Design and Development of Water Quality Monitoring System in IOT

M. Joseph Vishal Kumar, Krishna Samalla

Abstract--- Due to the impact of polluted water globally tremendous changes are taking place towards development of a reconfigurable smart sensor interface device for water quality monitoring system in an IOT environment. Water quality monitoring system measures the water level parameters are collected by the sensors. The sensors are sending to the microcontroller board. We are using sensors like Co2, temperature, ph sensor, water level sensors and turbidity sensors. This sensor controls the whole operation and monitored by Cloud based wireless communication devices. The microcontroller system can be seen as a system that reads from the input perform processing and writes to output. For his Water monitoring system output will be in digital form. In this output of these sensors directly goes to the microcontroller. Whenever outputs of the other sensors are in analog form. Then we need to convert the analog values to digital values before connecting to the controller. In this paper water quality is pure as sensors play a major role for water quality monitoring system, the time and costs in detecting water quality of a reservoir as part of the environment.

Keywords--- Microcontroller (RPI), Co2 sensor, Temperature sensor, Turbidity sensor, PH sensor, water level sensor etc.

I. INTRODUCTION

There were lots of inventions, but at the same time were pollutions, global warming and so on are being formed, because of this there is no safe drinking water for the world's pollution. Nowadays, water quality monitoring in real time faces challenges because of global warming limited water resources, growing population, etc. Hence there is need of developing better methodologies to monitor the water quality parameters in real time[8]. In this paper we design a low cost system for real time water quality monitoring using IOT (internet of things).In this system we used several sensors for measuring the physical and chemical parameters of the water. The smart water quality systems consist of a raspberry pi controller. These water quality parameters pH measure the hydrogen ions. It will show the water is acidic or alkaline7PH is the pure water[3]. Globally the water we are using for various ways for agriculture, industries and travel which may affect the water quality. In this project we are using temperature sensor is used to measure temperature values for how the water is hot or cool. Daily we areusing wireless communication technologies and wireless sensor networks providing safe drinking water of various applications of wireless system. Now a day's it is very useful to use water level sensor to measure the water level quantity of the agriculture etc. whenever water is filled than we will create some alarm intimation sound[1]. Here we have created 3 levels (low, high, medium) for this we designed a real-time water quality monitoring system in IoT environment. All the collected data from different sensors will be sent to the cloud using WIFI through internet. Here UBIDOTS is used as cloud platform to send all the sensor data[11]. The system consists of several sensors to measure water parameters and the raspberry PI B+ model as a controller with inbuilt WIFI module. Wireless Sensor Networks (WSN) originally was used in industrial applications and military but today different applications are used for various tasks from light to heavy industrial applications[6]. The water quality monitoring is one of the first steps required in the development and management of water resources.

II. LITERATURE REVIEW

ZulhaniRasin and Mohd Abdullah entitled "Real Time Water Quality Monitoring System". In this paper they discuss about safety of drinking water, the quality should be monitored in real time for that purpose they used Zigbee technology. This system consists of sensors like pH, turbidity, temperature by using these sensors they measures the quality of water. In this system they used zigbee technology so that all sensors data are sent to the monitoring section, the monitoring section consist of zigbee receiver which is connected to the PC[1].

Nikhil Kedia entitled "Water Quality Monitoring for Rural Areas-A Sensor Cloud Based Economical Project" This paper highlights monitoring methods, sensors, embedded design for measure water qualityand also explores the Sensor Cloud domain. While automatically improving the water quality is not feasible at this point, efficient use of technology and economic practices can help improve water quality and awareness among people[11].

Ch. Pavankumar, S. Praveenkumar they propose a system which monitor air and water quality based on Bluetooth platform. The system consists of various sensors like temperature, humidity, gas and salt. Also they used ultrasonic sensor to measure underwater obstacle. In this system the all sensors data are directly send to user's mobile phone by using Bluetooth. For monitoring air and water quality they used android application which will access all sensors parameters from the system[2].

AainaVenkateswaran, HarshaMenda P, Prof PritiBadar presents Smart Sensors for Real-Time Water Quality Monitoring using ZigBee.

