



# Water Quality Monitoring Model using Machine Learning

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**Abstract:** *Water is one of the vital elements for the existence of life. Quality and accessibility of potable water are growing concerns all over the world. Water from natural sources is usually contaminated with wide variety of substances like pathogenic microorganisms, organic waste, fertilizers and sediments, petroleum that pose health concerns. Taking these factors into consideration, we have proposed a system that classifies water as clean or turbid, considering its physical properties. The system makes use of IoT and Machine Learning Technology. It consists of physical and chemical sensors that detect pH, turbidity, temperature, and TDS to investigate the influencing parameters. The data is collected by sensors, saved in a database, and then submitted to the machine learning model for analysis. When any of the parameters falls below the standard values the water is classified as turbid. There are some pre-existing similar systems that use sensors and machine learning to analyse water quality. However, the novelty in our proposed model lies in the use of neural networks with an optimum number of hidden layers that will predict the best result. Use of neural networks overcomes the shortcomings of other classification algorithms like SVM, KNN etc, as the neural network model analyses the data multiple times over various epochs and gives the optimum result. Also, we will be using advanced sensors that can give precise inputs to the ML model. This tracks the water quality and notifies the user about the water sample being examined.*

**Keywords:** Machine Learning, Neural Networks, Internet of Things

## I. INTRODUCTION

During the recent years, the monitoring and quality check of water has been a growing concern. Only 2% of the world's water resources are fresh water supplies which are getting polluted because of various human activities. Also, these freshwater resources are rapidly getting depleted due to global warming and other climate change induced phenomena, deforestation, fuel spillages, sewage and wastewater, agriculture contamination etc. Contaminated water is linked to transmission of diseases such as cholera, diarrhoea, and many other diseases. According to WHO (World Health Organization), consumption of contaminated water has caused 30 percent deaths worldwide. A water quality monitoring system could be an important primary step in preventing such hazards. This study proposes a system that uses IoT and machine learning technology to analyse if the water is fit for drinking or not. The same when done in a laboratory is time-consuming and requires a lot of effort and is sometimes inefficient too. This could be improved by using computer technology developed recently. This system also aims to provide the immediate users (the common people) with a simplified and swift method to determine if the water to be used is fit for consumption.

The technologies that we proposed to use to realize this system :

### 1.1 IOT

The Internet of Things (IoT) describes the network of physical objects that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet.[14]

**1.2 ML**

Machine learning is a branch of artificial intelligence (AI) and computer science which focuses on the use of data and algorithms to imitate the way that humans learn.[14]

**II. OBJECTIVES**

According to the World Health Organisation (WHO), at least two billion people use a drinking water source contaminated with faeces. Microbial contamination of drinking-water because of contamination with faeces poses the greatest risk to drinking-water safety. Safe and readily available water is important for public health, whether it is used for drinking, domestic use, or food production or for industrial applications. Inadequate management of urban, industrial, and agricultural wastewater means the drinking-water of people is dangerously contaminated or chemically polluted. Safe and sufficient water facilitates the practice of hygiene, which is a key measure to prevent not only water-borne diseases, but acute respiratory infections and numerous neglected tropical diseases. Our system aims to provide a handy device that can analyse the quality of water based on its physical parameters in the immediate surrounding itself, without the need for sending the water sample to a laboratory. It will utilize the power of ML technologies to classify if the water is fit for consumption. It thus saves the time and effort of the user. Also, the complete process of checking the water quality is simplified and expedited. With this we aim to make a cost-effective smartphone-based water monitoring solution.

**III. SCOPE**

In the proposed system, we are using physical properties of water such as pH, turbidity, and temperature to determine the quality of water. This can be improved by using more precise chemical parameters like dissolved oxygen, TDS, certain ion concentration etc. There is a scope of improvement where the precise amount and type of impurities in the water can be shown along with the result. Different methods of improving the quality of water based on the type of impurity can be suggested to customer.

