International Journal on Emerging Technologies (Special Issue on NCRIET-2015) **6**(2): 1-6(2015)

ISSN No. (Print) : 0975-8364
ISSN No. (Online) : 2249-3255

Water Quality Monitoring Over Wireless Sensor Network and Purification

Siddarud Bannikoppa and Veeresh Bhairi

Department of Electronics and Communication Engineering,
Basaveshwar Engineering College, Bagalkot (Karnataka), India

(Corresponding author: Siddarud Bannikoppa)

(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: This paper discuss about the constantly monitoring the water quality available through the taps by various sensors. The sensors involved in this are pH sensor, temperature sensor and a turbidity sensor. The data available from the various sensors is transmitted to the remote base station using 434 MHz RF module. The current study focuses on the use of multiple sensors as a device to check the of water quality as an alternative method of monitoring the condition of the water resources. The parameters which indicate the water quality are chemical substances, conductivity, dissolved oxygen, pH, turbidity etc. This work mainly concentrates on monitoring of Temperature, pH level and turbidity parameters of the water. Next step is to purify the water by using reverse osmosis process. As the monitoring is intended to be carried out in a remote area with limited access, signal or data from the sensor unit will then be transmitted wirelessly to the base monitoring station.

Keywords: Water, sensors, Wireless sensor network, Reverse osmosis.

I. INTRODUCTION

Water is one of the most essential need for the existence of human beings. The water that is available for drinking is usually contaminated by the industrial wastes and the debris found on the rock surfaces in lakes, ponds and wells. Thus the water consists of various foreign particles that make it harmful for drinking. The water that is available in home supplied through the pipes from wells. As water is a solvent, there are various dissolved minerals such as sodium, calcium, potassium, chloride, etc. which gives a tangy taste to it**.**

This work "Water quality monitoring over wireless sensor network and purification" started after considering the critical situation of the polluted natural water resources in our country. Normally the pure water comes from the sky or from the springs gets polluted when it reaches the surface of the earth. The water gets polluted due to various reasons. As the country is making its progress through industrialization, our water resources are prone to a threat of pollution especially from the industrial activities. It is a challenge in the enforcement aspect as the location of water resources due to limitation specially in man power, facilities and cost of equipment. This often lead to a too late to be handled situation. For that, it is important to have such a monitoring system with characteristics of autonomous, lower cost, reliable and flexible.

The use of automation in monitoring task will reduce the reliance on man power at the monitoring site thus reducing the cost.

This work focuses on the use of multiple sensors as a device to check the water quality as an alternative method of monitoring the condition of the water resources. Several sensors that are able to continuously read some parameters that indicate the water quality level such as chemical substances, conductivity, dissolved oxygen, pH, turbidity etc will be used to monitor the overall quality level. As the monitoring is intended to be carried out in a remote area with limited access, signal or data from the sensor unit will then be transmitted wirelessly to the base monitoring station. A currently becoming popular and widely used technology based on wireless sensor network is extensively used in this work as it is able to provide flexibility, low cost implementation and reliability. A high power transmission with a relatively low power consumption RF based wireless sensor network technology is applied in this work. It is chosen due to its features that fulfill the requirement for a low cost, easy to use, minimal power consumption and reliable data communication between sensor nodes. The 16×2 LCD is used for monitoring purposes at the base monitoring station is another main component. The LCD should be able to display the parameters being monitored continuously in real time.

Based on the quality of water measured it is sent to purification unit for further processing then in this work usage of RTC has been done for timely distribution of water through channel. Several measurement and performance analysis to evaluate the reliability, feasibility and effectiveness of the proposed monitoring system are also presented.

Monitoring of water quality continuously and to send the signals to the base station so that with the help of the GUI the user can easily monitor the quality of the water. Due to many industrial wastes dumping in the water makes it polluted. The wastes from the industries are dumped in the nearby lake or pond. So the water gets polluted and becomes unfit for living things. The manual verification of the quality of the water is tedious process. So that we have proposed a system which can use the sensor nodes which can continuously monitor the water and the signals are transmitted to the base station through the RF. The measured values are sending as signals to the base station with the help of RF Transceiver. The signal received in the base station displayed in the Screen with the help of GUI [3].

