# DESIGN AND SIMULATE WATER QUALITY MONITORING BASED ON SENSORS

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# Design and Simulate Water Quality Monitoring Based on Sensors

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***Abstract***— Water is the initial ingredient that all living things, including humans, eat and is the foundation of life. When monitoring the quality of water, various water characteristics are considered, including pH, turbidity, temperature, conductivity, dissolved oxygen, ammonia, metal ions, and dissolved salts. In the meantime, a number of factors—such as chemical residues, manufacturing waste, or groundwater contamination by oil residues and other pollutants that could seriously endanger human health—have contributed to an increase in the amount of pollution in the water. In this paper, we designed an Android application that integrates and displays water transactions. The water quality monitoring system is designed using five sensors: temperature, pH, turbidity, and an LED optical ring. It also includes an Arduino Uno and a Bluetooth piece. Together, outfit a sealed container with a water quality monitoring system and supply the proper voltage for it. The proposed system was designed experimentally and simulated in Proteus software. as a result, the system tested and successfully measured the pH, turbidity, temperature, air, and humidity, and the values displayed on the mobile app interface.

**Keywords—** pH, Temperature, Turbidity, Humidity, Design System.

## I. INTRODUCTION

Water is necessary for human existence to survive [1]. Numerous illnesses that are transmitted throughout the world due to waterborne contamination include cholera, diarrhea, and diphtheria. The most loving approach to stop the spread of these illnesses and epidemics is to keep an eye on the drinking water's quality. It is an essential responsibility of public health management [2]. The World Health Organization has set water quality standards for drinking water [3,4]. In Africa, groundwater supplies provide around 75% of the drinking water, which highlights the significance of maintaining water quality [2]. Water quality can be determined by a number of factors, such as the hydrogenic number (PH), turbidity, temperature, oxidation potential, proportion of minerals in the water, and the percentage of chlorine and dissolved oxygen. Furthermore, only detecting a signal sample is insufficient to determine and assess the water's quality [5]. The first step in water protection is to assess the water quality by collecting samples of chemical and physical indicators. You can obtain information by using it. because there aren't many quick and efficient ways to identify water pollution. Over the past thirty years, specialized organizations and institutions have directed more research toward the detection of water quality and quality standards.[6] gives an overview of water quality measurement campaigns that have already been carried out. Set up the four water quality indicator standard solutions. The absorption spectra of eight standard solutions with various concentrations were gathered in order to determine the distinctive wavelengths of the nitrogen absorption spectra of phosphate, nitrite, and ammonia in the visible light section. With MATLAB, the Lambert Beer law is used to establish the standard curves for various color quantization models, yielding the best grayscale model conclusion. The correlation coefficient ranges from 0.87 to 0.99, with 0.87 being the lowest. For the visible spectrum grayscale image, a convolutional neural network model was created in MATLAB, and its prediction accuracy was 89%. By using univariate linear fitting, a prediction model of voltage and concentration value was constructed for chemical oxygen demand (COD), since its characteristic wavelength is the UV band of 254 nm in the absorption spectra. The correlation coefficient for this model was 0.99 [1, 4]. This article describes a framework for wireless sensor network-based water quality monitoring (WSN-based WQM) systems, discusses the technologies used at each stage of the monitoring process, and provides an overview of the state of the art in the design and implementation of WSN-based WQM systems. Additionally, current solutions that monitor water quality using WSNs are detailed. There is also a discussion of the data processing methods, energy management plans, and communication strategies used in these systems [7]. The most effective method for raising the Raman cross-section to improve Raman scattering at the moment is surface-enhanced Raman spectroscopy (SERS). The active substrate, which includes the kind of noble metals utilized and the size and orientation of the particles, is primarily responsible for its amplification factor. With more functional activated substrates available, advances in nanofabrication techniques help SERS be applied to very low concentration detection. SERS can be enhanced by more than 10 orders of magnitude when combined with resonance Raman spectroscopy; some of these combined SERS systems have attained limits of detections (LODs) below the maximum contaminant levels (MCL). Sadly, not every molecule has the potential to be SERS active. Even if the substrate can be further processed to improve this, further study is required to create workable systems. [5, 8] A variety of physico-chemical and bacteriological analyses were performed to investigate parameters related to water quality, including fluoride ion concentration, turbidity, pH, and fecal coliform. In order to determine risk parameters and areas for improvement, the

World Health Organization's (WHO) recommendation values were compared to the findings of water quality tests conducted during the study. In order to identify places susceptible to a distinct level of risk category, spatial distribution maps for fluoride ion concentration and fecal coliform were also created [8, 9]. Most water quality analysis methods are laboratory-based and require skilled personnel to operate. Therefore, they are expensive in performance and require transportation of the sample to the laboratory. These factors delay the response to pollution events, which hits water safety and public health. Thus, there is a growing and urgent need for a powerful and low-cost on-site detection system that is constant, fast, and accurate.

