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# Water Quality Monitoring in IoT Environment

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***Abstract: -*** *Water pollution is one of the biggest fears for the green globalization. In order to ensure the safe supply of the drinking water, the quality needs to be monitor in real time. This project presents a reconfigurable smart sensor interface device for water quality monitoring system in an IOT environment. The smart WQM system consists of Arduino Uno R3, sensors, ESP8266EX WiFi module, CC2500 RF transceiver and android mobile. The Arduino Uno R3 is a microcontroller board based on the ATmega328. Arduino boards are relatively inexpensive compared to other microcontroller platforms tool. The proposed WQM system collects the four parameters of water data such as water pH, water level, turbidity and water temperature in parallel and in real time basis with high speed from multiple different sensor nodes. The water current will be monitored by accelerometer and the level of water will be monitored by opto isolator which is a digital sensor used to detect the water level connected at the digital pin of the controller and if the water level is above the threshold, then the notification will be sent to android app and also the live location detected through GPS will be also be sent to the Preloaded mobile numbers in the Android App through GSM and then the necessary action can be taken.*
***Keywords: -*** *Arduino UNO R3, ESP8266EX WiFi module.*

## I. Introduction

The Wireless Sensor Network (WSN) and wireless communication technologies have been increasingly developed for assisting human's personal and professional daily tasks. The applications of wireless technologies have been developed for the data acquisition, building control, environmental monitoring systems and automation of manufacturing processes in recent years. Today's state-of-the-art WSNs have more advantages such as low costs for both installation and maintenance, and longer operating time. The remote sensor network can be used for stationary or mobile sensor networks. The remote sensor network is commonly used for different purposes such as surveying the development of city infrastructure, environmental monitoring, telemedicine or remote health care, research in agriculture, fishing surveillance, farming, border security, traffic management, forestry management, and disaster prevention. A WSN consists of compactly dispersed sensor nodes for sensing, signal processing, embedded computing, and connectivity [1]. This system enables the interaction between persons or computers and the surrounding environment through wireless link. Although the WSNs were used in military and heavy industrial applications originally, today's WSN applications are used for different purposes from the light industrial to heavy industrial systems. The WSN system allows users to monitor and control the connected devices from the base station through different wireless communication standards such as WiFi, General Packet Radio Service (GPRS) [2], Bluetooth, Zigbee, Radio Frequency Identification (RFID) [3] and cellular technologies. The users can monitor the data through a wireless network which can be designed based on one of those wireless communication standards. The advantages of WSN are low power consumption, redundant data acquisition, remote monitoring, fast network establishment, wide coverage area, and high monitoring precision and low duty cycle. Thus, the WSN to the real world is practically unlimited from physical security, environmental monitoring and climate changes, positioning and tracking and health care to logistic, localization, and so on [4]. The Internet of Things was developed in parallel to WSNs and is a physical network which connects all things in order to exchange the data and information through the data sensing devices such as sensors, actuators and computers in line with relevant protocols. In other word, many things are connected into networks in one form or another. The aims of intelligent, identifying, monitoring, locating, tracking and controlling things are achieved by IOTs [5]. There is a variety of IOT applications such as RFID tags, sensor technology, mobile technology and other smart technologies. The integration of inexpensive and low powered sensors into IOT is a major evolution of WSNs. The WSN in IOT applications enables the information and communication systems invisibly embedded in the environment since the sensor network enables people to interact with the real world remotely. In the proposed smart WQM system, the water quality monitoring system consists of a group of sensors to monitor the water parameters such as water level, water temperature, turbidity of water and water pH value. Firstly, the sensors detect the water parameters and then the

data is manipulated through Arduino UNO R3 microcontroller which transmits the data to ES8266EX WiFi module and then the sensor output data is displayed on the android mobile. Also, an additional feature is the water level detection that gives an alert to the area in text message form. The project will create a warning system which will prevent loss of life and property. Microcontroller senses the input from sensors and sends the warning to the receiver using ESP8266EX WiFi module. The receiver end also consists of a microcontroller connected to Wifi module. This microcontroller upon receiving warning message from the transmitter will broadcast water level alert to the population in harbor area via text notification using GSM which can be useful in case of Tsunami.

