

# Wireless Sensor Network for Real Time Monitoring and Detection of Water Contamination

*Trupti R. Patil, Prof.R.M.Khaire*

Dept. of Electronics  
BVDUCOEP  
Pune,India

Dept of Electronics And Telecommunication  
BVDUCOEP  
Pune,India

[Trjoshi84@gmail.com](mailto:Trjoshi84@gmail.com)

**Abstract:** Clean drinking water is very important for the health of Human being. Water distribution system facilitates the delivery of water to consumers But this systems are prone to contamination – which may be intentional or accidental. Infrastructure of the drinking water distribution system is very complex in the environment. This paper gives a novel and low cost approach towards the problem of water quality monitoring. The paper focuses on developing low cost sensors for monitoring different water parameters. These sensors are in-pipe sensors and can be used for real time monitoring of the water quality in water distribution systems. A sensor array is developed based on some important water parameters. selected water parameters are pH, Turbidity, Electrical Conductivity and Temperature. A circuit for analog signals conditioning, processing is also developed.

## I INTRODUCTION

Drinking water quality and safety is ensured by the authorities, but a 100% safeguard against contamination may be accidental or incidental is practically impossible. There may be different points at which contaminants may enter into the water distribution system. If we consider our water distribution systems they are prone to different contaminations. These contaminations may be incidental or they may be accidental. There may be different points at which contaminants may enter into the water distribution system due to which water become hazardous to the health. . If a contaminant enters in a water distribution system it will get mix with the water which is flowing in the distribution system and get transported with the flowing water It is Very Difficult (or virtually impossible) to protect all points of entry of contaminants. But we can try to minimize such contamination .With a rising population and growth of economy we require a better on line water quality monitoring system.

Traditional methods of detection of water contamination involves collection of water samples which need to be collected manually at various locations and at different times , then they are tested in the laboratory .So in such method of testing we require more time to get results and in this approach of testing it is not possible to do the online monitoring. Also it is very difficult to take samples at remote locations .This leads to a need of developing a more efficient water quality monitoring system which can monitor and detect water contamination in a real time manner .As Network Technology is developing with the help of combination of communication media ,computer technology and rising sensor network technology we can find the solution to such problems.WSN plays an Vial role in the real time and large scale monitoring .US Environmental

Protection Agency (USEPA) has carried out an extensive experimental evaluation of water quality sensors to assess their performance on several contaminations.[1,2] They have concluded that many biological and chemical contaminants have an effect on many water parameters monitored including Electrical Conductivity ,Turbidity ,and pH.

This paper will contribute in designing and development of low cost Wireless Sensor network based system. The system can be used at the premises of Water distribution system for continuous monitoring of water quality.

The paper is organized as below: Section II gives details of related work ,Section III described about Water quality parameters ,Section IV details about System design ,Section V Talks about Results , finally Section VI concludes the paper.

## III: RELEATED WORK

There are few online water monitoring systems available E.g, J-MAR BioSentry[4] , Hach HST Guardian Blue [3] but such systems are very bulky and costly

In a research paper “Detection of water-quality contamination events based on multi-sensor fusion using an extended Dempster–Shafer method presented by –“ Dibo Hou1, Huimei He1, Pingjie Huang1, Guangxin Zhang1 and Hugo Loaiciga2” [3] The author has presented a method for detecting contamination events of drinking water sources based on the Dempster–Shafer (D-S) evidence theory. The purpose of

this system is to protect water supply systems against intentional and accidental contamination events.

Research paper Titled “ Contamination of Water Distribution Systems” By Walter M. Grayman, PhD, PE[6] presents Mathematical hydraulic and water quality models of water distribution systems which can be used to estimate the movement of a contaminant in a distribution system

In paper “Integrated Solid-state Sensors Monitoring Water Quality for the Next Generation of Wireless Sensor Networks “ By -Serge Zhuiykov1, Eugene Kats1 1CSIRO [4] the research has been dedicated to the development of solid-state sensors which can be used for real-time monitoring of water quality parameters such as pH and dissolved oxygen (DO), dissolved organic carbon (DOC) at relatively high spatial resolutions.

The USACERL (U.S. Army Corps of Engineers Construction Engineering Research Laboratory) is working on a project to develop a more seamless and effective online water quality monitoring system.[5]

With all this ongoing research in the development and design of sensor and Microsystems the research is also going on in the development of software and algorithms for detection of water quality.

### III WATER PARAMETER DETAILS

World Health Organization (WHO) [8] and other organizations like EU[9],USEPA[10] gives guidelines for drinking-water quality .So the drinking water quality standards are based on the guidelines provided by such organizations .These organizations tells which chemical ,microbiological and other parameter should be tested and monitored in sake of the health of the consumer.

For proposed system the water quality parameter which need to be monitored are as given in below table with there standard values.

TABLE I

PARAMETERS CONSIDERED FOR MONITORING

Sr no	Parameter	Units	Quality range
1	Turbidity	NTU	0 - 5
2	pH	pH	6.5 – 8.5
3	Temperature	Degree C	-
4	Electrical Conductivity	μS/cm	500-1000

The parameters to be selected for the monitoring are Turbidity ,pH ,Temperature and electrical conductivity. another important parameter for human health is Nitrate, but it is not selected as measurement methods may subject to failures.