In this paper the unified water (Portable Water Quality Monitoring System) will be implemented. It is a water quality monitoring system using Internet of Things technology that detects samples using sensors to detect pH, turbidity, percentage of chlorine, dissolved oxygen, temperature, and oxidation potential, in addition to showing the percentage of minerals in the water. Components of the work in brief, connecting the DC socket to the controller. The temperature sensor DS18B20 will be designed to measure the water temperature while the turbidity sensor analyzes water quality. The analog pH sensor is precisely designed to detect the acidity or alkalinity of the solution, and precision sensors are designed to detect the percentage of minerals in water. Also, among the devices used in this work is the programmed Uno Arduino microcontroller, which is the brain of the system that performs the necessary calculations regarding its concerns about the comparison of the received analog signal from the sensor and the preset value. This microcontroller also synchronizes tasks related to other components in the system. The 05-HC Bluetooth module is used as a gateway to allow the Uno Arduino microcontroller to interact with the MIT App Inventor, [10] which is an integrated development environment for web applications for Android and iOS. The results are then displayed on a phone using the mobile application, which is developed and powered by the inventor app MIT. as well as the system designed in proteus software.

## II. Proposed System

The water quality monitoring system comprises five different sections/parts, as indicated in Table.1

Table 1. Designed Components

| | Units | Components |
|---|---|---|
| 1 | Control unit | ATmega328p microcontroller Arduino Uno |
| 2 | Communication unit | Bluetooth module |
| 3 | Sensing unit | Temperature, pH, and turbidity sensors |
| 4 | Software requirement | Windows OS, Arduino IDE, MIT app inventor, Think Speak IoT platform |
| 5 | Power supply unit | AC adapter |

Based on the table 1, the design concept is illustrated as follows.

i. After power conversion, the system would be powered via a DC jack. The microcontroller unit, which manages the subunits, is linked to the DC jack [10].
ii. While the turbidity sensor assesses the quality of the water, the DS18B20 temperature sensor is intended to detect the temperature of the water. The analog pH sensor is specifically designed to determine if a solution is alkaline or acidic.
iii. The brains of the system are a programmed Arduino Uno microcontroller, which performs the necessary mathematical operations to compare the analog data from the sensors that are received with the pre-set value. Moreover, this microcontroller synchronizes duties pertaining to other system components [11].
iv. The Arduino Uno microcontroller may communicate with the MIT App Inventor (a web application integrated development environment for Android and iOS) through the HC-05 Bluetooth module, which serves as the gateway.
v. The MIT App Inventor-powered smartphone app that has been built will be used to display the water quality results [12, 13].

## III. Syetem Mathemetical Model

The system collects date from the sensor and converts into readable value using the following equations:[14][15][16].

1. *Water temperature:*

$$T_{Water=}anlogRead\ (A0) \times \frac{5}{1023} \times 100 \quad (1)$$

2. *pH:*

$$pH = m_{pH} \cdot anlogRead\ (A1) \times \frac{5}{1023} + C_{pH} \quad (2)$$

3. *Turbidity:*

$$T_{turbidity} = a_{turbifity} \cdot anlogRead\ (A2) \times \frac{5}{1023} \times b_{turbidity} \quad (3)$$

4. *Humidity:*

$$H_{Air} = Humidity - Reading \quad (4)$$

5. *Air Temperature:*

$$T_{Air} = Temperature - Reading \quad (5)$$

## IV. Sending Date Via Bluetooth

To send date to an Android application via Bluetooth, the measured value is formatted into a single string as follows:

$$Date = \text{"T\_water:"} + T_{water} + "pH: " + pH + "Turbidity: " + T_{turbidity} + "H - Air : " + H_{Air} + "T - air: " + T_{air}\ \mathrm{T} \quad (6)$$

## V. System Design

The water quality monitoring system design is divided into two interdependent sections: the software and the hardware.

### A. Hardware Implementation

The sketch circuit of the system as shown in Figure 1. the complete system in a plastic box, removing all of the sensors at once, installing a switch for on and off, creating a slot for the power supply, and setting up the Arduino Uno. As shown in Figure 2, the design begins with an Android program application through the MIT App invertor environment. Next, the sensitive desk, pH, temperature, humidity, and turbidity sensors, along with the light circuit, are lifted. The system is then assembled in a box, and the system's efficiency is tested. The data is then uploaded to an Android device after the project has been tested using the Arduino IDE program.

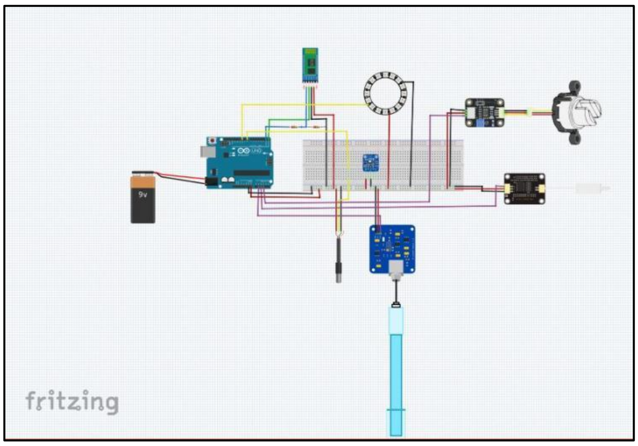

Fig. 1. Sketch Circuit of the System


Fig. 2. A Quality Water System

*1) Parameters Setting:* Here are the usual and acceptable values of PH (pH), turbidity and temperature in water [17][13]:

*(i) PH value (pH):*

- Alkaline water: the optimal value is between 7.2 and 8.5.
- Neutral water: the optimal value is between 6.5 and 7.5.
- Acidic water: the optimal value is between 6 and 6.5.