## II. Internet of Things

The Internet of Things (IOT) is a revolutionary new concept that has the potential to turn virtually anything "smart". The Internet of Things 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 share that data across the internet where that data can be utilized and processed for various purposes. All the devices have its unique it helps to capture the real-time data automatically IOT have sensors, processors and portal main basic building batch. Internet of Things (IOT) is a kind of network technology, which is based on information sensing equipments such as RFID, infrared sensors, GPS, laser scanners, gas sensors and so on, can make anything join the Internet to exchange information, according to the protocol, which gives intelligent identification, location and tracking, monitoring and management. At the present day, Smart phones have become the lectern for communication and estimating field. As Mobile phones grow to be a comfort to use and cheaper it can be used for transmitting various types of information. Due to the distribute of mobile phones, various mobile data administration applications are being expanded. The report of the water standard monitoring can be very efficient as well as with good accuracy for analysing the data when the sensor technology is combined along with the mobile data application. Mobile devices, PC and tablets have the display and keypad unit sensors which are embedded in it. By using an IP address in the internet, the Phones may be joined together easily with the Internet (IoT devices satisfies every requirement). In IoT mobile devices act as hub/cellular network. smart things are part of the Internet in Ubiquitous Network Architecture; hence authorized users have approach for information. The data are collected from each objects by using servers which acts as sink.

## III. History of WQM System

There has been lots of research on development of sensors for measuring the different water quality parameters. Recently, an environmental monitoring system based on WSN system using different wireless communication standards has attracted intensive interest. Jing [1] designed a wireless remote monitoring system for water supply based on GPRS using PIC microcontroller. The PC management software is developed using VC++6.0 software platform. Purohit and Gokhale [2] designed a real-time water quality measurement system using Intel microcontroller, Global System for Mobile communications (GSM) module, assorted water quality measuring sensors, Analogue to Digital Converter (ADC), and a liquid crystal display (LCD). Since microcontrollers have more complex architecture, the development time and cost increase due to the complexity of the circuit design. Beri [3] designed an autonomous real-time device to measure the physical and chemical parameters of water such as pH, temperature and turbidity using Arduino Atmega microcontroller & Zigbee wireless module. Hsia [4] developed a water meter system and leakage detection based on FPGA chip to realize a signal generator, a detection circuit, data encoder and a serial port for the transmission of data. The proposed system consists of pressure sensor, an ADC and FPGA design board. Chi et al. [5] presented a reconfigurable smart sensor interface device for industrial area of WSN in the IoT environment. These interface devices are restricted as they are commonly based on the comparatively complex dedicated electronic boards [6- 8]. Vijayakumar and Ramya [9] designed a real-time water quality monitoring system in IoT environment. The system consists of several sensors to measure water parameters and the raspberry PI B+ model as a core controller. For WSN environmental monitoring application, the energy consumption is a critical issue due to the deployment of a WSN based on the IEEE 1451 standard by combining with Complex Programmable Logic Device (CPLD) & the application of wireless communication in IoT environment. The method proposed by M.K. Khurana in [10] is a low-cost approach, however, the designed system can only measure the pH level of water..The research should be performed to achieve a broad space for development in the large number of energy constrained sensor nodes in an unattended environment. Therefore, a low-power, low-cost single-chip fully integrated autonomous System On-Chip (SoC) based wireless sensor node is required to solve these problems. So. this proposed system consists of group of sensors to monitor the water parameters like water level, pH, turbidity & water temperature. The measured values from the sensors can be processed by the core

controller. The Arduino model can be used as a core controller. Finally, the sensor data can be viewed on android mobile using WI-FI module.

3.1 System Design

The objective is to design a real time water monitoring system in IoT environment for day to day living and extend this work for the disaster management such as Tsunami detection which is comprised of :

1) Measurement of pH of water, turbidity, temperature, water level and water current.
2) To combat natural disaster calamities using Arduino Uno R3 and its WiFi module ESP8266EX and sensors.