### Turbidity:

According to the Environmental Protection Agency (EPA), turbidity is “The cloudy appearance of water caused by the presence of suspended and colloidal matter”. Turbidity measurement is used to detect the clarity of water. Turbidity is nothing but an optical property of the water which is based on the amount of light reflected by particles which are suspended in the water

### pH:

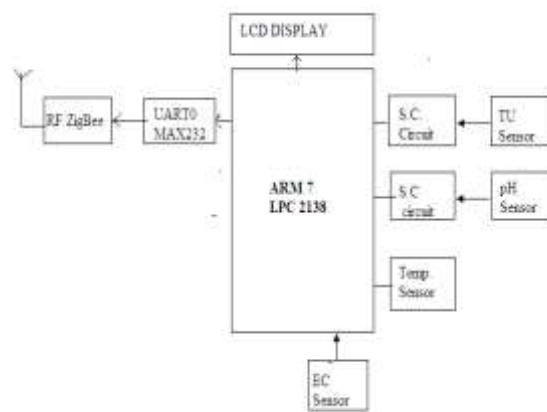
pH is a measure of the basicity or acidity or of an aqueous solution. Solutions which have a pH value less than 7 are said as acidic and solutions which have a pH greater than 7 are basic or alkaline. Clean and pure water has a pH very close to 7 pH is said to be negative logarithm of activity of the (solvated) hydronium ion ,and is often expressed as the measure of the hydronium ion concentration

### IV SYSTEM DESIGN AND ANALYSIS

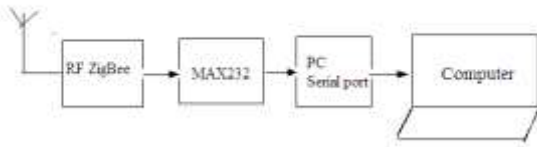
The system is build with the help of WSN and Embedded system technology.WSN is a ad-hoc network which can be easy to configure without infrastructure like cable.

Sensors which are Interfaced with the nodes will collect the parameters from the water environment .The collected parameter values will be transferred to the computer (remote center) with the help of Zigbee. In this system three type of sensors i.e. turbidity sensor, ph level sensor, and temperature sensors are used .These sensors will collect the values of water parameter to detect turbidity, ph level, temperature. For conductance measurement a small PCB is designed which will have a pattern to detect whether water is conductive or non conductive

The proposed system architecture is as shown in Block diagram:



Block diagram of Measurement Unit



Block diagram of Control Unit

The system is comprised of two Units Measurement Unit and Control Unit.

Measurement Unit consist of the measurement node which is ARM based board that collects measurements of water quality from different sensors which are interfaced to the microcontroller .Based on these measurements the controller decides the water quality .All the sensors are in pipe sensors that are installed at the site.

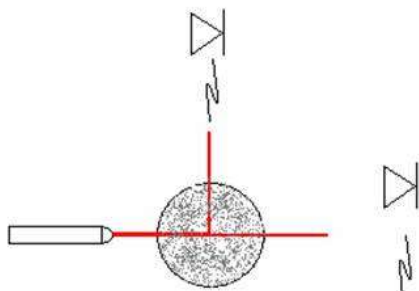
The water quality parameters which are collected and detected by the sensors are turbidity, pH level, Electrical conductivity and Temperature. By comparing all these detected values with the standard values system will determine that whether the water is clean water or contaminated water.

ZigBee is the emerging communication technology which is used in the proposed system for acquiring different water quality parameters from the water distribution system .This information is then transferred to the remote centre.

**Sensor Development:**

Turbidity Measurement:

Number of instruments are available in the market which will measure the turbidity ,but most of them are costly and not feasible for in pipe application and for WSN. The aim here is to develop cheaper and easy to Use sensor for turbidity measurement which can be mounted in the water distribution pipe .The measurement principle used here is based on the fact that when there are suspended particles in the water and if we shine the light source through it then not all light will pass straight through the water ,some light will get reflected from the suspended particles.



Turbidity Measurement Principle

So the setup for turbidity measurement will consist of the light source and the detector In this design .LED is used as the light source and LDR is used as detector .

**DETECTOR :**

There can be two choices for detector either to use photodiode as detector or LDR .Basically both are photo sensors but selection is depend on the application.In this project main aim was that the photosensor should operate efficiently in the hardy and rough environment.LDR is typically suited for such environment ,Hence It is selected as detector. Also photo diode is generally preferred in the applications that work on only two values on or off.

