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Monitoring Water Quality Using RF Module

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Abstract*— Water is one of the most essential needs for the existence of human beings. The water that is available for drinking purposes 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 our homes flows through pipes for transmission from wells. As water is a solvent, there are various dissolved minerals in it such as sodium, calcium, potassium, chloride, etc. which gives a tangy taste to it. Thus in our project we constantly monitor the water available through the taps through various sensors. The sensors which we are using are pH sensor, temperature sensor and a turbidity sensor (LED-LDR assembly). We have implemented the project in real time and this has been found to be very reliable, and efficient in a long run. We transmit the data available to a remote base station using a 2.4 GHz RF module which makes it convenient to monitor at a remote location and requires less man power.

***Index Terms*— pH sensor, Temperature sensor, Turbidity sensor, 2.4 GHz RF module.**

I. INTRODUCTION

This work 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 it the location of water resources due to limitation especially 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 project focuses on the use of multiple sensors as a device to check the level of 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 project 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 development of graphical user interface (GUI) for the monitoring purposes at the base monitoring station is another main component in the project. The GUI should be able to display the parameters being monitored continuously in real time. Several measurement and performance analysis to evaluate the reliability, feasibility and effectiveness of the proposed monitoring system are also presented.

II. OVERVIEW

Our project is to monitor the 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 water quality is mainly based on the pH value of the water. It is the scale of 0 to 14. The pH value 7 is neutral. The value 0 to 6 is acidic and the value 8 to 14 is alkaline. The pH value is measured with the help of the pH sensor and the pH measurement. Moreover the temperature of the water and the turbidity of the water also measured. The measured values are send 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.

III. BLOCK DIAGRAM

The block diagram has a individual transmitter and a receiver block. A common 12 Volts power supply is used for both the sections. A 2.4 GHz RF transceiver is used so as to transmit the data values to the remote base station. The necessary steps can be thus taken from the remote base station itself.

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Block Diagram

Transmitter:

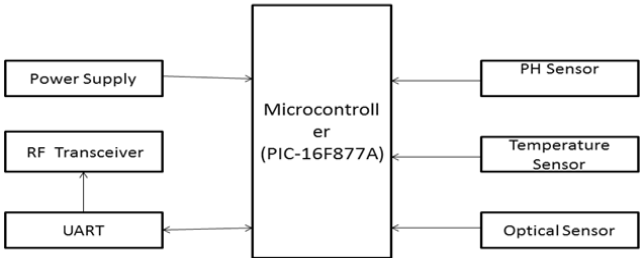

Fig. 1 Transmitter Block Diagram

Receiver:

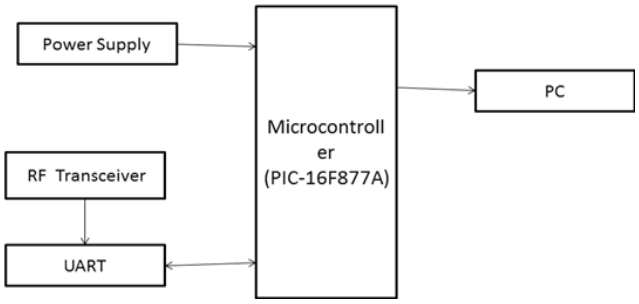

Fig. 2 Receiver Block Diagram

IV. HARDWARE DESIGN

The hardware design of our project consists of a 16F877A PIC microcontroller, pH sensor, temperature sensor, turbidity sensor (LED-LDR assembly), 12 V power supply, 2.4 GHz RF transceiver, UART and a PC with hyper terminal software.

A. PIC 16F877A Microcontroller

PIC microcontrollers (Programmable Interface Controllers), are electronic circuits that can be programmed to carry out a vast range of tasks. They can be programmed to be timers or to control a production line and much more. They are found in most electronic devices such as alarm systems, computer control systems, phones, in fact almost any electronic device. PIC Microcontrollers are relatively cheap and can be bought as pre-built circuits or as kits that can be assembled by the user. PIC has a RISC architecture which makes it easy to configure.

B. PH sensor

We have used a standard pH sensor in our project. It has two electrodes i.e. a reference electrode and a measuring electrode. It is preset with an analog voltage of 40 mV. 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.

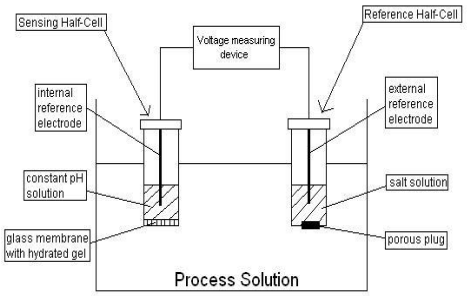

Fig. 3 pH Sensor Operation

C. 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, while the LM35C is rated for a −40° to +110°C range (−10° with improved accuracy). The LM35 series is available packaged in hermetic TO-46 transistor packages, while the LM35C, LM35CA, and LM35D are also available in the plastic TO-92 transistor package. The LM35D is also available in an 8-lead surface mount small outline package and a plastic TO-220 package.

