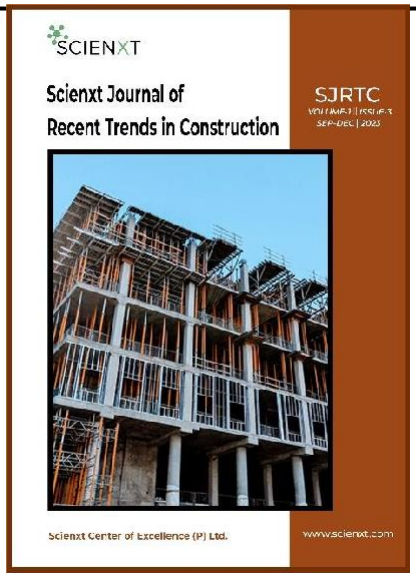


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# ANALYSIS OF WATER QUALITY PARAMETERS BASED ON IOT

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## Abstract

Pollution of water is one of the main threats in recent times as drinking water is getting contaminated and polluted. The polluted water can cause various diseases to humans and animals, which in turn affects the life cycle of the ecosystem. If water pollution is detected in an early stage, suitable measures can be taken and critical situations can be avoided. To make certain the supply of pure water, the quality of the water should be examined in real-time. Smart solutions for monitoring of water pollution are getting more and more significant these days with innovation in sensors, communication, and Internet of Things (IoT) technology. In this paper, a detailed review of the latest works that were implemented in the arena of smart water pollution monitoring systems is presented. The paper proposes a cost effective and efficient IoT based smart water quality monitoring system which monitors the quality parameters uninterruptedly. The developed model is tested with three water samples and the parameters are transmitted to the cloud server for further action.


**Keywords -**pH, Temperature and Turbidity sensors, arduino board.

*Introduction*

Water pollution ensues when lethal materials move into water sources like ponds, rivers, lakes, seas and oceans, gets dissolved and suspends in water or gets deposited on the bed. Pollution will degrade the quality and purity of water. Ensuring pure and safer water is really challenging due to undue sources of chemicals and contaminants. Pollution of water can be instigated by numerous ways; one of the main reasons for pollution is industrial waste discharge and city sewage. Secondary sources of pollution are pollutants that enter the water from soils or from atmosphere via rain or from groundwater systems. Usually, soils and groundwater comprises of residues of modern practices in agriculture and also indecorously disposed wastes from industries. The major pollutants of water include viruses, bacteria, fertilizers, parasites, pharmaceutical products, pesticides, nitrates, fecal waste, phosphates radioactive substances and plastics. These materials will not alter the color of the water always, but they might be indiscernible contaminants. Hence small quantity of water from such water resources and marine organisms are examined for determining the water quality.

Declining quality of water is detrimental to the health, environment and economy. David Malpass, President of the World Bank cautions about the influence on economy: "Deteriorating water quality is stalling economic growth and exacerbating poverty in many countries". It means that, if the biological oxygen demand, the pointer used for measurement of organic pollution in water, surpasses the threshold, the Gross Domestic Product (GDP) growth of the constituencies surrounded by the allied water basins will decrease by a third. The consequences of water pollution or poor water quality are:

- **Destruction of biodiversity:** Pollution of water reduces aquatic ecosystems and initiates unrestrained increase of phytoplankton in water resources

- **Scarcity of drinkable water:** If pollution of water increases or quality of drinking water is not maintained, then there will be no clean water for drinking or public health or sanitization, in rural as well as urban areas

- **Food chain contamination:** Fishing carried out in polluted water resources and utilization of waste water for agriculture and livestock husbandry may lead to addition of toxins or contaminants into foods that are injurious to the health after consumption

- **Infant mortality:** As per WHO, diarrhoeal diseases associated with lacking of hygiene results in death of nearly 1,000 children per day across the world. Water quality monitoring is demarcated as the assortment of data at set or desired places and at periodic intervals for providing information that might be accustomed to describe present conditions of water

- **Disease:** According to WHO (World Health Organization) information, roughly 2 billion people across the world do not have any option for pure water resources, but they have to drink water polluted by excrement, which exposes them to many ailments.