**LDR:**

LDR ie Light dependant resistor or photoresistor is a light controlled variable resistor.LDR exhibits photoconductivity means the resistance of the LDR decreases with increase in light incident on it. It finds application mainly in light sensitive circuits

**Light Source:**

A White light-emitting diode (LED) is selected for light source. It is a pn-junction diode, which emits light when activated. [12]

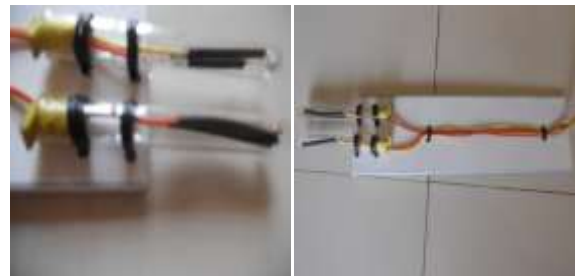


Fig:Turbidity measurement setup

**pH measurement:**

For pH measurement pH probe is used. Different types of pH probes are available in the market. In this design combined Electrode type pH probe is used.



(a) (b) (c)

Fig:(a)pH probe (b)Actual setup (c)Signal conditioning circuit for pH

**Conductivity Measurement:**

For conductivity measurement a small PCB is designed which will have a pattern to detect whether water is conductive or non conductive.



(a) (b)

Fig: (a) PCB for detecting conductivity (b) Signal conditioning circuit

**Temperature Measurement:**

For Temperature measurement we can use thermister ,thermocouple or LM35 .In this design LM35 is use as a temperature sensor .

**Processor:**

Processor Selected for the system is ARM7.It is a Family of RISC architecture .It has a very low power consumption and price for high performance devices. The contribution in the low cost system is the design of low cost networked embedded systems using ARM processor

**Complete System Modeling**



**V RESULT**

Main screen of the Water quality management system will be as shown below:



System is verified for different samples of Water .

**Sample1:** Pure water is taken as sample 1.The result is as shown below.



Result on LCD display



Visual display on Computer

**Sample 2:** Acidic Water is taken as sample 2 Result is as shown below



Result on LCD display



Visual display on Computer

**Sample 3:** Turbid water is taken as sample 3. Result is as shown below



Result on LCD display



Visual display on Computer

When the water quality parameters exceeds the allowable value a computer generated alarm is blown.

## IV CONCLUSION

With the urbanization of our society and Environment change, water pollution problems have become more complex, which requires continuous on-line monitoring and

multi-stage treatment process. Traditional methods of water quality analysis which can called as Offline approach , involves the manual collection of water samples at various locations and at different times followed by coming to the laboratory and carrying a range of analytical tests in order to characterize the water .It is very time consuming an also not much efficient. This is because It involves relatively high labour costs as well as the costs associated with maintaining a laboratory.

In This project I have designed a system with the help of Wireless sensor network and Embedded System technology which will monitor and detect the water contamination in Drinking water distribution system .The water parameters selected for the monitoring are Turbidity, pH, Electrical Conductivity and Temperature.

## REFERENCES

1. Theofanis P. Lambrou, Christos C. Anastasiou, Christos G. Panayiotou, and Marios M. Polycarpou "A Low-Cost Sensor Network for Real-Time Monitoring and Contamination Detection in Drinking Water Distribution Systems"2014
2. J. Hall . "On-line water quality parameters as indicators of distribution system contamination," *Journal American Water Works Association* , vol. 99, 2007
3. Dibo Hou<sup>1</sup>, Huimei He<sup>1</sup>, Pingjie Huang<sup>1</sup>, Guangxin Zhang<sup>1</sup> and Hugo Loaiciga<sup>2</sup> "Detection of water-quality contamination events based on multi-sensor fusion using an extended Dempster-Shafer method "2013
4. Serge Zhuykov<sup>1</sup>, Eugene Kats<sup>1</sup> "Integrated Solid-state Sensors Monitoring Water Quality for the Next Generation of Wireless Sensor Networks "ICSIRO, Materials Science and Engineering Division, 37 Graham Road, Highett, VIC. 3190, Australia 2012
5. Drinking Water Contamination Warning Systems – Design and Implementation of an Online Water Quality Monitoring System for Military water systems
6. Walter M. Grayman, "Contamination of Water Distribution Systems " - PhD, PE
7. Nisha Ashok Somani 1 and Yask Patel 2 "ZIGBEE:A low power Wireless Technology for Industrial applications " -. International Journal of Control Theory and Computer Modelling (IJCTCM) Vol.2, No.3, May 2012
8. Guidelines for Drinking-Water Quality, World Health Organization, Geneva, Switzerland, 2011.
- 9.U.S. Environmental Protection Agency, "Drinking water standards and health advisories," Tech. Rep. EPA 822-S-12-001, 2012
10. Drinking Water Regulations (No.2), European Communities, Europe,2014
11. - B.H. Tangena<sup>1</sup>, P.J.C.M. Janssen<sup>1</sup>, G. Tiesjema<sup>1</sup>, E.J. van den Brandhof<sup>1</sup>, M. Klein Koerkamp<sup>2</sup>, J.W. Verhoef<sup>2</sup>, A. Filippi<sup>3</sup>, W. van Delft<sup>4</sup> "A Novel Approach for Early warning of Water Contamination Events" 2010
12. "Carlsberg Group Company History Page". Carlsberggroup.com. Retrieved 7 May 2013