The purification is vital in many manufacturing and process industries. The entire process is being controlled through a PLC. Water treatment describes those industrial-scale processes used to make water more acceptable for a desired end-use. These can include use for drinking, industry, medical and many other uses. The water to be treated is feed to RO system for purification then followed by bottle filling process. Our motto is to minimize the water loss with the help of our system while water purification, for this purpose most efficient Ph transmitter is designed using signal conditioning circuitry. The waste water from RO system is checked for neutral Ph and further addition of acid or base is done with respect to corresponding reading. Well-designed Ph transmitter and accurate controllers will help to accomplish most accurate water treatment. Reverse osmosis is a purification process that requires special equipment. The system consists of a two-part tank that is separated by amembrane. Untreated water enters the tank on one side and is forced through the membrane. The membrane allows clean water to filter through while holding back contaminants. The treated water enters the second half of the tank and then is collected and stored for consumption [5].

The Design of water environment system based on wireless sensor network. This system takes MSP430F1611 main processor to develop automatic water environment monitoring system. In this paper authors proposed a system which the online automonitoring of water parameters like temperature and Ph [7].

II. PROBLEM FORMULATION

Pure water is used in day today life that is for drinking, industrial/household purpose. Impurities in water increases as time goes so monitoring and purifying it is a crucial task. For turbidity sake the water which is taken under consideration is taken in a test tube has to be tested. The difficulties involved were in getting the components of right value. The RO filter tends of get clogged because of the solid impurities in water.

III. WORKING PRINCIPLE

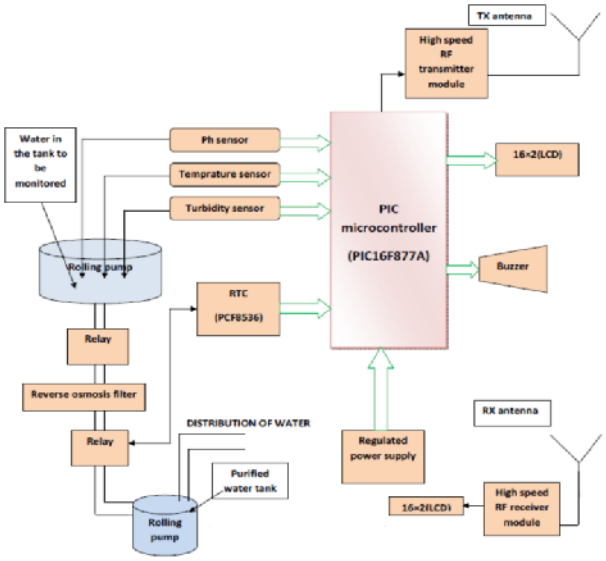


Fig. 1. Block diagram of water quality monitoring over wireless sensor network & purification.

The above block diagram shows the working principle of "water quality monitoring and automated purification, distribution system". It can be analyzed in analog as well as in digital mode. These operations can be performed by a switch. If switch is connected to ground, it works in analog mode otherwise it switches on to the digital mode.

LCD is connected to microcontroller as 4 bit data mode, before displaying anything in LCD Initialization have to do, so microcontroller will control the LCD initialization and select the data register and command register according to the purpose. The application of LCD in this project is used to display the values read by different sensors while monitoring water and also to different timer options are shown on display for RTC.

The relay coil is connected between the supply rail (+V) and the input signal. This acts as load on the driver. When the input signal coming into the relay subsystem is low, a potential difference across the relay coil causes current to flow. It is this flow of current that causes contacts to switch.

The buzzer is connected between the supply rail (+V) and the input signal. This acts as load on the driver. When the input signal coming into the buzzer subsystem is low, a potential difference across the buzzer causes current to flow. It is this flow of current that causes the buzzer to sound.

Here microcontroller PIC16F877 will act as heart of the system, and it operates in digital mode and is programmed such a way that three sensors such as pH, turbidity, LM35 temperature sensors are interfaced with microcontroller and it collects the information gathered by these sensors and microcontroller compares these values with that of preset standard values if the condition is not satisfied .preset values are set using key pad which consist of up, down, enter buttons as a result setting of standard values given by water authority has been carried out.12v DC motor will stop and does not allow the further movement of water and buzzer will produce beep sound indicating that water is beyond contamination limit which cannot purified by RO filter and if comparison in microcontroller is approved the normal process continues.

Remote monitoring unit consist of high speed RF module with transmitter and receiver in it. The transmitter/receiver (Tx/Rx) pair operates at a frequency of 434 MHz's. An RF transmitter receives serial data and transmits it wirelessly through RF through its antenna connected at pin4. The transmission occurs at the rate of 1Kbps - 10Kbps.The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitter. As a result respective pH, turbidity, temperature values can be read on 16*2 LCD by pressing the read button. Usually this receiver end is considered as handheld section and can be monitored from the distance of about 150mtrs.