The proposed system can be used in fields such as:

1. Government water purification system.
2. Hospitals and restaurants.
3. Official authorities like ITC can build a simultaneous larger model in order to inspect the quality of mineral water manufacturers.
4. Mineral water manufacturers can use the system for water quality inspection.
5. The common people

Everyone has the right to sufficient, continuous, safe, acceptable, physically accessible, and affordable water for personal and domestic use.

Our system has the potential to provide the common people access to a method/device to check the quality of water they are using in a hassle-free way. Children at risk from water-related diseases can be given access to improved sources of water. This would result in better health, and therefore better school attendance, with positive longer-term benefits in their lives.



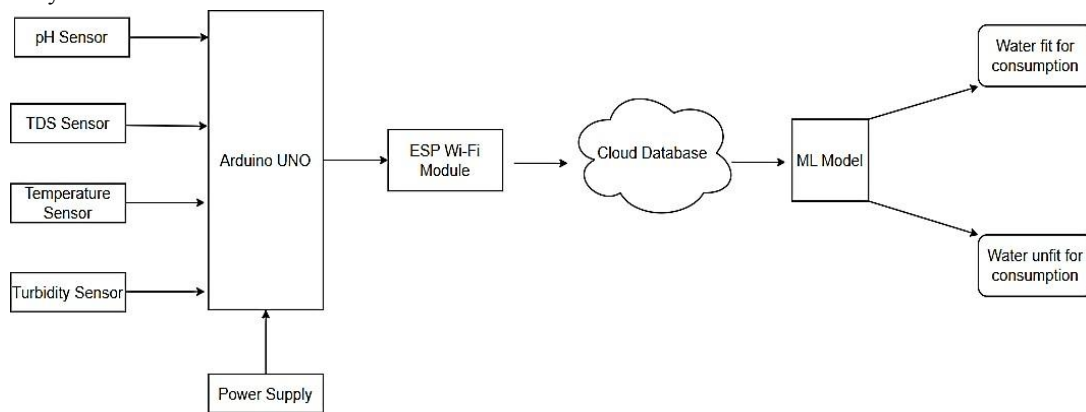
IV. LITERATURE SURVEY

Sr.no.	Title	Author	Year	Description
1	Artificial Intelligence Based Mobile Application for Water Quality Detection	Naga Siva Kumar Gunda and sentinel	2019	The paper ensures the development of an AI-based mobile application platform, which captures the sensor image, built using an in built smart phone camera, identifies the presence of sensing parameter based on colour. It also demonstrates the use of developed application
2	Deep learning based water quality estimation and anomaly detection using virtual constellation and cloud computing	Kyle T. Peterson	2020	This paper applies Novel Deep Learning method for the estimation of blue green algae, chlorophyll-a, fluorescent dissolved organic matter in water. It uses landsat-8 and sentinel-2 datasets.
3	Smart phone Camera based Water Quality Reflectance measurement and Typical Water quality parameter Inversion	Min Gao	2022	This paper aims to extract more accurate water reflectance data from smart phone photographs with variable exposure parameters, and to test usability of these data in deriving water quality parameters.
4	Use of Satellite Imagery for Water Quality Studies	F. L. Hellweger	2003	This Paper Uses Satellite Imagery for water quality studies in the new York harbour region. Ground data from a routine sampling program are compared to imagery from the Landsat Thematic Mapper.it correlates the turbidity of water and the red reflectance in regions affected by Hudson River Sediments based on correlation the estuarine turbidity maximum of the Hudson river is mapped. The study also correlates Chlorophyll-a concentration with the ratio of landsat TM green to red reflectance.
5	Artificial Intelligence based monitoring system of water quality parameters for early detection of non-specific bio-contamination in water distribution systems.	Silvia Tinelli	2019	This research aims to simulate bio-contamination risk propagation under real life conditions in the water distribution systems. It proposes the use of pattern recognizers like Support Vector Machines and innovative sensing technology solutions such as Artificial Neural Network. The paper proposes an SVM able to identify two different classes for 'anomaly' and 'not anomaly' classification.