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The system is able to measure physiochemical parameters of water quality, such as flow, temperature, pH, conduction and also the redox potential. These physiochemical parameters are used to detect water contaminants. The sensors which are designed from first principles and implemented with signal conditioning circuits are connected to a microcontroller-based measuring node, which processes and analyses the data. In this design, ZigBee receiver and transmitter modules are used for communication between the measuring and notification node. The notification node presents the reading of the sensors and outputs an audio alert when water quality parameters reach unsafe levels[6].

III. EXISTING SYSTEM

The water quality monitoring system was previously developed, in that system they used various sensors to measure water quality. For monitoring purpose they used Bluetooth and zigbee technology[1],[2].But both communication technologies have some disadvantages like they have short distance for communication so the user should be within the range for monitoring parameters. The data from the sensors are transmitted from the server, couldn't be uploaded to the cloud server which is due to disconnection at the node during transmitting data from sensors[11]. In this system there is problem lagged data is uploaded to the cloud server in between due to zigbee technology. For setting up this technology it requires more amount of hardware and it is very costly. Also in that system there is no alert indication when parameters are are abnormal.

IV. PROPOSED SYSTEM

Block Diagram

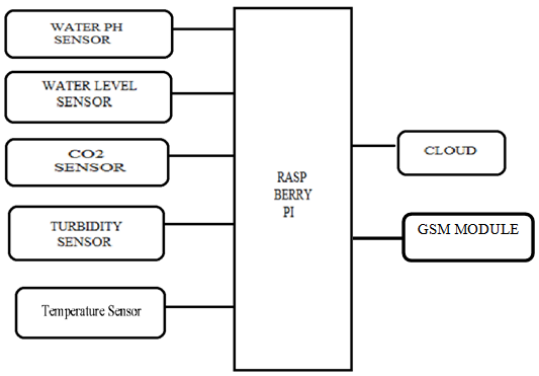

Fig (3.1): System Block diagram

V. FUNCTIONAL DESCRIPTION

Raspberry Pi

The Raspberry Pi 3 Model B features a quad-core 64-bit ARM Cortex A53 clocked at 1.2 GHz. This puts the Pi 3 roughly 50% faster than the Pi 2. Compared to the Pi 2, the RAM remains the same – 1GB of LPDDR2-900 SDRAM, and the graphics capabilities, provided by the VideoCore IV GPU, are the same as they ever were. The Pi 3 now includes on-board 802.11n WiFi and Bluetooth 4.0. WiFi, wireless keyboards, and wireless mice now work out of the box.

Fig (3.2): Raspberry pi

pH Sensor

The pH (always written little p, big H) of a substance of how many hydrogen ions in a certain volume of water. 'pH' stands for potential of hydrogen. The definition pH is minus the logarithm of hydrogen ion activity in the solution. pH is gram equivalent per liter of hydrogen ion concentration in a solution. pH has a property of multifunctional in nature, it can test light, pH and soil. It varies between 0 to 14. It is the logarithmic measurement of moles of hydrogen ion concentration per liter of solution. The solutions having pH value between 0 to 7 are acidic solutions, with large hydrogen concentration. Whereas the solution having pH value between 8 to 14 are basic solutions, with small hydrogen concentration. Solutions having pH value of 7 are neutral solutions. Measuring the pH gives the alkalinity or acidity of a solution. This sensor is essential to monitor pH level of soil for optimal growth of crops according to the requirements.

Temperature sensor

The DS18B20 digital thermometer provides 9-bit to 12-bit Celsius temperature measurements and has an alarm function with nonvolatile user-programmable upper and lower trigger points. The DS18B20 communicates over a 1-Wire bus that by definition requires only one data line (and ground) for communication with a central microprocessor. In addition, the DS18B20 can derive power directly from the data line ("parasite power"), eliminating the need for an external power supply.

Water level sensor

Float level switch is a simple structure, easy to use level control devices, it does not provide power, no complicated circuit, it has a smaller volume than the general mechanical switch, long working life and other advantages. As long as the material selection is correct in shape, and the nature of any liquid or pressure, temperature can be used, which in the shipbuilding industry, generating equipment, petrochemical, food industry, water treatment equipment, dyeing and finishing industry, hydraulic machinery, etc. have been widely applications.

VI. CO2 SENSOR

The MQ-6 Gas sensor can detect or measure gases like LPG and butane.

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The MQ-6 sensor module comes with a Digital Pin which makes this sensor to operate even without a microcontroller and that comes in handy when you are only trying to detect one particular gas. When it comes to measuring the gas in ppm the analog pin has to be used, the analog pin also TTL driven and works on 5V and hence can be used with most common microcontrollers.