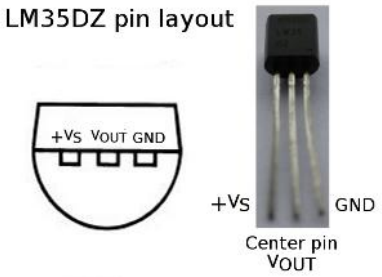

Fig. 4 LM35 Model

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D. Turbidity sensor

The turbidity sensor 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 (and its hole partner) 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 bandgap. 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 (i.e. longer wavelengths and lower frequencies) 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.

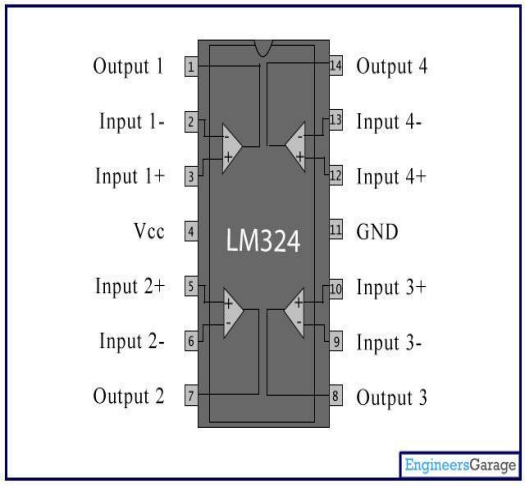

Fig. 5 LM324 Pin Diagram

E. 2.4 GHz RF Transceiver

The RF module is a single chip 2.4GHz transceiver with an embedded baseband protocol engine, designed for ultra low power wireless applications. The RF module is designed for operation in the world wide ISM frequency band at 2.400 - 2.4835GHz. An MCU (microcontroller) and very few external passive components are needed to design a radio system. The module is configured and operated through a Serial Peripheral Interface (SPI.) Through this interface the register map is available. The register map contains all configuration registers in the module and is accessible in all operation modes of the chip. The embedded baseband protocol engine is based on packet communication and supports various modes from manual operation to advanced autonomous protocol operation. Internal FIFOs ensure a smooth data flow between the radio front end and the system's MCU. The radio front end uses GFSK modulation. It has user configurable parameters like frequency channel, output power and air data rate. The air data rate supported by the module is configurable to 2Mbps.

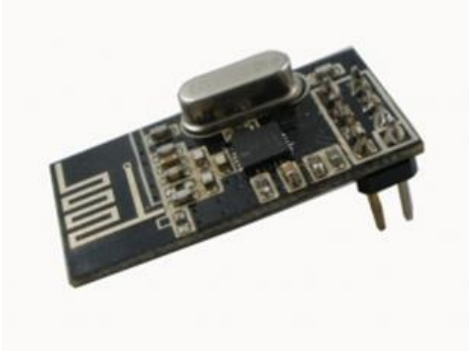

Fig. 6 2.4 Ghz RF Transceiver

V. OPERATION

In our project the water quality is measured and verified by using the three parameters such as pH sensor, temperature sensor, LDR assembly. The above three parameters are measured in the sensor node and the signals are sent to the base station with the help of 2.4 GHz RF transceiver (Transmitter section). In the base station the signals are received with the help of the RF transceiver (Receiver section) and the values are displayed in the PC. The coding is done in embedded C and the output is displayed in hyper terminal software. The pH value of the water is in the scale of 0 to 14 in which 7 is neutral, below 7 is acidic and above 7 is alkaline. The temperature of the water is found by the temperature sensor LM35 which has the range of -55'c to +110'c.The LDR assembly is used for measuring the turbidity of the water. The water sample taken is placed over the LDR and depending upon the light intensity on the LDR the value of the turbidity is measured. The reference value is of 20. If the value is above the reference value the turbidity is in limit. If the value is below the reference value the turbidity exceeds the limit.

VII. FUTURE WORK

As we all know if the pH value of the water is between 0 to 6 it is acidic. We can convert it into alkaline by adding chlorine which can be done with the help of the solenoid valve. Depending upon the acidic value, the valve is opened and the chlorine is added so that the water can be safe to consume.

VIII. 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

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monitoring task can be done by any person with minimal training at the beginning of the system installation.

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