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Development of Wireless PH Measuring Device

G.Sharma[1], N.Pradhan[2], B.chettri[3], D.Bhattacharjee[4]

UG student, Dept. of ECE, Sikkim Manipal Institute of Technology, Majhitar, Sikkim, India[1]

UG student, Dept. of ECE, Sikkim Manipal Institute of Technology, Majhitar, Sikkim, India[2]

UG student, Dept. of ECE, Sikkim Manipal Institute of Technology, Majhitar, Sikkim, India[3]

Assistant Professor, Dept. of ECE, Sikkim Manipal Institute of Technology, Majhitar, Sikkim, India[4]

ABSTRACT: We present the work on the development of wireless pH measuring device. The system consists of measuring electrode, embedded hardware and two way wireless transceiver. Thus this device can be implemented to monitor the pH level of a river, pond or lake or any water bodies remotely. This is a low cost and versatile system which is easy to install and has a very few steps for its operation. The system is very reliable and suitable for real time application. This system is incorporated with various intelligent error detection protocols which makes the system efficient. The system is designed using ATmega 328, 8 bit microcontroller based embedded system platform, glass electrode has been used as a pH sensor and wireless communication is achieved by using IEEE 802.15.4 compatible wireless transceiver. There is also a control algorithm for generation of the alarm signal if the pH value measured does not come in the range of the preset value.

KEYWORDS: Glass electrode, embedded hardware, two way wireless transceiver, low cost and versatile, intelligent error detection protocol, ATmega 328 and IEEE 802.15.4.

I.INTRODUCTION

The pH value of a water source is a measure of its acidity or alkalinity. The pH level is a measurement of the activity of the hydrogen atom, because the hydrogen activity is a good representation of the acidity or alkalinity of the water. The pH scale ranges from 0 to 14, with 7.0 being neutral. Water with a low pH is said to be acidic, and water with a high pH is basic, or alkaline. Pure water would have a pH of 7.0, but water sources and precipitation tends to be slightly acidic, due to contaminants that are in the water. Surface water typically has a pH value between 6.5 and 8.5 and groundwater tends to have a pH between 6.0 and 8.5. The pH of a water source can vary naturally. A change in the pH of water can have a number of consequences. In the environment, many plants and animals are harmed, or even killed; as a result of acidification.pH measurement is based on the use of a pH sensitive electrode (usually glass), a reference electrode, and a temperature element to provide a temperature signal to the pH analyzer. The pH electrode uses a specially formulated, pH sensitive glass in contact with the solution, which develops a potential (voltage) proportional to the pH of the solution. The reference electrode is designed to maintain a constant potential at any given temperature, and serves to complete the pH measuring circuit within the solution. It provides a known reference potential for the pH electrode.

II.PROBLEM DEFINATION AND PROPOSED SOLUTION

Some of the work on the similar topics has already been done previously but most of them were not wireless system. Although some of them were wireless system but they were either very costly or large in size:

Design of water quality measurement sensors robot based on wireless communication environment, Although the system was reliable and was less power consuming (which operate on 12v battery) but the system was costly and much complicated to install and was loaded with a complicated system like sensor robot, GPS etc which makes it costlier and

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difficult to maintain[1].Water quality monitoring system using Xbee based wireless sensor network, this was a low cost system but there were complications due to the use of a various sensors network and the uses of the other measuring sensors such as temperature sensors, turbidity measuring device which makes it complicated [2]. Design of a water environment monitoring system based on wireless sensors networks, the transmission medium used for this was GPRS system which works in a licensed band and it also has a database system which makes the system costly [3]. To remove all the above complication we have designed a much lower cost system which is less complicated and reliable for measuring the Ph wirelessly. The system which we have designed is easy to install and maintain which require very less power. The advantage of this system is it is a wireless system and can be used for a remote pH measurement. The system is also very easy to implement in a very harsh and remote location because of its small size, very less weight and robustness.