**Objectives**

•This provide real -time data collection and analysis, which canhelp in making timely decisions and actions regarding water management, treatment, safety ,and conversation.

•To measure perilous quality metrics like physical, chemical andmicrobial properties.

•To provide real-time analysis of the sensor data and recommend appropriate corrective measures.

•Enable prompt alert and response to water contamination events, which can protect aquatic ecosystem human health and crop production.

•To keep under observation the source and pathways of pollutants/ contaminations continuously.

•To find the deviations in measured metrics and give timely warning in recognition threats or hazards.

The requisite for involvement of the user for sustaining the quality of water and beholding at additional aspects like hygiene, environment sanitation, disposal and storage are crucial components in maintaining the quality of water bodies.

## Methodology

In general water quality monitoring system consists of various sensors such a pH sensor, turbidity sensors, temperature sensors, conductivity sensors, humidity sensors and many other sensors. Fig.1 shows the general block diagram of smart water quality monitoring system. As shown in the figure, core controller forms the heart of the system. All the sensors are connected a core controller and this controller controls the operation, gets data from sensors, and compares it with that of the standard values and sends the values to the concerned end user or authorities through wireless modules.

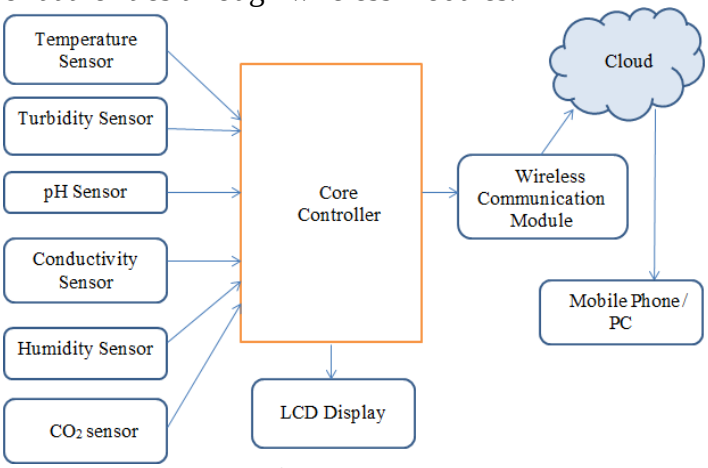
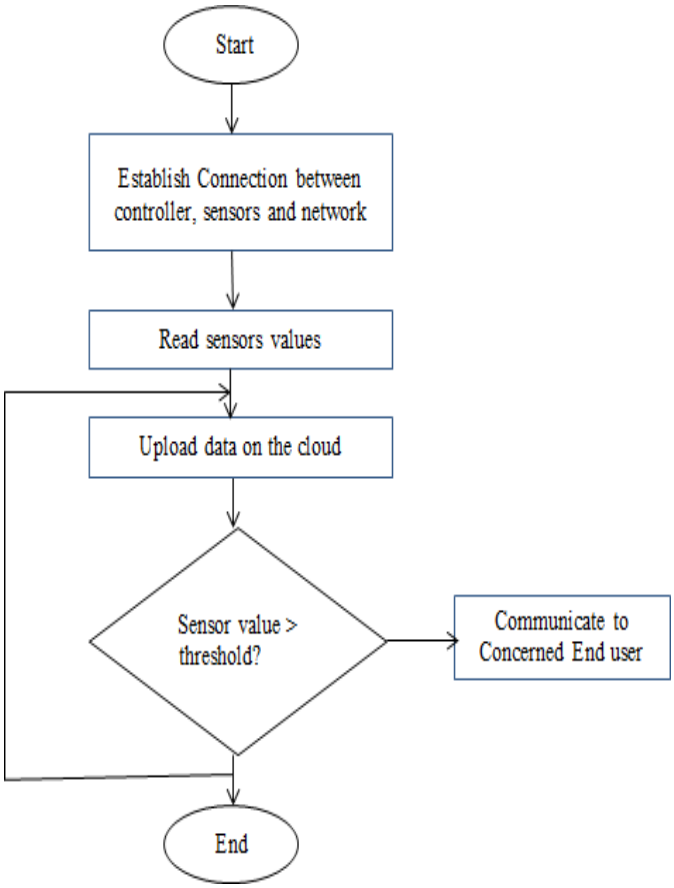