Real-time clock PCF8563 is also interfaced with PIC microcontroller. The PCF8563 is a CMOS Real-Time Clock (RTC) and calendar optimized for low power consumption. This is used to set different timings for each channels this unit is having built in battery backup and three keys up, down, enter. A programmable clock output, interrupt output, and voltage-low detector are also provided. The register address is incremented automatically after each written or read data byte. It consist of Internal power-on reset function .In this proposed system time can set either in 24 or 12 hour format according to the time set DC motor will allow purified water to flow into the respective channels leads to the proper timely distribution of purified water RTC consist of lithium cell operating at the range of 3V to 5.5V Provides year, month, day, weekday, hours, minutes, and seconds based on a 32.768 kHz quartz crystal with alarm, timer functions.

IV. DESIGN AND IMPLEMENTATION

A. Hardware description

Based on the circuit diagrams this project has following circuits: PIC Microcontroller (PIC16F877), 16*2 LCD, Relay, Regulated Power Supply Unit, Rolling pump, Reverse Osmosis filter, RF module, RTC, Temperature sensor, pH sensor, Turbidity sensor.

Temperature Sensor - The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4°C at room temperature and ±3⁄4°C over a full −55 to +150°C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1°C in still air. The LM35 is rated to operate over a −55° to +150°C temperature range.

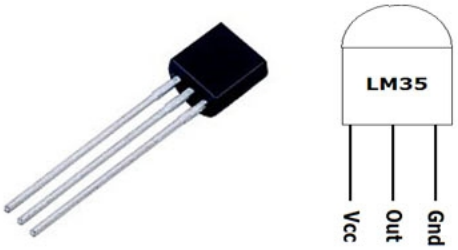


Fig. 2. LM35 temperature sensor.

pH Sensor - pH sensor in this system consist of two electrodes i.e. a reference electrode and a measuring electrode. When a salt solution is placed under the measuring electrode, electrolysis process takes place with the help of the reference solution under the reference electrode. A particular amount of analog voltage is produced. If the voltage is above 40 mV the pH value that is detected is found to be accurate. The pH has 3 levels between 0 to 14 where 7 is neutral, below 7 is acidic and above 7 is alkaline. The water available to us is found to have a pH value above 7 due to the excess chlorine in them.

Similarly when water comes in contact with these electrodes the transistor starts conducting which results in transistor conductance value to go low means when salt or impurities are more in water the resistance of water decreases same way if transistor conductance value increase the voltage drop will go towards zero (high conductance) and if +5v (less conductance).

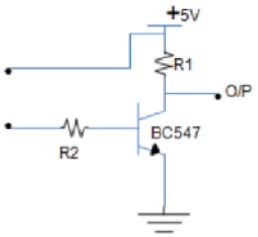


Fig. 3. Internal structure of pH sensor.

Turbidity Sensor -Turbidity sensor works based on IR reflective theory. When IR ray is passed through clear water all the rays will easily pass through water this will be applied to the IR photodiode now photodiode starts conducting thus resulting in transistor collector voltage to go near to ground if it is contaminated water there will be less receiving signal because this will be terminated by water impurities. This means water is not safe for drinking thus water is sent for purification unit for further processing.

Reverse Osmosis Filter - Reverse osmosis works by using a high pressure pump to increase the pressure on the salt side of the RO and force the water across the semi-permeable RO membrane, leaving almost all (around 95% to 99%) of dissolved salts behind in the reject stream. The amount of pressure required depends on the salt concentration of the feed water. The more concentrated the feed water, the more pressure is required to overcome the osmotic pressure.

In very simple terms, feed water is pumped into a Reverse Osmosis (RO) system and you end up with two types of water coming out of the RO system: good water and bad water. The good water that comes out of an RO system has the majority of contaminants removed and is called permeate. Another term for permeate water is product water – they mean the same thing. Permeate is the water that was pushed through the RO membrane and contains very little contaminants. The 'bad' water is the water that contains all of the contaminants that were unable to pass through the RO membrane and is known as the concentrate, reject, or brine. All three terms (concentrate, reject, and brine) are used interchangeably and mean the same thing. Below is a simple schematic that shows how an RO system works.

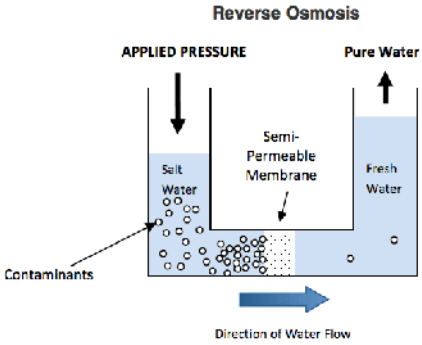


Fig. 3. Reverse Osmosis process.