III.SYSTEM ARCHITECTURE

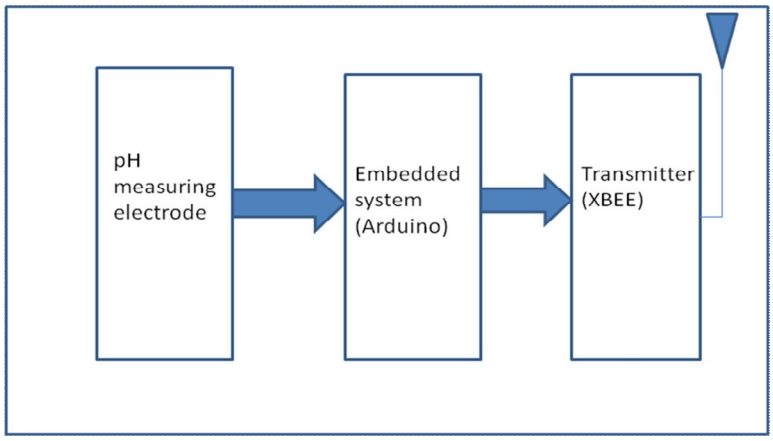

Fig 1: Transmission and measuring

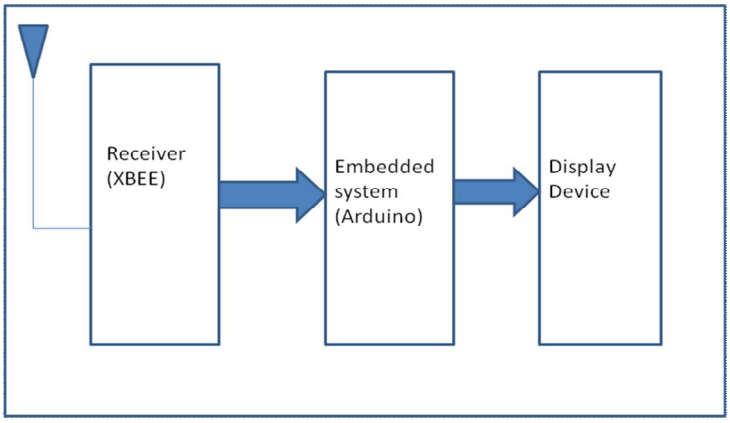

Fig.2 : Reception and displaying unit

IV.DESCRIPTION OF SYSTEM ARCHITECTURE

The glass electrode is used for measuring the Ph level of any liquid. The electrode will generate the voltage accroding to the ph level of the measured liquid. The output of the Ph electrode is given as the analog input to the ATmega 328. The output of the electrode can be viewed as the serial data on the serial monitor via ATmega 328.

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IV.a.Transmitter Section

It consist of the Xbee transmitter which works on the frequency of 2.4GHz which is standardised by IEEE 802.15.4 and can give the range upto 1.6Kms depending upon the LOS(Line Of Sight) .The serial data from the transmitter line is given to the Xbee transmitter which is configured to maintain the Baud rate of 9600 bauds. The transmission of the serial data is continuous in nature so that the user on the remote display device can view the current Ph level of the water Bodies.

IV.b.Remote Display System

TheRx section consist of a Xbee receiver which is configured to receive the serial data transmitted by the xbee Transmitter. This data is given to the Rx line of the ATmega 328 which is configured to receive the data at the rate of 9600 bauds. The ATmega 328 has a look up table with the help of which the corresponding pH value can be displayed according to the value of the serial data received.

The serial data received by the ATmega 328 is compared with the value stored in the look up table. If the value matches with the value given in the look up table then the corresponding pH value will be displayed using LCD and the same value can be displayed in the serial monitor also.The system will generate the error signal if the measured pH value does not come in the range of preset value which can be set wirelessly.