Turbidity Sensor

Turbidity is the quantitative measure of suspended particles in a fluid. It can be soil in water or chocolate flakes in your favorite milk shake. While chocolate is something we soo want in our drinks, soil particles are totally undesired. Keeping aside the potable purposes, there are several industrial and household solutions that make use of water in some or other manner - for instance, a car uses water to clean the windshield, a power plant needs it to cool the reactors, washing machines and dish washers depend on water like fish.

GSM Module

SIM800 is a complete Quad-band GSM/GPRS solution in a SMT type which can be embedded in the customer applications. SIM800 support Quad-band 850/900/1800/1900MHz, it can transmit Voice, SMS and data information with low power consumption. With tiny size of 24*24*3mm, it can fit into slim and compact demands of customer design. The modem needed only 3 wires (Tx,Rx,GND) except Power supply to interface with microcontroller/Host PC. The built in Low Dropout Linear voltage regulator allows you to connect wide range of unregulated power supply (4.2V -13V). Featuring Bluetooth and Embedded AT, it allows total cost savings and fast time-to-market for customer applications.

VII. FLOWCHART

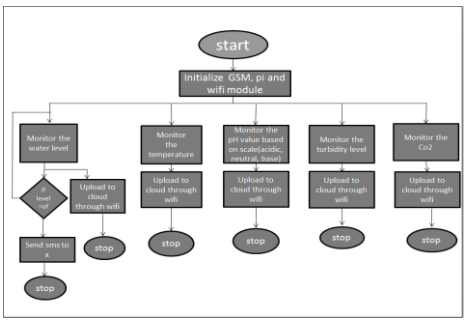
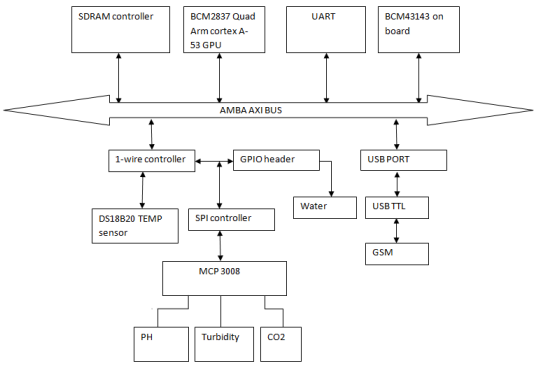


Fig (3.3): System Flowchart

VIII. SYSTEM ARCHITECTURE



Fig(3.4) System Architecture

In this system we are used raspberry pi as central processing unit so this unit controls the all sensors and module. In this system all the sensors are placed at the bank of water i.e. may be near the river, lakes,ponds. The data from the sensors are transmitted from the nodes through gateways one by one to the pi. In this system we used some sensors like Water pH sensor, Co2, Turbidity, Temperature sensor, Water level sensor for measuring water quality. These sensors are interfaced with GPIO pins of raspberry pi. Here the analog outputs of co2, ph, turbidity are digitalized by using analog to digital convertor i.e. MCP 3008 which is a 10 bit resolution its can take 10 samples accurately. It has total 8 channels with these we can connect 8 analog sensors at a time. Its precision is much similar to aurdinoUno and with 8 channels its can read 8 analog data at a time. It is basically using the SPI interface (serial peripheral interface) which is a software protocol to get data from the analog acts as interface. The MCP connects to the raspberry pi using SPI serial connection. We can use either the hardware SPI bus or 4 GPIO pins & software to talk to MCP 3008 The SPI software is more flexible and we are internally enabling the SPI pins or the GPIO header. SPI is also called as 4wired protocol because we are using 4 wires to connect no of devices is (cs chip selection, MISO master in slave out, master out slave in and clk) the data is transmitted and received. The temperature sensor DS18B20 communicates over the 1- wire bus which requires one data line for communication with microcontroller. Data from decimal values are converted to integer values. He data is stored into the cloud 0.5micro sec one by one. BCM 2837 is the Broadcom chip used in the Raspberry Pi 3, and in later models of the Raspberry Pi 2. The underlying architecture of the BCM2837 is identical to the BCM2836. The only significant difference is the replacement of the ARMv7 quad core cluster with a quad-core ARM Cortex A53 (ARMv8) cluster. The GSM module is connected to the serial communication port of raspberry pi, which used to send the alert message to the authority. The raspberry pi will read the all sensors data and send to the cloud which is used to monitor the all sensors data to user. Also raspberry pi will check water level, if water level is above threshold value then it will generate the alert signal and alert message will send to the authority mobile number.