As the feed water enters the RO membrane under pressure (enough pressure to overcome osmotic pressure) the water molecules pass through the semi permeable membrane and the salts and other contaminants are not allowed to pass and are discharged through the concentrate stream, which goes to drain or can be fed back into the feed water supply in some circumstances to be recycled through the RO system to save water. The water that makes it through the RO membrane is called permeate or product water and usually has around 95% to 99% of the dissolved salts removed from it.

B. Software Description

Proton IDE is a professional and powerful visual Integrated Development Environment (IDE) designed specifically for the proton plus compiler. Proton IDE is designed to accelerate product development in a comfortable user development environment without compromising performance, flexibility or control. Pic basic proton IDE is also termed as third party programming language and its supporting languages for i/p is basic language and o/p files are hex, .LST .Program writing environment is PIC kit2.

Programming language is understood as a set of commands and rules according to which we write the program and therefore various programming languages such as BASIC, C, and PASCAL etc. Program consists of sequence of commands of language that our microcontroller executes one after another. BASIC compiler is the program run on PC and its task is to translate the original BASIC code into the language of 0 and 1 understandable to the microcontroller.

V. TESTING AND RESULTS

Testing of this project, starts with testing various section independently initially and then assembling each section to check the overall working of the project. Various section include microcontroller board, relay, LCD, RTC power supply.

PIC16F877 is a CMOS-FLASH microcontroller. The output voltage for logic high is 5V in all the port pins. The logic zero is exactly 0V. The reset circuit will give a reset voltage of 5V positive edge and provide delayed discharge path when push button switch is pressed. The crystal used gives 20 MHz frequency. The output of the XTAL1 and XTAL2 pins were checked on the CRO, 5vpp sine wave. External pull up resistors of 10K were connected at port0. A program for generating a square wave on all the port pins was written and tested first. The output was 5Vp-p square wave. The contrast of the LCD connected at port 0 is controlled using a 10k potentiometer. System was further expanded by using sensors. 8-bit transmission was being carried out from the microcontroller to the LCD. RF Receiver is used for receiving the information from RF transmitter.

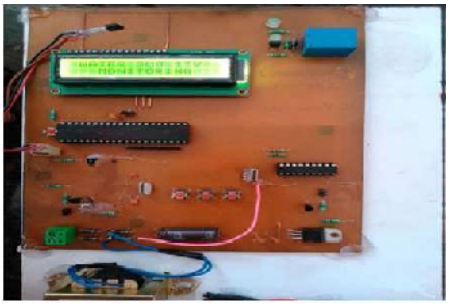
The PCF8563 contains sixteen 8-bit registers with an auto-incrementing register address, an on-chip 32.768 kHz oscillator with one integrated capacitor, a frequency divider which provides the source clock for the Real-Time Clock (RTC) and calendar, a programmable clock output, a timer, an alarm, a voltage-low detector, and a 400 kHz I2C-bus interface. All 16 registers are designed as addressable 8-bit parallel registers although not all bits are implemented. The first two registers (memory address 00h and 01h) are used as control and/or status registers. Address locations 09h through 0Ch contain alarm registers which define the conditions for an alarm. Address 0Dh controls the CLKOUT output frequency. 0Eh and 0Fh are the Timer control and Timer registers, respectively. The

Seconds, Minutes, Hours, Days, Months, and Years as well as the Minute alarm, Hour alarm, and Day alarm registers are all coded in BCD format.

A. Procedure for testing

The below figure shows the proposed model of water quality monitoring section.

Switching on the power supply the message “Water Quality Monitoring” willbe displayed on transmitter end LCD similarly “Remote Water Monitoring” will be displayed on base station or receiver end LCD.



(a)

After initialization of microcontroller three sensors are used to collect data related to Water quality by bringing water sample in test tube contact with the respective sensors as a result information will be gathered and is compared with preset standard values if the condition gets satisfied then submersible pump will allow the water to RO filter for Purification unit.

(b)

Fig. 5. Snapshot of water quality monitoring transmitter and receiver section.