V.SYSTEM FUNCTIONALITY

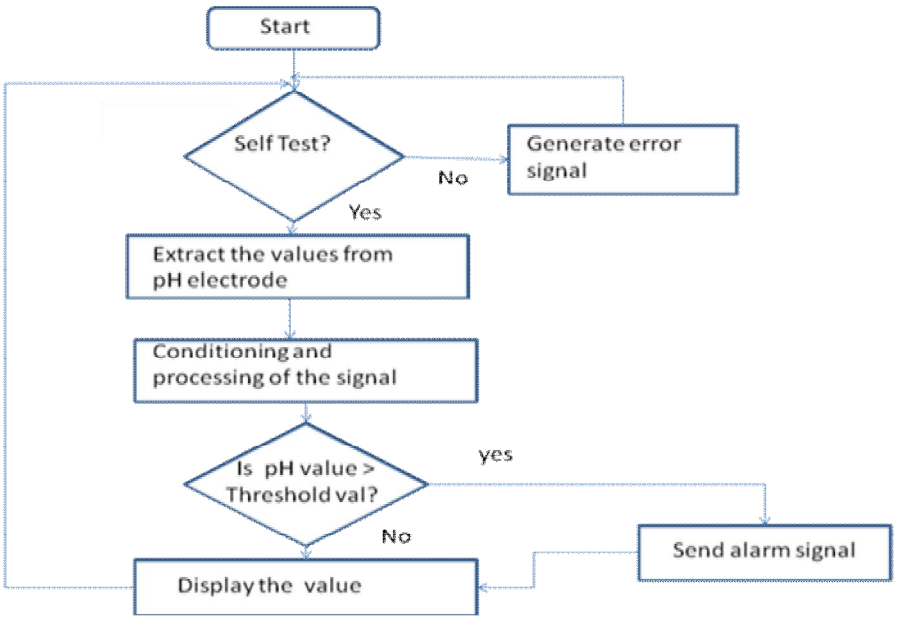

Fig 3: flow diagram of the system

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Fig 3 represents the system flow diagram which initially starts with the self testing programme for detection of the error. If the error is detected then system will generate the error signal and send it to the remote receiver. If there is no error then pH is sensed by the pH electrode and is send to the Analog to Digital Converter (ADC).Then the value received from the ADC is averaged for 50 readings. Then the average value is send to the remote receiver. The received value is compared to the stored value in the Look up table to display the actual pH reading on Display device. The pH value is also compared with the preset pH value in order to generate the error alarm signal if the pH value crosses the reset value. The presest value can be set according to the user requirement and it can be set from the remote receiver. The wireless module works on two different modes unicast and broadcast. During normal operation unicast mode is used and for alarm signal transmission broadcast mode is used. The system also having a battery power monitoring system for replacing a battery on time.

Fig 4.:pH measuring electrode.

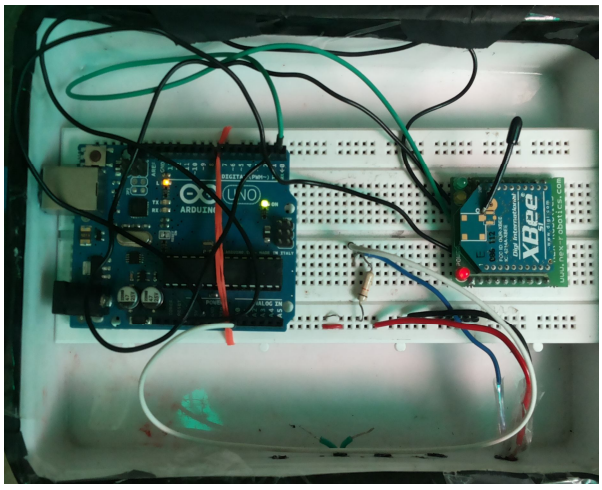

Fig 5: Hardware Prototype

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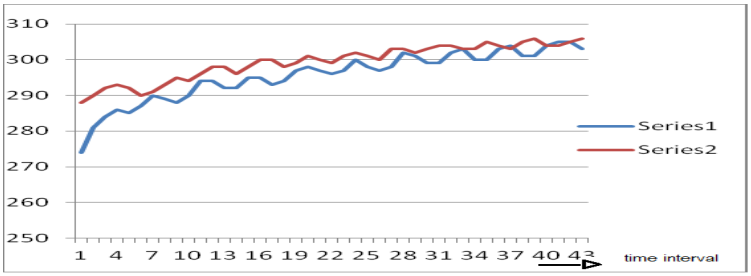

Fig 6: Remote display section

VI. HARDWARE DESCRIPTION

Figure 4 represents the pH measuring electrode which is connected to the transmitter section this party of the system goes inside the water to measure the pH level of the water. This is basically the glass electrode which has a high level of accuracy. In order to increase the stability and accuracy of the signal extracted, we also have to use the temperature sensor. Figure 5 represents the hardware prototype of the system . The processor which we have used is ATmega 328 and this is programmed using the arduino platform. The processed and condition signal from the arduino is given to the XBEE transmitter which has a very good range upto 1.7km and works at a frequency of 2.4GHz. The ATmega 328 is a 8 bit microprocessor which has 4Kb of memory. The system is powered by 6v rechargeable battery and DC to DC converter is used to get 5v regulated supply for the circuits .Fig 6 represents an embedded system and a XBEE receiver and a LCD display. The signal received via the XBEE receiver goes to the embedded system where the received signal is processed and the required output is displayed using LCD display. The LCD which we have used has the specification 16*2.