## IV. System Architecture

Setup is shown in Fig. 1

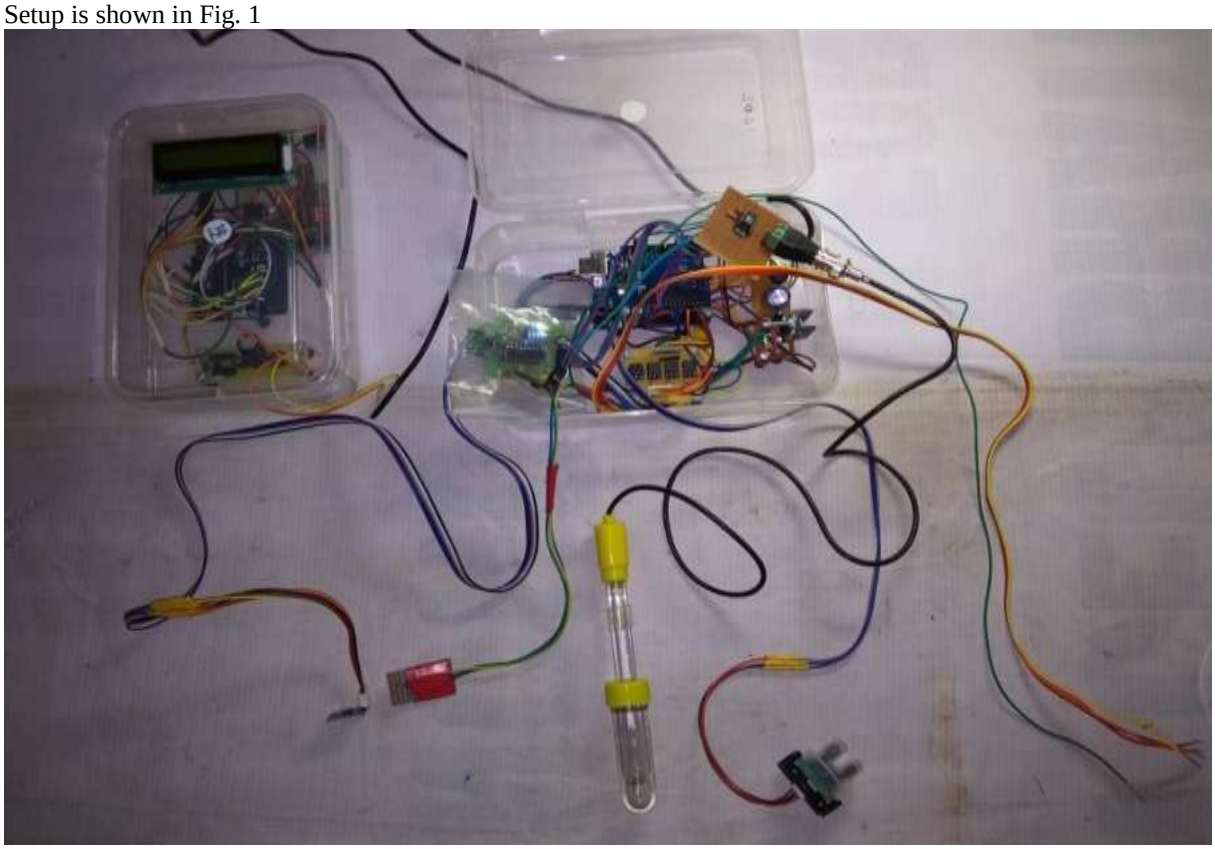

**Fig.1** System setup.

This system consists of:

1. Termperature sensor: LM35 Temperature sensor is used to measure the temperature of water.
2. Turbidity sensor: CZ16/02 Turbidity sensor detects water quality by measuring level of turbidity.
3. pH sensor: pH sensor is used to measure hydrogen-ion activity (acidity or alkalinity) in water.
4. Water level sensor: MCT2E Opto-Isolator detects the level of water.
5. Accelerometer: ADXL335 senses forces of acceleration i.e. vibrations, movement, speed.
6. WiFi module: ESP8266EX WiFi module sends all the sensed data by microcontroller to android mobile wirelessly.
7. Transceiver: The CC2500 transmitter will continuously send the sensors monitored data from controller to CC2500 receiver interfaced with controller present at boat side.