Fig. 1. Taxonomy diagram of Water Quality Monitoring System




With the advances in IoT technology, the water quality monitoring system is becoming smarter with reduced power consumption and ease of operation. Fig. 2 shows the operating flow chart of smart water quality monitoring system.

Fig. 2. Working of smart water quality monitoring system

The core controller is integrated with various sensors such aspHsensor, conductivity sensor, temperature sensor, turbidity sensorand many sensors. The sensor leads are placed in the water to betested. The sensor values will be processed by ADC and thecore controller reads the value and it will be uploaded on the cloud. The values will be monitored continuously by checking whether the sensor value is greaterthan threshold or not. If the sensor value is greater than threshold, then it will be communicated to the concerned enduser for further action. If sensor value is lesser than threshold,then the parameters are again checked for different water source.

**pH sensor:** The pH of a solution is the measure of the acidityor alkalinity of that solution. The pH scale is a logarithmic scale whose range is from 0-14 with a neutral point being 7. Values above 7 indicate a basic or alkaline solution and values below 7 would indicate an acidic solution. It operates on 5V power supply and it is easy to interface with arduino.The normal rangeof pH is 6 to 8.5.

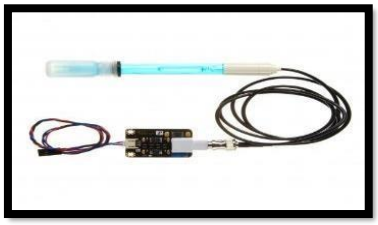


*Fig: pH sensor*

**Turbidity sensor:** Turbidity is a measure of the cloudiness of water. Turbidity has indicated the degree at which the water loses its transparency. It is considered as a good measure of thequality of water. Turbidity blocks out the light needed bysubmerged aquatic vegetation. It also can raise surface water temperatures above normal because suspended particles near the surface facilitate the absorption of heat from sunlight.

*Fig: Turbidity sensor*

**Temperature sensor:** Water Temperature indicates how water is hot or cold. The range of DS18B20 temperature sensor is -55 to +125 °C. This temperature sensor is digital type which gives accurate reading.

**Fig: Temperature sensor**

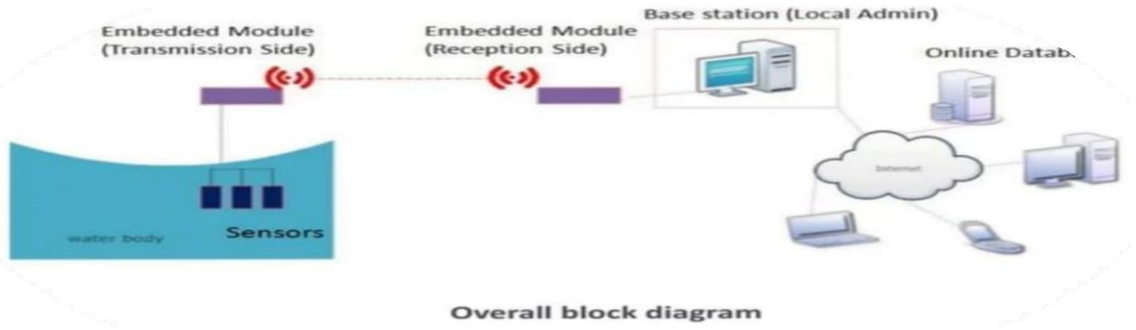
**Arduino Uno:** Arduino is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP headerand a reset button. It contains everything needed to support the microcontroller. Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive listof current, past or outdated boards see the Arduino index of boards


*Fig: Arduino uno*

**Wifi module:** The ESP8266 WiFi Module is a self containedSOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware. The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community.