BCM 2837

the Broadcom BCM 2837 that is built specifically for the new Pi 3, the Broadcom BCM2837 system-on-chip (SoC) includes four high-performance ARM Cortex-A53 processing cores running at 1.2GHz implementing the ARMv8-A 64 bit instruction set, with 32kB Level 1 and 512kB Level 2 cache memory, a VideoCore IV graphics processor, and is linked to a 1GB LPDDR2 memory module on the rear of the board. The ARM Cortex-A53 is one of the first two micro architectures implementing theARMv8-A64-bit instruction set designed by ARM Holdings. The Cortex-A53 is a superscalar processor, capable of dual-issuing some instructions.

It is marketed by ARM as either a stand-alone, more energy-efficient alternative to the more powerful Cortex-A57microarchitecture, or to be used alongside a more powerful micro architecture in a big LITTLE configuration.

AMBA AXI BUS

The ARM **Advanced Microcontroller Bus Architecture (AMBA)** is an open-standard, on-chip interconnects specification for the connection and management of functional blocks in system-on-a-chip (SoC) designs. It facilitates development of multi-processor designs with large numbers ofcontrollers and peripherals with a bus architecture. Since its inception, the scope of AMBA has, despite its name, gone far beyond microcontroller devices. Today, AMBA is widely used on a range of ASIC and SoC parts including applications processors used in modern portable mobile devices like smart phones. AMBA is a registered trademark of ARM Ltd.

AXI is third generation of AMBA interface defined in the AMBA 3 specification, is targeted at high performance, high clock frequency system designs and includes features that make it suitable for high speed sub-micrometer interconnect:

- Separate address/control and data phases
- Support for unaligned data transfers using byte strobes
- Burst based transactions with only start address issued
- Issuing of multiple outstanding addresses with out of order responses
- Easy addition of register stages to provide timing closure.

SPI

Serial peripheral interface (SPI) is one of the most widely used interfaces between microcontroller and peripheral ICs such as sensors, ADCs, DACs, shift registers, SRAM, and others. SPI is a synchronous, full duplex master-slave-based interface. The data from the master or the slave is synchronized on the rising or falling clock edge. Both master and slave can transmit data at the same time. SPI specifies four signals: clock (SCLK); master data output, slave data input (MOSI); master data input, slave data output (MISO); and slave select (ÇSS). Figure 1 shows these signals in a single-slave configuration. SCLK is generated by the master and input to all slaves. MOSI carries data from master to slave. MISO carries data from slave back to master. A slave device is selected when the master asserts its ÇSS signal.

SDRAM

The Model B Rev 2.0 Raspberry Pi has 512 MB of SDRAM, while the older revisions and remaining models have 256 MB. Contrast this to the AVR class ATmega168p, which has 1 KB of static RAM. SDRAM is synchronous dynamic random access memory, which synchronizes with the system bus for improved performance. It uses a form of pipelining to gain this advantage.

The SDRAM DDR3 uses a 1.5V SSTL I/O standard, which is very likely incompatible with anything on the Raspberry Pi given that there doesn't seem to be anything but GPIO on the card. Most likely the Raspberry Pi uses 3.3V(or even 5V) on the GPIO which if you also powered the DDR3 with that voltage you've likely got a dead memory module. Besides that unless you designed a hardware DDR3 controller (e.g. in an FPGA) you're most likely never going to get it working via GPIO of a processor.

Internet of Things

In the past decade, all human life changed because of the internet. The internet of things has been heralded as one of the major development to be realized throughout the internet portfolio of technologies. The Internet of Things (IOT) is concerned with interconnecting communicating objects that are installed at different locations that are possibly distant from each other. Internet of Things represents a concept in which, network devices have ability to collect and sense data from the world, and then sharethat data across the internet where that data can be utilized and processed for various purposes.