V. SYSTEM ARCHITECTURE

A number of sensors like pH sensor, turbidity sensor and temperature sensor are connected to an Arduino UNO microcontroller board in the proposed system. This gathers the data from the sensors and sends them to a Wi-Fi Module. The Wi-Fi Module sends data to the cloud. The data is collected in a database, and the findings are transmitted to a Machine Learning model for analysis. Based on the analysis by the ML model, the user is alerted of the quality of water being tested based on the different parameters that have been tested and the result predicted by the model.

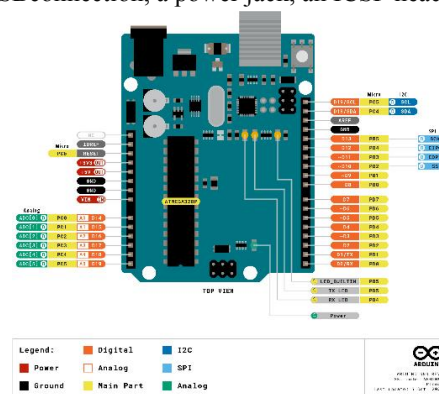


5.1 Hardware

The hardware includes an Arduino UNO microcontroller. It has a Wi-Fi module that enables easy connection to the user. The pH sensor, temperature sensor and turbidity sensor are all couples with the microcontroller in the proposed model.

The important hardware components that we propose to use are:

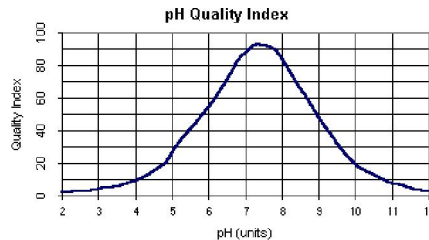
- 1. **Arduino UNO:** Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header and a reset button.



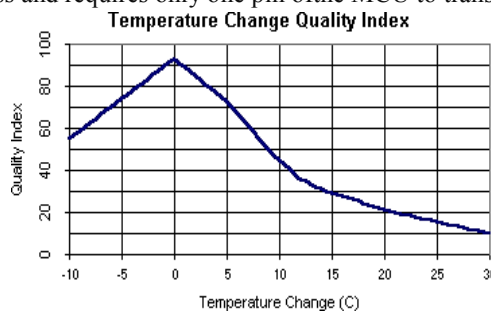
- 2. **Esp8266 Wi-Fi module:** The ESP8266 is a low-cost Wi-Fi microchip, with a full TCP/IP stack and microcontroller capability. This is used for controlling gadgets over the Internet.
- 3. **pH Sensor:** The pH sensor measures the activity of the hydrogen ion of the liquid. It helps in determining if the water is acidic or alkaline. The scale of pH is 0-14, where pH 0-6



defined acidic and 8-14 defined alkaline. pH 7 is a neutral solution. pH sensor with Arduino or Raspberry Pi is a very cost-friendly pH sensor and that is very easy to handle. The driver board of the kit support 3.3V and 5V both.



- 4. Turbidity Sensor:** The gravity Arduino turbidity sensor is a water quality monitor that measures the level of turbidity of the water. By transmitting and scattering the light it measures the suspended particle in water. Analog and digital signal output modes can be found by this liquid sensor.
- 5. Temperature sensor:** The DS18B20 is a 1-wire programmable Temperature sensor from maxim integrated. It can measure a widerange of temperature from -55°C to +125° with a decent accuracy of ±5°C. Each sensor has a unique address and requires only one pin ofthe MCU to transfer data

