Internet of Things based Real time Water Monitoring System

L.Raja, G.Shanthi, P.S.Periasamy

Abstract: In real time computing, the embedded systems are a collection of electrical and mechanical systems with a association of small computers. The advancement of such electro mechanical systems with the environment is crucial in today's scenario. Nowadays, the environmental pollution creates hazardous effect on the living creatures. The harmful pollutants should be identified and should be evacuated for the survival of mankind and other living organisms. Among the environmental pollutions, water pollution is more contaminated than air and soil. The water pollution damages the individual species and all biological creatures. The qualitative analysis of water is a thrust area of research with intelligent systems. At present, testing equipment are used in the laboratories to perform investigations with various water samples. These laboratory analysis make use of chemicals, reagents and sensors for determining the suitability of water for drinking purposes. Such laboratory methods are time consuming and are relatively expensive. To address this issue, quality of drinking water needs to be measured and monitored in real time for the safety of the people. This paper attempts to develop a low cost real time monitoring system to measure various parameters such as PH value, turbidity level and temperature. The measured values are processed through Raspberry Pi 3 module. The results are validated with real-time samples collected from various places and conveyed to the remote user through cloud server.

Index Terms: IoT, Raspberry Pi, PH, turbidity, Water Quality.

I. INTRODUCTION

The water content available in earth's surface is bounded by 97.5% of salt water and 2.5% of fresh water. Among the available fresh water only 1% of water resource is available for human beings and the remaining are in the form of glaciers and ice caps So, such a precious mineral essential [7] for human life should be safeguarded from the environmental pollution. This mineral finds its usage widely in agriculture, cooking and drinking purposes of living organisms. The progressive pollutant nature of water becomes hazardous for drinking and the intake of unhealthy water results in indigestion and water borne diseases for living creatures.

Now-a-days pollution of water is often caused by the discharge of inadequately treated squander water into natural bodies of water. Water gets polluted mainly due to industrialization (i.e.,) the wastages or destructive chemicals emerging from the industries into the rivers, lakes, fertilizers used in agricultural land .Water pollution is a major threat to all living organisms on the earth. The quality of drinking water needs to be measured and monitored in real time for the safety of the people. Hence there is a need for monitoring [7] the water quality.

Traditionally the water quality is monitored by collecting water samples manually from different locations followed by analyzing the ideal characteristics of water in the laboratory. Such methods [1] are time consuming and relatively expensive. For example, if the water sample is given to the water quality testing laboratories, it is necessary to wait for 24 hours to receive the result.

Therefore, there is a need to develop a system that overcomes the drawbacks of the laboratory methods. The novel system should provide continuous online monitoring for public health protection without degradation in the accuracy of manual methods. So this paper attempts to overcome the drawback of existing system. The objective of our paper is to develop a low cost real time water quality monitoring system [10] using remote network enabled embedded system.

II. RELATED WORK

Geetha S, Gouthami S [3] has designed a system using TI CC3200, a controller with built in Wi-Fi module and dedicated ARM MCU for wireless communication. Sensors are connected to the controller, either directly using UART or remotely using Zigbee. Some of the previous works aim at alerting the user in the form of SMS about the water quality. The usage of TI CC3200 (Texas instrument CC3200) reduces the complexity and improves speed of operation. The designed system is applicable only for the analysis of tap and ground water. The cost, data storage and retrieval are not possible. Another drawback of such systems is additional cost for SIM card operation. Also, large quantities of data storage and retrieval are not possible at the user premises, and there is excessive power consumption due to heat dissipation of the sensors.

Central Ground Water Board [2] formed by the Government of India has determined safe limits of drinking water parameters. The laboratory measurement of water quality parameters is based on these limits which are taken as the standard values. The sensed values are compared to these standard values to determine the suitability of water for drinking.

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M. Pradeepkumar, et.al [6] proposed a system using Arduino Uno which is a microcontroller board based on the ATmega328. it has to be connected to a computer with a USB cable or power it with a AC-to-DC adapter or battery. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. The authors used Zigbee technology so that sensed data of this system are accurate and reduced usage of manpower and material resources. The automation reduced the time for parameter comparison so that its economically affordable for layman. It has low maintenance, and helps in prevention of water diseases. Besides these advantages the systems suffer from the drawbacks. This system is not applicable for long range wireless data transmission, Keyboard commands are required for reading the sensor's output. The RAM available in Arduino is less compared to Raspberry Pi (i.e.,) it has only 256kb and it is designed to run a single program at a time.