UBIDOTS

UBIDOTS is an Internet of Things (IoT) data analytics and visualization company. We turn sensor data into information that matters for business-decisions, machine-to-machine interactions, educational research, and increase economization of global resources. UBIDOTS exists as an easy and affordable means to integrate the power of the IoT into your business or research. UBIDOTS technology and engineering stack was developed to deliver a secure, white-glove experience for our users. Device friendly APIs (accessed over HTTP/MQTT/TCP/UDP protocols) provide a simple and secure connection for sending and retrieving data to and from our cloud service in real-time. UBIDOTS' time-series backend services are performance optimized for IoT data storage, computation, and retrieval. Our application enablement platform supports interactive, real-time data visualization (widgets), and an IoT App Builder that allows developers to extend the platform with their own HTML/JS code for private customization when desired. UBIDOTS exists to empower your data from device to visualization.

IX. RESULTS& DISCUSSION

The water level sensor is used to detect and indicate the level of the water in the tank. Sensing is done by using the probes at 3 different levels based on the level of water as shown in the fig (4.2), fig(4.3),fig (4.4).Turbidity sensor quantitative measure of suspended particles in the fluid or liquid. Water with high turbidity is murky, while water with low turbidity is clear. As shown in figure (4.8), fig (4.9). pH sensor, commonly used for water measurements, is a measure of acidity and alkalinity, or the caustic and base present in a given solution based on its nature as shown in the fig(4.5),fig(4.6),fig(4.7). One-wire temperature sensors like the DS18B20 are devices that can measure temperature with a minimal amount of hardware and wiring.

These sensors use a digital protocol to send accurate temperature readings directly to your development board without the need of an analog to digital converter or

other extra hardware as shown in the graph fig (4.10)&fig(4.11) Sensitive material of MQ-2 gas sensor is SnO2, which with lower conductivity in clean air. When the target combustible gas exist, The sensor's conductivity is more higher along with the gas concentration rising. As shown in fig(4.12),fig(4.13) GSM module is used for the alert indication when the water overflows.

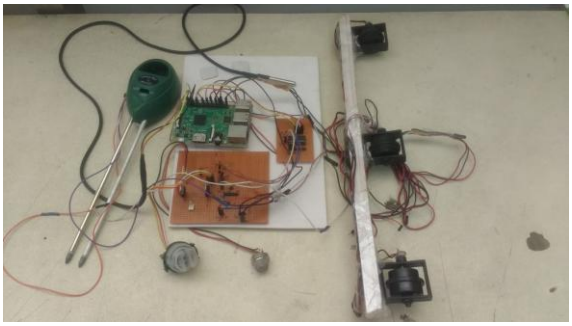


Fig 4.1: Hardware module of system

Fig 4.2: Water level at level1 (LOW)

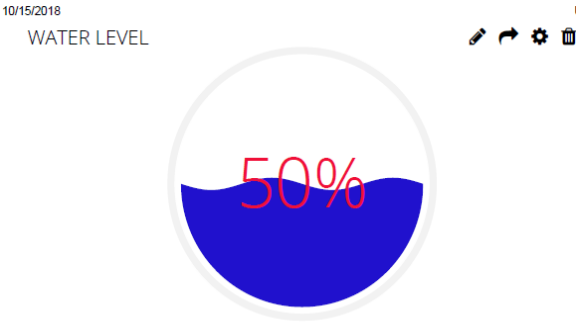


Fig 4.3: Water level at level2 (MEDIUM)

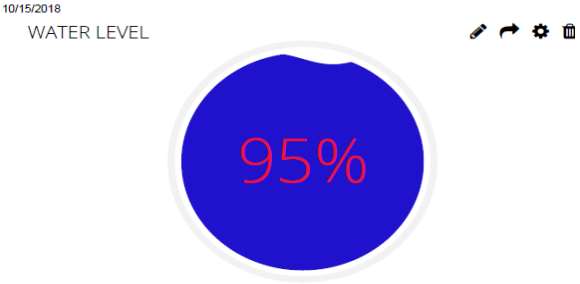


Fig 4.4: Water level at level3 (HIGH)