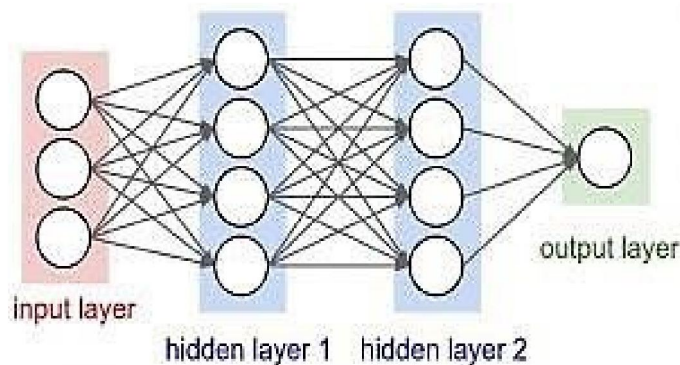


5.2 Software

The data that will be continuously generated by the hardware components will be stored in a Firebase database. The Firebase Realtime Database is a cloud- hosted NoSQL database where we can store and synchronise data between the ML model that will be used.

The data gathered by the sensors is given as input to the Machine learning model (in this case a neural network). It predicts the outcome, i.e., if the water is fit for consumption or not (predicts the quality of water). Artificial neural network helps to classify data in a much better way as it analyses the hidden patterns in the data rigorously using the multiple hidden layers inside it.

There are three layers are present in an ANN model - the input layer, hidden layer, and the output layer. The model will be trained using extensive datasets that already exist. These datasets are routed through networks to produce output.





VI. CONCLUSION

SR NO	PROJECT	TECHNIQUES	RESULT	ISSUES
1.	A Biological Sensor System Using Computer Vision for Water Quality Monitoring	The classification model based on neural network model is used to categorize the parameters of different water quality environments	Provided more accurate results in the case of multi-level classification in compared to shallow neural network.	Explanation to the progress of applicability, accuracy and reliability of the systems approach is not given.
2.	Water Quality Monitoring System using IoT and Machine Learning	Wireless sensor technology	The type of sensors and number of sensor nodes provide high scalability, low cost, and low power consumption.	Time consuming as multiple sensor nodes is employed.
3.	IoT Based Realtime River Water Quality Monitoring System	IoT, Machine Learning and Cloud Computing technique are used.	The system is fully automated which uses Node MCU, which is lighter in weight and also less in cost. Email alerts system and access to data picturization to the authorized water analyst users is also included for its enhancement.	Additional quality sensors such as temperature sensor, TDS sensor can detect the chemical and physical parameters which can help in improvement of the results and thus will make the system more effective.
4.	Intelligent IoT Based Water Quality Monitoring System	Machine to Machine communication (M2M) approach	K-Means Clustering a Machine learning algorithm has been employed for prediction based on the Ph, turbidity, conductivity values.	Security in data and data integrity is needed to be ensured while transmitting the data for Prediction and stimulating the valve tank and in water storage area too.
5.	A multi-class classification system for continuous water quality monitoring	Uses Artificial Neural Network, Radial Basis function, Deep Belief Network, Decision Tree, Improved Decision Tree, Support Vector Machine, Improved Support Vector Machine	Support vector machine and improved support vector Machine produced more accuracy and efficiency than other techniques	Big data demonstrates the issues in lively water quality monitoring. Data quality and validation is also an issue here.

This study provides an economical technique to assess water quality and eliminate the possible health hazards. IoT devices and machine learning algorithms are used to forecast the potential safety of water. To gather water parameters, the proposed system comprises multiple sensors such as temperature sensors, TDS sensors integrated on an Arduino compatible kit.[14] The implemented solution notifies the user about its contamination. Based on the analysis of above cited papers, we believe that our proposed system will overcome their limitations due to the following reasons:

1. We will be using neural network model to analyse the data generated by the water sensors, which will lead to more accurate predictions based on the analysis of input data over various epochs.



2. We will be using advanced sensors that detect both physical properties (temperature, pH, turbidity) and chemical property (TDS) of water. This will help us to better analyse the quality of water.

This proposed model safeguards standard quality detection of water using low price embedded devices like Arduino Uno and ESP Wi-Fi module.

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