Vijayakumar N, et.al [13] proposed a Raspberry Pi B+ as a controller for their system. The proposed system has an edge of transforming analog data into digital without GSM module. Instead, it is supported with an inbuilt WiFi. Besides these advantages it also suffers from the drawback of using Raspberry Pi B+ board having RAM only 512MB.

The Wireless sensor networks plays vital role in the water quality monitoring systems. A chlorine concentration based water monitoring system has been proposed [8] for water distribution. This system makes use of solar energy as the power source for monitoring parameters such as pH, turbidity and oxygen density. In real time, solar enabled sensor nodes are used at the base stations for monitoring various parameters. Authors also conveyed several advantages such as flexibility, low carbon emission and low power consumption. This method does not consider the temperature and relative humidity.

A. Monitored Parameters

At present there are several methods available that collect the water samples manually from different locations with varying characteristics of water. The laboratory analyst test collected water samples with certain key parameters The equipment used for testing the water are pH meter, highest turbidity value is measured by Jackson Candle turbid meter, lowest turbidity value is measured by Nephelometers and also they titrate the water samples with chemical reagents for testing the water quality accurately. These water testing kits [11] are handled only by the skilled people and the acquired results are not suitable for real time monitoring. The central ground water board has given the threshold value for those parameters for safe drinking of water and is tabulated in table I.

Table I: Central ground water board thresholds for safe drinking water

Parameters	Units	Desirable Range	Maximum Range
pH Value	Moles/litre	6.5-8.5	9
Turbidity	NTU	5	10
Temperature	^{o}C	0-30	70

III. PROPOSED METHODOLOGY

The proposed system overcomes certain drawbacks of the existing system. The developed system is a low cost system for real time monitoring of the water quality using embedded systems and networking. In the proposed system, three parameters are measured.

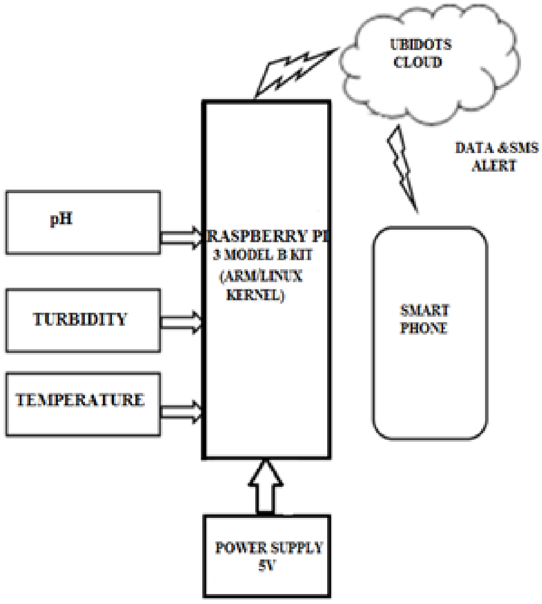

Fig.1. Block diagram of proposed system

They are pH value, turbidity in NTU (Nephelometric Turbidity Unit) and temperature of water. The system consists of pH, turbidity and temperature sensors [4]. The pH sensor is used to measure the pH level of water. Turbidity sensor [10] is used to find the purity level of water and the thermistor is used as a temperature sensor to measure the temperature of water. The measured values are then sent to the microcontroller.

The system makes use of Raspberry Pi 3 model for its high clock speed of 1.4 GHz, 1 GB RAM and also has built-in Wi-Fi and Bluetooth is shown in the fig.1. The sensor parameters such as temperature, turbidity and pH are measured by placing the sensor into different water samples. The controller gathers the sensed data and processes it. The processed data is sent to the cloud for large storage. The threshold value is pre-defined and it can be stored in the microcontroller memory. The current value is compared with pre-defined values and immediately the decision is taken based on the comparison of the sensed values and the pre-defined values. If the measured values exceed the certain threshold values [5] set in the cloud then the alert message will be sent to the remote user warning that the water is not suitable for drinking purpose. If the measured values are below or equal to the certain threshold values then the alert message will be sent to the remote user stating that the water is suitable for drinking purpose. Threshold is set in the cloud based on the WHO (World Health Organization) standards.