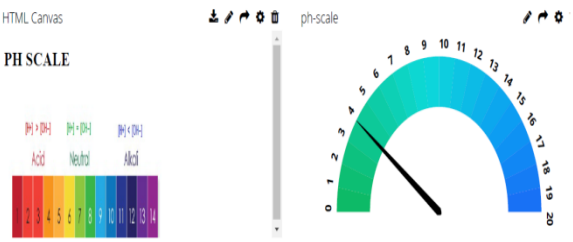


Fig 4.5: pH values in acidic

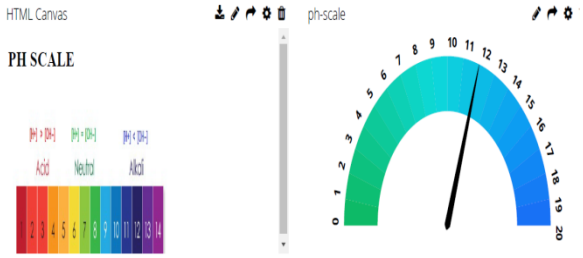


Fig 4.6: pH values in alkaline

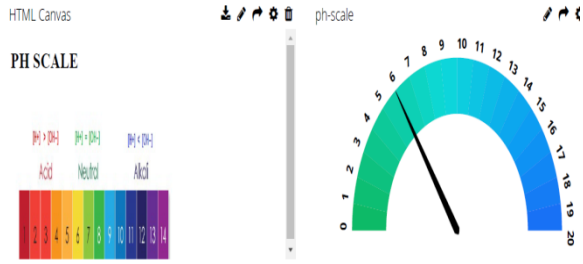


Fig 4.7: pH values in neutral

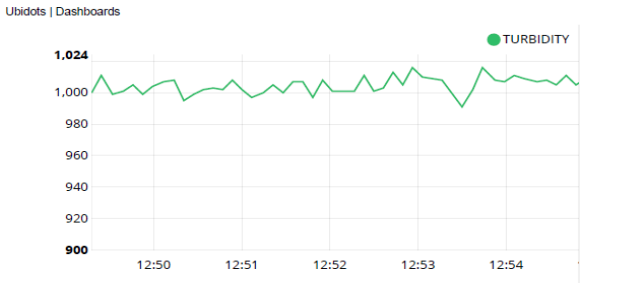


Fig 4.8: normal is water flowing

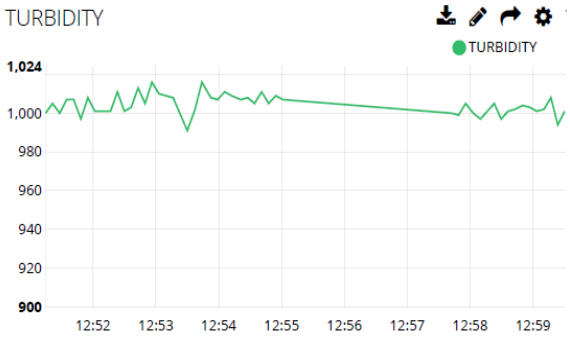


Fig 4.9: muddy water is flowing

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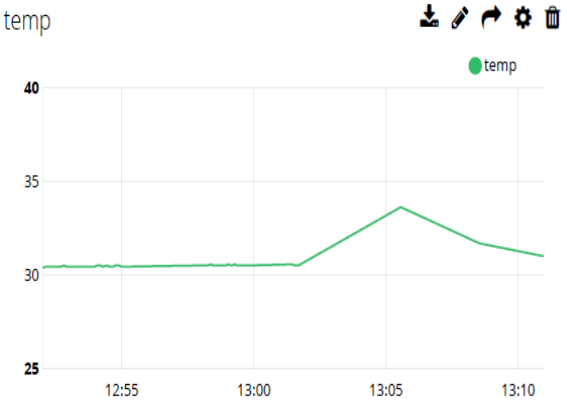