*(ii) Turbidity:* Pure and healthy water for human consumption: its turbidity is less than 5 NTU (unit reflecting turbidity).

(iii) Temperature range:

- Cold water for drinking: between 10 degrees Celsius and 15 degrees Celsius.
- Warm water for bathing and home use: between 37degrees Celsius and 43 degrees Celsius [18, 19].

*2) Designed an Android Application Program:* The design of Android application program implemented through inventor of the MIT APP. The inventor of the MIT application uses a block-based programming language to develop applications for Android devices. A design has been developed User interface and application backend using the cluster-based programming language of the MIT application inventor English [13, 17]: When the sensors take their reading and transmit it via Bluetooth to the Android device. then will display the water quality values through the front interface. After the program was designed and connected all the sensors together. through Arduino Uno and Bluetooth piece the Android program has been linked together with the water quality measurement system and displayed the measured parameters as in Figure 2.

Fig. 3. A Project App Interface
(Not Connected to the Bluetooth Module Yet)

https://doi.org/10.20428/jst.v30i3.2433

The Arduino Uno microcontroller is programmed with the C-Programming language, using the Arduino IDE. The programming involved the declaration of libraries (which were downloaded and added to the IDE) to be utilized by the sensors and the Bluetooth module. Thus, upon the app program's connection to the HC-05 Bluetooth modules, the interface shows the PH, temperature, humidity, and turbidity data. The temperature is shown in red in Figure 3, which shows the color representation of each parameter and its corresponding value. The temperature is shown as 32.3 degrees Celsius. The humidity is displayed as 59.0% and is colored blue. Lastly, a green representation of the turbidity with a value of 0.87 NTU is shown. These values can therefore be compared using the standard range that was previously explained in the parameter setup. Additionally, this method makes it simple to measure these metrics utilizing a Bluetooth connection on a mobile device.


Fig. 4. Project app connected to the HC_05 and taking reading from the sensors

*B. Software Implementation*

In this branch, the Office of PH Sensors, turbidity, temperature, acid, and humidity sensors were downloaded and connected to an Arduino Uno and a virtual station in the simulation program. Then, the appropriate power was connected to each sensor using the appropriate resistors for each sensor's voltage. The circuit was simulated using the Proteus software. Add a codec library to suit your needs, then create an Arduino program and use a virtual terminal to display the output. In addition to a virtual station for presenting the sensor data, Figure 4 simulates the operation of all the prior sensors—pH, temperature, humidity, air temperature, and turbidity—in a single circuit.

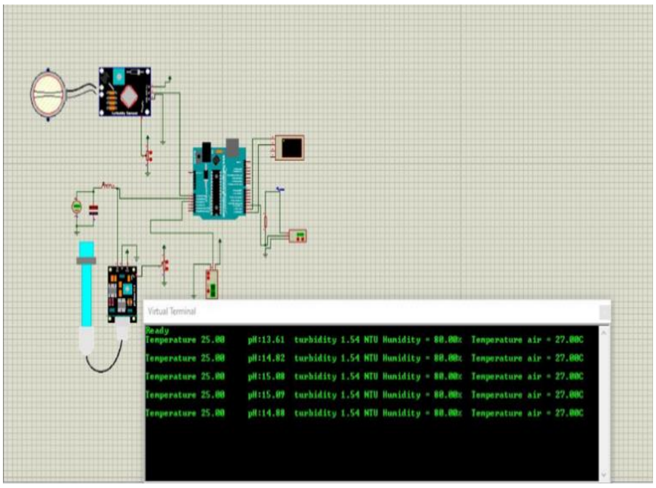

Fig. 5. Proposed System Using Simulation for All the Sensors.

Table 2. Results from Simulation

| Temperature | PH | Turbidity | Humidity | Temperature air |
|---|---|---|---|---|
| 25 | 13.6 | 1.54 | 80% | 27 |

The simulation findings, which are shown in Table 2, make this evident. All of the values in the range that are discussed in the section above, but they also depend on the water's purity; the temperature in the water refers to its temperature, while the air temperature refers to the air outside. Additionally, the values are determined by the software's parameter settings. As a result, the system was effectively developed to measure the parameters related to water quality and weather.

## IV. Conclusion

In this research, a water quality assessment system with numerous sensors is constructed to measure air temperature and humidity as well as acquire data on water parameters. Additionally, the Android app uses MIT app software to develop an app that shows the value of every water coefficient obtained from the sensors using a Bluetooth section. With just a touch of a button, the low-cost system can measure water quality multiple times in a short amount of time, making it convenient to transport and position the device where it is needed. Furthermore, the apparatus permits the measurement of humidity and air temperature by experimental methods or by simulation through pretus software.

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