IV. HARDWARE SPECIFICATIONS

The hardware requirements for the proposed system are given in the table II.

Specification	Hardware
Operating system	Linux
Microcontroller	Raspberry Pi3
CPU Speed	1.2GHz ,64 bit quad core ARM Cortex A53
SDRAM	1GGB (shared with GPU)
Software	Ubidots [9]
Language	Python

The hardware implementation of the proposed system is shown in the fig.2. In this, sensors are immersed into various samples of water and are interfaced directly to raspberry module. The ADC used in module directly converts the equivalent electrical quantity of measured physical parameters. The controller module transfers the converted data to the cloud. In the cloud, the threshold value is set based on the standards of world health organization. These threshold values are compared with the measured physical parameters. If the compared value is less than or equal to threshold value, then water sample is suitable for drinking. Likewise, if the compared values exceeds threshold, a message will be sent from the cloud to the user mobile stating that the water is not suitable for drinking.

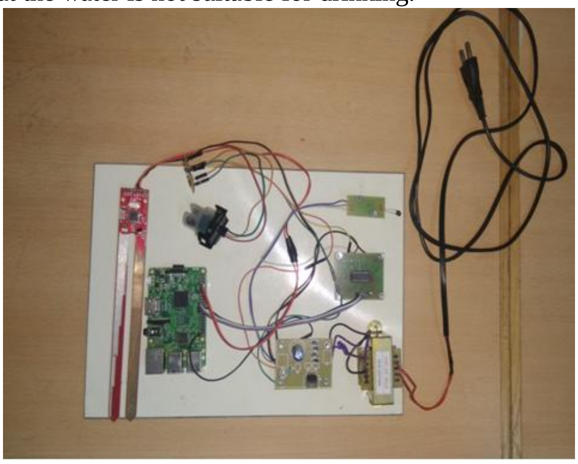

Fig.2. Hardware Implementation

V. RESULTS & DISCUSSIONS

The tap water is found to have desirable range of pH, turbidity and temperature values. Fig. 3 shows the results that are obtained when the tap water sample is tested. The results that are obtained by testing the salt water sample are shown in the fig. 4. It can be seen that the water sample has a pH value that is not in the desirable range due to the salt content excess of desirable level.The results obtained by testing the oil mixture sample are shown in the fig. 5. It can be seen that the water sample has a pH value that exceeds the desirable range. The result obtained by testing impure water sample contaminated with soil is shown in the fig. 6 and it can be seen that the turbidity and pH values are not in the desirable range.