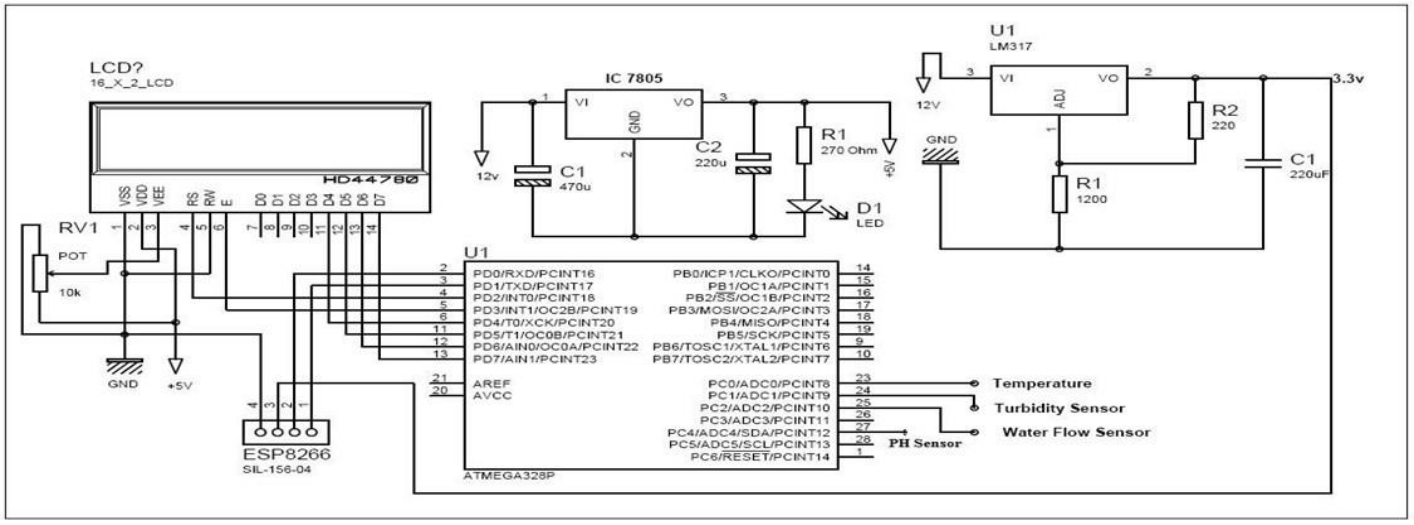
*Fig: WiFi module*

• **liquid-crystal display (LCD): It** is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in color or monochrome.[1] LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden, such as preset words, digits, and sevensegment displays, as in a digital clock




Overall block diagram

## Schematic Analysis




The schematic diagram of the proposed work is as shown in Fig.3.

Fig. 3. Schematic diagram of Water Quality Monitoring System

The work consists of two parts, the first one is hardware & second one is software. The hardware part has sensors whichhelp to measure the real time values, another one is arduino ATMEGA328 converts the analog values to digital and LCDshows the displays output from sensors, Wi-Fi module gives the connection between hardware and software**.**ATMEGA328 has inbuilt ADC and Wi-Fi modules.

The water quality parameters are checked by one by one andupdated in the cloud server as well as the values are displayed in the LCD display.