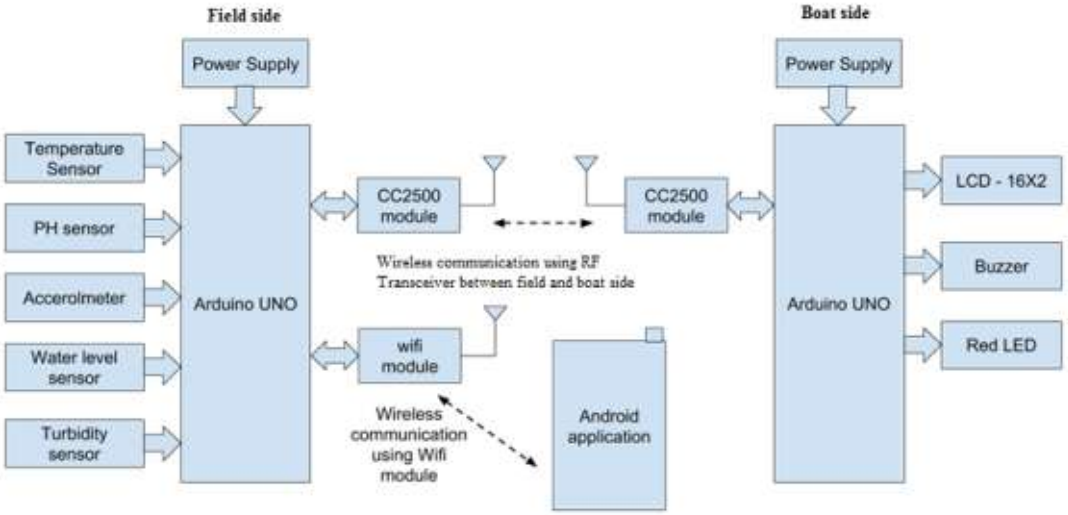


**Fig. 2** Block diagram of WQM system in IoT environment.

Fig. 2 shows the block diagram of Water Quality Monitoring System in IoT environment. The communication between controller and android mobile takes place through WiFi module which itself acts as a server and transmits all the sensed data to mobile. The monitoring devices like all the sensors are continuously monitoring the quality of water. Flow of the project is explained as follows:

A. Firstly, power on both the system (field and boat side) which will power on the controller and all the system components interfaced with the controller.

B. To connect the android app with the controller wirelessly through wifi, search for the name of WiFi server which we have predefined in controller's coding by turning on WiFi option in android phone and connect to it by entering the IP 192.168.4.1 and Port number 1234 of WiFi module which is also set through coding.

C. After the successful connection, the data which is monitored through sensors will be displayed on android app.

D. Sensors such as turbidity sensor checks the purity of water, temperature sensor checks the surrounding temperature , pH sensor detects pH level of water , water level sensor checks the water level and accelerometer sensor detects the current flow of water if it is normal or abnormal.

E. The turbidity, temperature, pH sensor and accelerometer sensors are analog sensors so they are connected on the analog pins of arduino and water level sensor i.e. Opto-Isolator is digital sensor hence connected with a digital pin of arduino.

F. The inbuilt ADC is present at the analog pins of arduino which converts the sensed analog values into digital.

G. Arduino will read all sensor data and calibrate it. After calibrating, it will match the data with the threshold values and detect any abnormalities in water.

H. Through wifi module, notification will be sent to android app and also the live location will be detected through GPS which will be also sent to the preloaded numbers in the android app through GSM.

I. The CC2500 transmitter will continuously send the sensors monitored data from controller to CC2500 receiver interfaced with controller present at boat side.

J. If there is any detection of values greater than the threshold values, then the notification will be sent to control room and the controller present at the control room will display the alert messages on LCD , turn on the buzzer and the red led's will start blinking.

Because of these kind of indications , necessary action can be taken at that time.