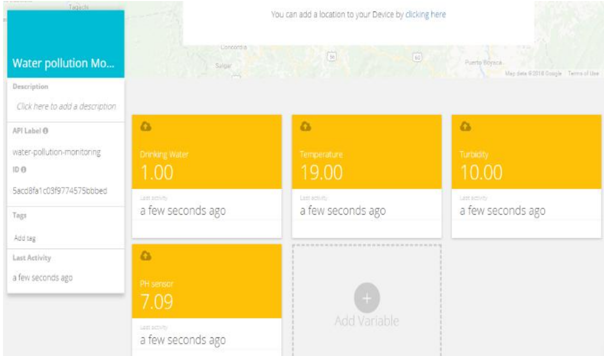

Fig.3. Tap water Sample

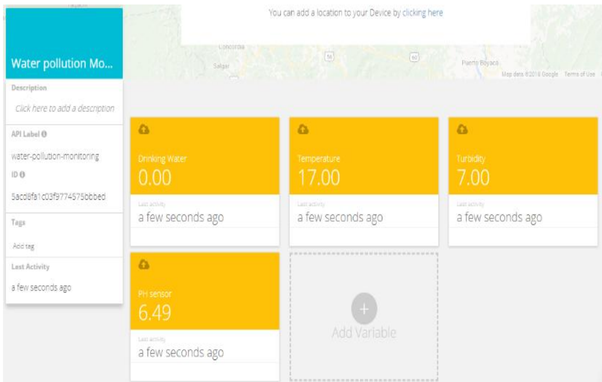

Fig.4. Salt water Sample

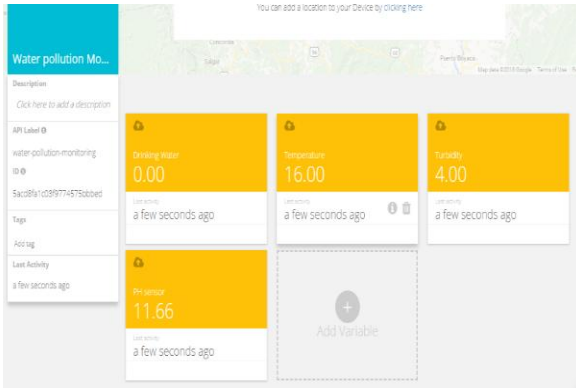

Fig.5. Oil mixture with normal water sample

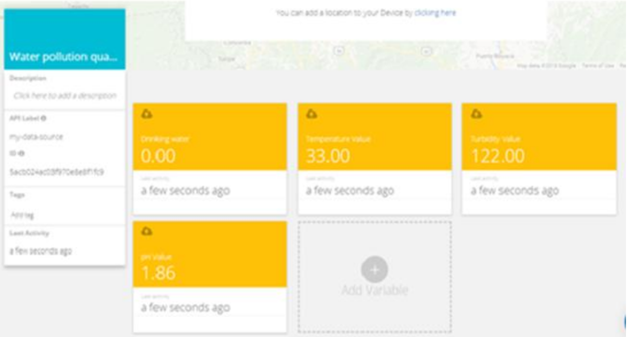

Fig.6. Sand mixture with normal water sample

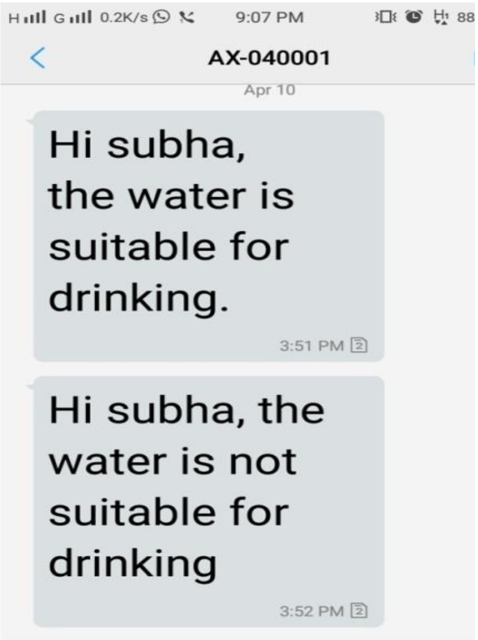

Fig.7. Alert message sent to the user's mobile

The alert message sent by the cloud to the user's mobile based on the analysis of the measured parameters is shown in the figure 7. In the case of tap water, the alert states that the water sample is suitable for drinking. In the case of impure water, the alert states that the water sample is not suitable for drinking. The comparison values of various parameters are shown in table III.

Table III: Comparison of measured parameters for different types of water

Solution	Measured Parameters and its value		
Different types of water	pH	Turbidity(NTU)	Temperature(ºC)
Tap water	7.83	7.00	33
Salt water	1.65	7.00	32
Impure water	1.86	122.00	33

VI. CONCLUSION

The proposed system measures and monitors the quality of water automatically, and it is low cost, less complex and does not require manual intervention. So the water quality testing is likely to be more economical, convenient and fast. The system has good flexibility. The implementation enables sensor to provide online data to consumers. The message alert can be viewed anywhere in the world using gadgets easily. The proposed technique aims to alert the human beings to drink quality water.

VII. FUTURE SCOPE

The experimental setup can be improved by incorporating anomaly detections algorithms in water quality, increasing the sensing range of sensors. This implementation can be suitable for environment monitoring, etc. By replacing the corresponding sensors and this system can be used to monitor other water quality parameters with minor changes in coding.

In the future, the system can be expanded to monitor hydrologic, air pollution, industrial and agricultural production and so on. It has widespread application and extension value.

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