## Discussion:

Due to the limited drinking water resources, intensive moneyrequirements, growing population, urban change in ruralareas, and the excessive use of sea resources for salt extraction has significantly worsened the water quality available to people. A smart water quality monitoring systemis an essential device which monitors the quality of water continuously. Fig. 4 showsthe developed model of smartwater quality monitoring system.

The water quality parameters are checked by one by one and updated in the cloud server as well as the values are displayedin the LCD display.

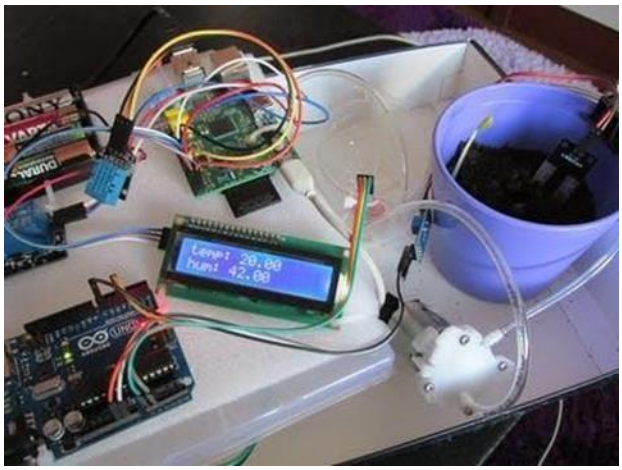


Fig. 4. Developed model of smart water quality monitoring system

As per the literature review, the range of different quality parameters for safe drinking water is tabulated in Table 1.

Table 1. Water Quality parameter range for drinking water

| Parameter | Range |
|---|---|
| pH | 6.5 to 8.5 |
| Turbidity | < 5 NTU |
| Conductivity | 200 to 800 µS/cm |
| Carbon Dioxide | < 2.0 mg/L |
| Humidity | 40% to 100% |

If the above listed parameters are in the specified range, thenthewater is safe for drinking. If these parameters are out of specified range, then the water is not safe for drinking purpose.

The developed model is tested with three different watersamples and the results are tabulated in Table 2.

Table 2. Water Quality parameters for different samples

| Sample | Parameter | Measured Value |
|---|---|---|
| Water Sample 1 | pH | 7.5 |
| | Turbidity | 4 NTU |
| | Conductivity | 450 µS/cm |
| | Carbon Dioxide | 1.20 mg/L |
| | Humidity | 42% |
| | Temperature | 20° C |
| Water Sample 2 | pH | 9.3 |
| | Turbidity | 5.6 NTU |
| | Conductivity | 600 µS/cm |
| | Carbon Dioxide | 1.820 mg/L |
| | Humidity | 60.44% |
| | Temperature | 29.4° C |
| Water Sample 3 | pH | 9.72 |
| | Turbidity | 5.33 NTU |
| | Conductivity | 709 µS/cm |
| | Carbon Dioxide | 1.89 mg/L |
| | Humidity | 64.67% |
| | Temperature | 26.4° C |

From the analysis, water sample 1 is drinkable and other twosamples are not drinkable.

## Conclusion

Water Pollution is a major threat to any country, as it affects health, economy and spoils bio-diversity. In this work, causesand effects of water pollution is presented, as well asa comprehensive review of different methods of water quality monitoring and an efficient IoT based method for water quality monitoring has been discussed. Althoughthere have been many excellent smart water quality monitoring systems, still the research area remains challenging. This work presents a review of the recentworks carried out by the researchers in order to make waterquality monitoring systems smart, low powered and highlyefficient such that monitoring will be continuous and alerts/notifications will be sent to the concerned authorities for further processing. The developed model is cost effective and simple to use (flexible). Three water samples are tested and based on the results, the water can be classified whether it is drinkable or not.

As a future directive, the suggestion is to use latest sensors for detecting various other parameters of quality, use wireless communication standards for better communication and IoT to make a better system for water qualitymonitoring and the water resources can be made safe by immediate response.