Fig 4.10: temperature values increases

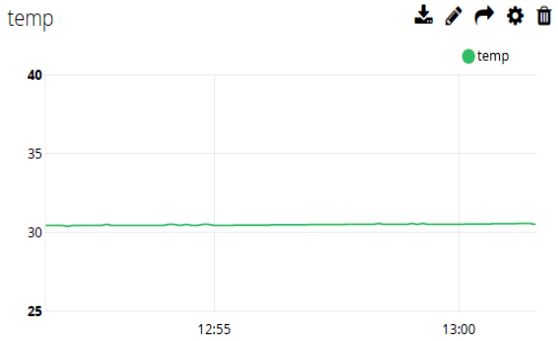

Fig 4.11: temperature values is normal

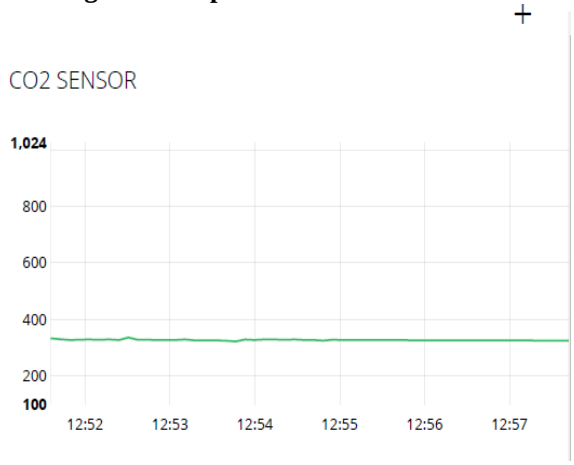

Fig 4.12: Co2 level is normal

Fig 4.13: Co2 level is more

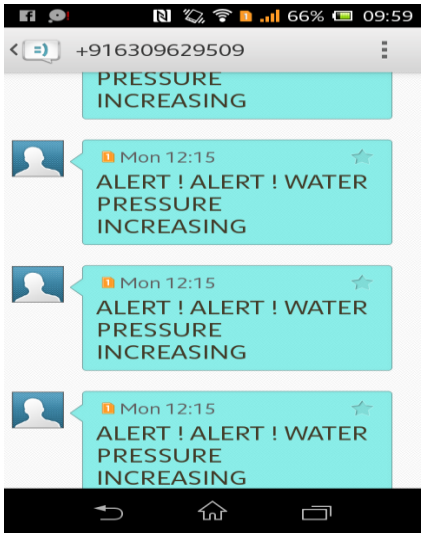

Fig (4.14): Alert msg when water level is high

X. CONCLUSION & FUTURE SCOPE

The conclusion of the parameters of water quality monitoring system is verified that the system achieved the reliability and feasibility of using it for the actual monitoring purposes. Monitoring of Turbidity, PH & Temperature of Water makes use of water detection sensor with unique advantage. The sensors are control the project the system can monitor water quality automatically, and it is low in cost and does not required people.

The future Scope of this project is, we can also remove GSM hardware and we can receive the emergency alerts to mobile phone from cloud server through internet due to his cost is reducing and hardware also reduced.

REFERENCES

1. Zulhani Rasin and Mohd Abdullah International Journal Engineering &Technology, "Water Quality Monitoring System Using ZigBee Based Wireless Sensor Network", 2016.
2. Ch. Pavankumar, S. Praveenkumar, “CPCB Real Time Water Quality Monitoring", Report: Centre for Science and Environment, 2013
3. R.M. Bhardwaj, “Overview of Ganga River Pollution”, Report: Central Pollution Control Board, Delhi, 2011
4. Tuan Le Dinh, Wen Hu, PavanSikka, Peter Corke, L. Overs, Stephen Brosman, “Design and Deployment of a Remote Robust Sensor Network: Experiences from Outdoor Water”, 32nd IEEE Conf. on Local, Computers, pp 799-806, Feb., 2007
5. Quio Tie-Zhn, Song Le, “The Design of Multi Parameter On Line Monitoring System of Water Quality based on GPRS”, Report: Advanced Transducers and intelligent Control System Lab, Taiyuan Technical University, Taiyuan, China, 2010
6. AainaVenkateswaran, HarshaMenda P, Prof PritiBadar, “The Water Quality Monitoring System based on Wireless Sensor Network” Report: Mechanical and Electronic Information Institute, China University of GeoScience, Wu Hen, China, 2012
7. PavlosPapageorgiou, “Literature Survey on Wireless Sensor Networks”, Report: University of Maryland, 16 July 2003

8. SatishTurken, AmrutaKulkarni, “Solar Powered Water Quality Monitoring System using Wireless Sensor Network”, IEEE Conf. on Automation, Computing, communication, control, and compressed sensing, pp281-285, 2011
9. Liang Hu, Feng Wang, Jin Zhou and Kuo Zhao “A Survey from the Perspective of Evolutionary International Journal of Pure and Applied Mathematics Special Issue 1367 Process in the Internet of Things”, International Journal of Distributed Sensor Networks, Article ID462752, 2015
10. Thing Speak-Understanding your Things-The open IoT Platform with MATLAB analytics, Math Works.
11. Nikhil Kedia entitled “Water Quality Monitoring for Rural Areas-A Sensor Cloud Based Economical Project”2015.