## V. Results

The system was tested under different conditions and with different qualities of water. The output of the system was successful and in accordance with the research objectives. By logging on the application, the official users can access the data and also the data is forwarded through SMS to them. The required parameters are shown in real-time. The results of the system are shown below. Five parameters namely pH, turbidity, temperature, water level and speed of water current flow are measured using the experimental setup.

| Parameters | Quality Range | Units |
|---|---|---|
| pH | 6.5-8.5 | pH |
| Turbidity | 80-120 | Percentage |

Parameters measured with different water samples:

| Parameter | Drinking Water | Baking Soda | Lemon Juice | Bleach |
|---|---|---|---|---|
| pH | 6.5 | 9 | 2 | 13 |

| Parameter | Drinking Water | Tap Water | Muddy Water |
|---|---|---|---|
| Turbidity | 98% | 160% | 419% |


**Fig. 3** Boat Side Display

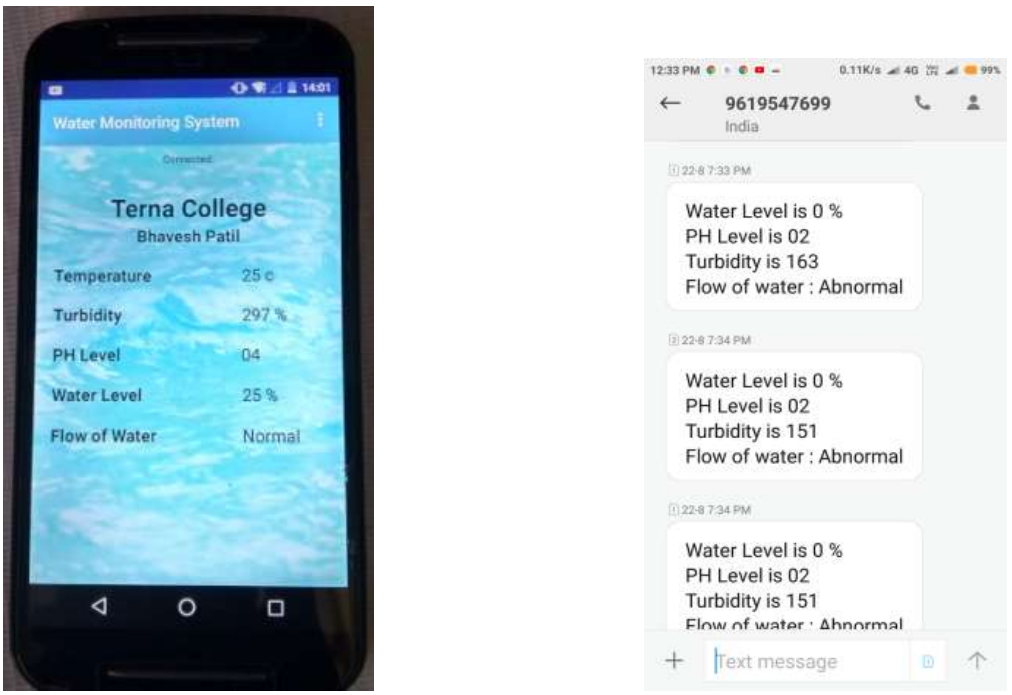


**Fig. 4** WQM mobile application and SMS on mobile.

Fig. 3 and 4 shows boat side display indicating danger weather and WQM mobile application and SMS on mobile indicating the readings of all the water parameters.

## VI. Conclusion

The real time water quality monitoring system for real time applications which is efficient and low cost with different impurities and in different periods of time has been tested after the implementation. The results of the test for all times have been successful. The level of pollution in the water bodies are governed and the sudden warnings are send to the public through messages and alarm. The diseases that are caused due to the presence of metals and pollutants in the water can be protected by this system. The severe level of pollutants in the Ganges and Yamuna rivers can be taken immediate actions. The task of monitoring can be done by using the less trained individuals. To test more parameters of the water quality for some applications, other sensors can be included in the system. The system has wide application and it is usable and affordable by all categories of users.

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