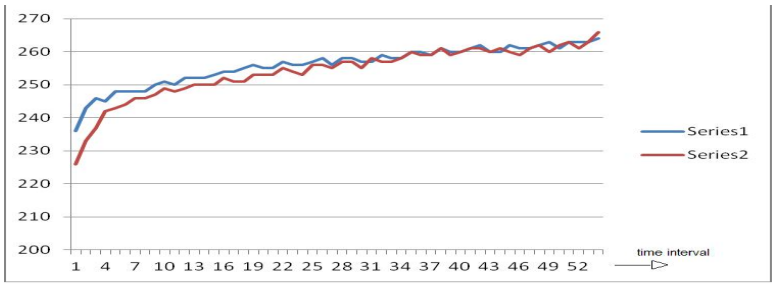

Fig 7a: Serial data vs Time interval For Ph value 4 comparing two set of Reading.

Fig 7a represent the graph of the two sets of serial data obtained from ATmega 328 taken at two diffrent interval of time. The serial data for pH value 4 obtained from the Atmega 328 was between 273-307.

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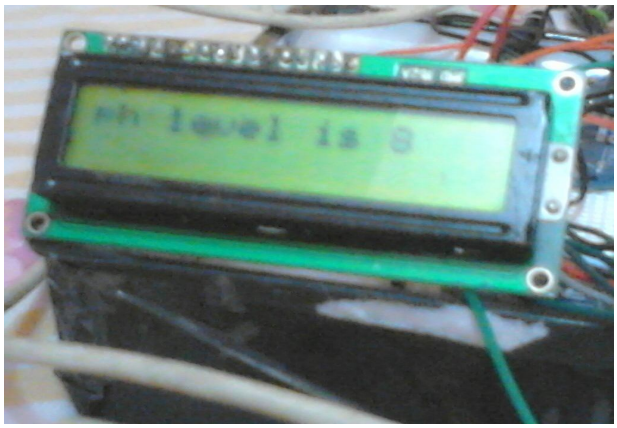

Fig 7b: Graph of serial data vs Time interval For Ph value 7 comparing two sets of reading

Fig 7b represent the graph of the two sets of serial data obtained from ATmega 328 taken at two diffrent interval of time. The serial data for pH value 7 obtained from the Atmega 328 was between 228-265.

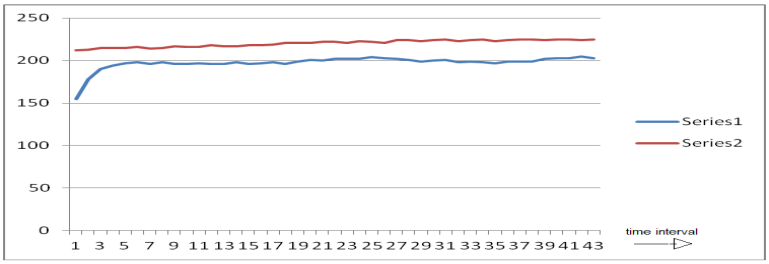

Fig 7c:Graph of serial data vs Time interval For Ph value 10 comparing two sets of reading.

Fig 7c represent the graph of the two sets of serial data obtained from ATmega 328 taken at two diffrent interval of time. The serial data for pH value 10 obtained from the Atmega 328 was between 151-220. The reading was much more stable as compared to the above values.

VII. RESULT AND DISCUSSION

Initially we carry out the laboratory experiment with the standard equipments to find the standardised value of the pH level of the given liquid. Then in the second stage we interfaced the pH electrode to our system and then we compared the pH value obtained from our system with that of the standard system. And the result obtained was correct and valid. Then we carried out the wireless range tests of the system and we found that the open air range was about 700m and the indoor range was about 100m.After the wireless range tests we transmitted the data wirelessly to the receiver. In order to find the error of the sensor (electrode) we carried out the repeatability tests for three different values of pH i.e. 4,7and 10. Considering the above result shown in the graph we came to the conclusion that the transient time for pH value 10 was very less compared to the pH value 4 and 7. The series1 and series 2 represent the two sets of serial data obtained for same pH value for different instant of time.

VIII.CONCLUSION

We have designed a system to measure the ph level of the water bodies which is cost effective and reliable with the ease of operation and can be implemented in any geographical location with simple modification. As this is a wireless system so it can be used as a Remote sensing Ph measuring device. Our designed system is helpful in location where the wired system cannot be implemented. Not only had the measurement of the pH this system can also indicate if the

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pH value process some preset value. Although the data was transmitted and displayed successfully but there was tolerated amount of repeatability error of the system.

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