B. Flow chart

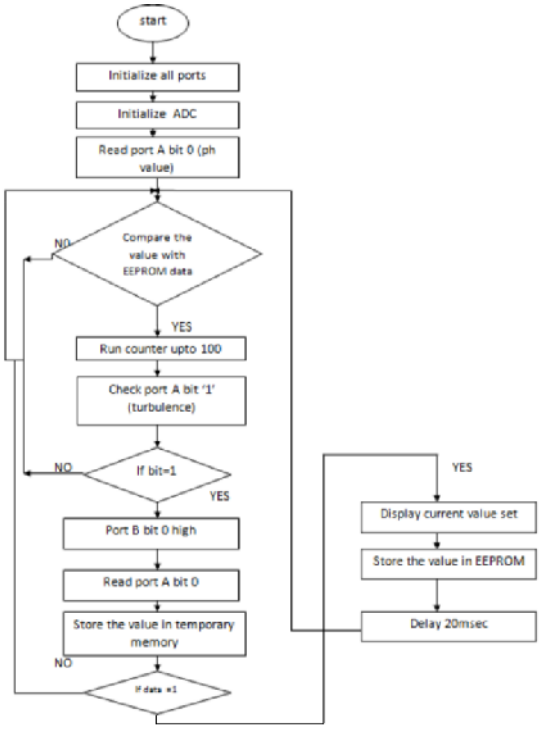


Fig. 4. Flow chart of water quality monitoring section.

Fig. 6. Snapshot of Real time clock section using PCF8563.

After switching on the power supply RTC will be displayed on LCD using push but ton switches we can set date, time, day of operation depending on the timer value set motor will turn on and thus water get distributed timely from the tank after purification process.

VI. FUTURE SCOPE ADVANTAGES AND APPLICATIONS

Different wireless modules can be installed for longer range and better transmission and performance. To improve the purity of water quality other purification methods such as ozone, UV etc. can be included in the next method. A network can be created and these values can be shared, plotted to know the level communication at different places. Other water qualities can be found by adding the sensors to the model. Modification to this model can be made so that it can be used in fields such as agriculture, horticulture etc. Automated Chlorination process depending on the contamination can be added to this proposed method to get more purified water.

Monitoring of quality is faster compared to analogous methods. Manual labour included is less as it is automated. As it is automated there is lesser chance of people complaining about water not being flown to their section. Chances of miscalculation compared to analog method are less. Efficient way for wireless data logging of hazardous applications. Less time delays, Quick response time, fully automate system, model is easy to install and use.

Data logging in hazardous application such as nuclear plants, gas plants, chemical plants etc. Wireless communication over long distances such as oil rigs, lakes, rivers, dams, oceans. Agriculture fields, Sewage treatment plant, Horticulture field, Household purpose, School and colleges, and Water distribution centers.

VII. CONCLUSION

The implementation efficiently monitors 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 or placed at the local residence close to the target area. The monitoring task can be done by any person with minimal training at the beginning of the system installation. A wireless sensor network is designed in the hope of tracking with the problem of the lack of a water environment monitoring system. It provides a useful feature's such as large monitoring ranges, flexible configuration and very small damage to the natural environment. The system successfully provides remote monitoring of the temperature, turbidity, and pH. In this way we successfully measured the different water parameters, and using this reading we concluded that whether water is contaminated or not it also provides the proper water resource management.

Different sensors for water quality installed at the node to meet the monitoring demands in different water environments and to obtain different parameter there is a respective readings for turbidity, pH and temperature of water to be monitored. At any moment when water parameter crosses its set point the buzzer turns on.

REFERENCES

[1]. Zulhani Rasin, Mohd Rizal Abdullah "Water Quality Monitoring System UsingZigbee Based Wireless Sensor Network" *International Journal of Engineering & Technology IJET* Vol: **9** No: 10.

[2]. A.C .Khetre, Prof. S.G. Hate."Automatic monitoring & Reporting of water quality by using WSN Technology and different routing methods." *International Journal of Advanced Research in Computer Engineering & Technology (IJARCET)* Volume **2**, Issue 12, December 2013.

[3]. Pradeep Kumar Somasundaram1, Dharon Joseph Edison. "Monitoring Water Quality using RF Module" *International Journal of Application or Innovation in Engineering & Management (IJAIEM)*, Volume **2**, Issue 7, July 2013.

[4]. IEEE Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Low Rate Wireless Personal Area Network (LR-WPANs), IEEE Standard 802.15.4TM, 2003.

[5]. Sagar Anant Kasrung, Amit Suresh Dhavade, Vikrant Dilip Dhembare. "Water Purification with Bottle Filling System" *International Journal of Computer Technology and*

[6]. Chae, M.J., Yoo, H.S., Kim, J.R., and Cho, M.Y. "Bridge Condition Monitoring System Using Wireless Network" 23rd *International Symposium on Automation and Robotics in Construction ISARC 2006*, Tokyo, Japan, 3 – 5 Oct 2006.

[7] Peng Jiang, Zheming Wang, "Design of water environment monitoring system based on wireless sensor network"IEEE *2nd International Conference on Industrial and Information Systems*, pp. 2010.