations in 2005, an estimated 1.1 billion people worldwide lack clean drinking water and 2.6 billion lack access to basic sanitation. Hence, 2005-2015 was designated the International Decade for Action: "Water for Life". Clearly, the international community has recognized that water distribution must be carefully monitored and controlled in terms of water quality and quantity. While the degradation of water quality (WQ) is almost invariably the result of human activities, certain natural phenomena can

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result in WQ falling below the standard required for particular purposes. Natural events such as torrential rainfall and hurricanes lead to excessive erosion, landslides and mudflows, which, in turn, increase the content of suspended material in affected rivers and lakes. Seasonal overturn of the water in some lakes can bring water with little or no dissolved oxygen (DO) to the surface. These events may be frequent or occasional and have increased as a result of climate change. Permanent natural conditions in some areas may make water unfit for drinking or for specific uses, such as irrigation. Additionally, there are naturally occurring areas of high nutrients, trace metals, salts and other constituents that can limit the use of water.

The nature and concentration of chemical elements and compounds in a freshwater system are subject to change by various types of natural processes – physical, chemical, hydrological and biological – caused by climatic, geographical and geological conditions. [3]

C. *Case Study of Kuwait Beaches*

We are going to discuss what happened during Sep. and Aug. of 2001, The Kuwaiti Bay, the embayment is enclosed to the Arabian Gulf it is experienced that there is a great fish and those fishes are considered a killer fishes, it is involving more than 2500 metric tonne of the savage mullet, because of the spherical Gram positive bacteria. In the Kuwaiti Bay, this issue had been preceded by the small killing fishes (one hundred to one thousand fish in the day) of podlanica sea bream in the aquaculture net pens which is connected to the bloom of Ceratium furca which is considered one of the species of the marine dinoflagellate. Sea bream had been found and considered a positive culture for the S. agalactiae, but didn't provide us with any obvious signs of the disease. Uncommonly the temperature of the warm was (more than 35 °C) and the conditions of the calm had been overcome during this time. As the severe kill fish had been progressed, different kinds of the harmful algae were visible for the people, such as the Gyrodinium impudicum, catenatum, Pyrodinium bahamense var and compressum. The number of the Cell especially G. catenatum - G. impudicum had been elevated to reach 1006 l−1 in different positions. It was hypothesized which there are several factors had participated in the primary outbreak of the disease that leaded from the bacteria, such as the unusual warm and the calm condition. These factors which enriched nutrient condition which appear obviously were conducive to the succeeding H.A.B outbreaks.

A wireless sensor network (WSN) is the system of the autonomous which composed of some of great numbers from the micro sensor nodes which are characteristics by high level of the sensing, and it calculate the communication, this system is low power and low cost. It is considered so smart system which manages different tasks in the monitoring process, as the different conditions of the environment. This system monitors the water environment and the typical application. The system have the ability to compare between the existing real time automatic and the monitoring systems, the WSN based on the environment of the water to monitor and to get the strong points. [4]

III. SYSTEM MODEL

A. *Hardware Requirements*

1] pH Sensor:

Range: 0 to 14 pH

Body: Glass

Type: Combination

Sensor Output: +/-59.4mV/pH change at 25C

Temperature: 0~100C

2] Conductivity sensor:

Range 0 to 10000uS/cm.

Cell constant: K=1

Operating Temperature: 0 to 80C

3] Turbidity Sensor:

Power supply required: 5V

Range: 0 to 10 NTU

Temperature: 0~100C

4] Temperature Sensor:

Calibrated directly in ° Celsius

Linear + 10.0 mV/°C scale factor

0.5°C accuracy guaranteeable

Rated for full −55° to +150°C range

Figure 3.1: Transmitter Section

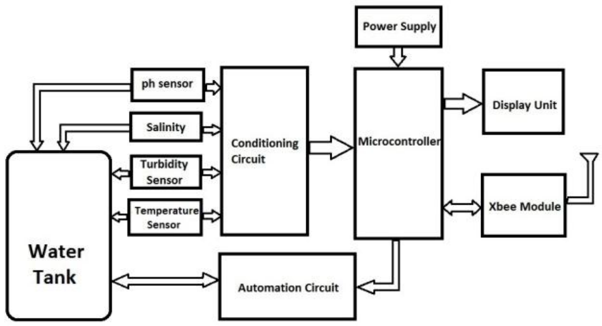
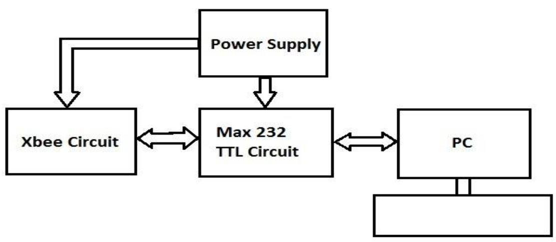


Figure 3.2: Receiver Section



IV. DESIGN

1] Turbidity Sensor:

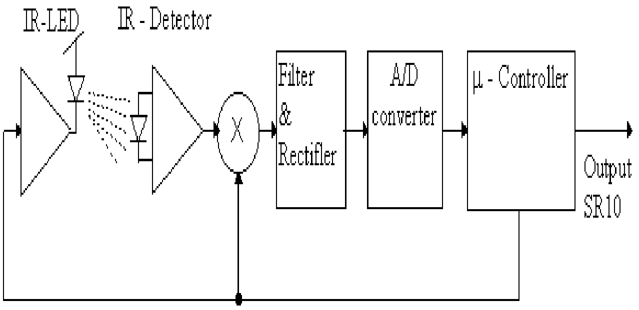


Figure 4.1: Block diagram of Turbidity sensor

The turbidity sensor we are using is a combination of a Light dependent resistor (LDR) and a light emitting diode (LED). LDR is a variable resistor whose value decreases with increasing incident light intensity. An LDR is made of a high-resistance semiconductor. If light falling on the device is of high enough frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electron conduct electricity, thereby lowering resistance. A photoelectric device can be either intrinsic or extrinsic. In intrinsic devices, the only available electrons are in the valence band, and hence the photon must have enough energy to excite the electron across the entire band gap. Extrinsic devices have impurities added, which have a ground state energy closer to the conduction band - since the electrons don't have as far to jump, lower energy photons are sufficient to trigger the device. If the voltage produced is above 20 mV then the turbidity is in limit or else if it below 20 mV then turbidity exceeds the limit which shows the water has lots of debris present in them.

2] pH Sensor:

A pH probe consists of 2 electrodes- a reference electrode and a measuring electrode as shown below in figure 4.2:

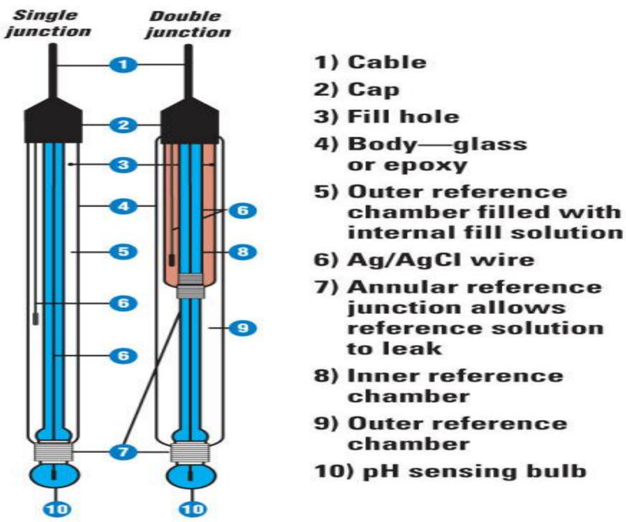


Figure4.2: pH Sensor

The reference electrode is positioned in a reference solution of fixed pH and is thus maintained at a constant voltage against which the voltage of the measuring electrode can be measured. The measuring element is a thin glass membrane that is permeable by H+ ions. When the probe is immersed in an H+ rich environment (acidic) the glass membrane is permeated by the H+ ions which exert a positive potential on the sensing electrode. Thus a potential difference is produced which indicates the pH of the solution.

3] Conditioning Circuit for pH Sensor:

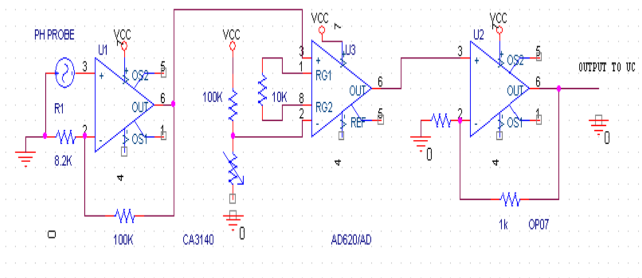


Figure 4.3: Signal Conditioning circuit of pH Sensor

Ideally the pH probe produces:

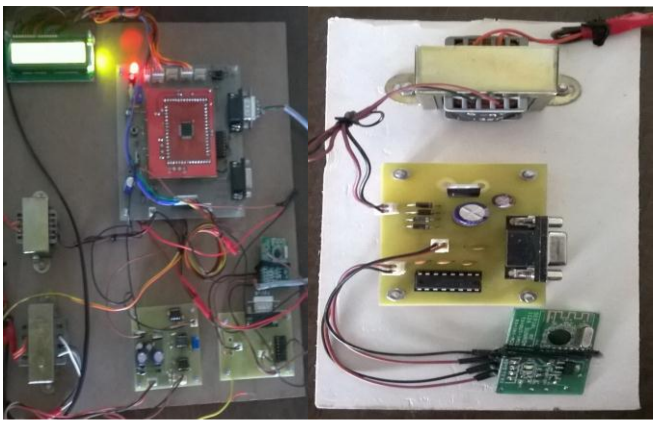
0V in a neutral solution

+ive voltage in an acidic solution

-ive voltage in a basic solution

The output of the pH probe is given to a non-inverting amplifier made using an Op-Amp. (The Op-Amp chosen is the TL072 which is a JFET Op-Amp with an input impedance of 1000G Ω. An extremely high input impedance is required because the impedance of a pH probe is anywhere between 10M Ω and 100 M Ω and care must be taken to ensure that it is not loaded down by the signal conditioning circuit.) The non-inverting amplifier, thus acts as a high input impedance buffer and also provides a gain of 2. The output of the first Op-Amp stage is given to an inverting amplifier+adder stage. This stage provides a gain of approx. -2 and also adds a voltage to the input to ensure a positive voltage at the output for all pH values. Thus a voltage starting at 0V for pH 0 and varying linearly with pH is obtained at the output

4] Hardware kit:



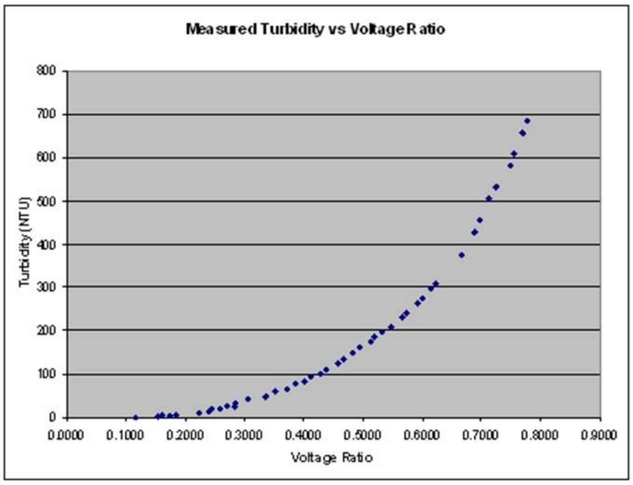
Transmitter kit Receiver kit

V. Simulation Results

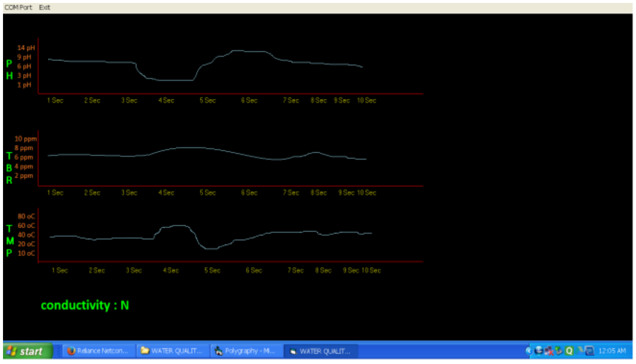
B. pH Sensor

VOLTAGE (mV)	pH value	VOLTAGE (mV)	pH value
414.12	0.00	-414.12	14.00
354.96	1.00	-354.96	13.00
295.80	2.00	-295.80	12.00
236.64	3.00	-236.64	11.00
177.48	4.00	-177.48	10.00
118.32	5.00	-118.32	9.00
59.16	6.00	-59.16	8.00
0.00	7.00	0.00	7.00

C. Turbidity Output



D. Visual Basic



VI. Conclusion

Thus by implementing our project we can efficiently monitor the water at low cost. This method offers low power consumption with high reliability. The use of high power WSN is suitable for activities in industries involving large area monitoring such as manufacturing, constructing, mining etc. Another important fact of this system is the easy installation of the system where the base station can be placed at the local 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.

VII. Future Scope

1. 1] In order to monitor quality of water in various sites, future works can be focused on establishing a system with more sensor nodes and more base stations. Nodes and base stations are connected as WSN, the different base stations are connected via Ethernet. The Ethernet can also be connected to internet so the user can just login to the system and get a real time water quality data faraway.

2] The data transceiver is integrated in Zigbee and is programmable. Finally, the prototype system with a single sensor node and base station is designed and implemented. Real-time water quality data can be seen from a GUI window in PC. The system has advantages such as low carbon emission, low power consumption, more flexible to deploy and so on. Connections between nodes and base station are via WSN, while connections among different base stations are via Ethernet. The Ethernet can also be connected to Internet so that users can login to the system and get real time water quality data faraway Process Improvement

3] The wireless data acquisition from remote places and database storage is the supporting structure of the system which can be used for further research studies like soil content analysis using different simulators. The simulation can be used for water pollution control in varying conditions. Also it can be used to guess abnormal moments in sea stomach by measuring the turbidity at the sea shore.

VIII. References

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[3] The design of a Water Quality Wireless Sensor Network (WQWSN).
[4] Wireless Sensor Network (WSN) for Water Monitoring System: Case Study of Kuwait Beaches.
[5] Solar based advanced water quality monitoring system using wireless sensor network. International Journal of Science, Engineering and Technology Research (IJSETR), Volume 3, Issue 3, March 2014 ISSN: 2278 – 7798 All Rights Reserved © 2014 IJSETR 385