**A**

**B.TECH. PROJECT**
**REPORTON**

# "WATER QUALITY MONITORING SYSTEM FOR DHULE REGION USING IOT"

*Submitted in partial fulfilment of the requirements for the award of the degree of*

**Bachelor of Technology**
**in Information Technology**
**by**


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SHRI VILE PARLE KELAVANI MANDAL'S

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**Academic Year 2023 – 24**

SHRI VILE PARLE KELAVANI MANDAL'S

# INSTITUTE OF TECHNOLOGY, DHULE

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**Academic Year 2023 – 24**

***CERTIFICATE***

This is to certify that the B.TECH. Project Report Entitled

**"Water Quality Monitoring System For Dhule Region Using Iot"**

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is a record of bonafide work carried out by them, under our guidance, in partial fulfilment of the requirement for the award of Degree of Bachelors of Technology (Information Technology) at Shri Vile Parle Kelavani Mandal's Institute of Technology, Dhule under the Dr. Babasaheb Ambedkar Technological University, Lonere, Maharashtra. This work is done during semester VIII of Academic year 2023-24.

Date:
Place: SVKM's IOT, Dhule

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Name and Sign with date
Examiner-1

Name and Sign with date
Examiner-2

# DECLARATION

We declare that this written submission represents ideas in our own words and where other's ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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# INDEX

# LIST OF ABBREVIATIONS

| | |
|---|---|
| WQMS | Water Quality Monitoring System |
| ROI | Return Of Investment |
| TDS | Total Dissolved Solids |
| NTU | Nephelometric Turbidity Units |

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# Abstract

In an era where access to safe drinking water is paramount, ensuring the quality of water has become a vital concern. This project presents a novel solution that leverages an array of sensors including pH, ORP (Oxidation-Reduction Potential), conductivity, dissolved oxygen, residual chlorine, turbidity, and salinity sensors to comprehensively assess the quality of water. The aim is to empower users with real-time information about the safety of the drinking water within a portable and convenient solution. The project's core concept involves integrating the sensors within a drinking water bottle. These sensors work collectively to analyze crucial parameters that define water quality. An Arduino board serves as the brain of the system, processing sensor data and making informed decisions based on predefined quality thresholds. Through a user-friendly interface, the device communicates whether the water is safe for consumption or if it falls below acceptable quality standards. The proposed system offers a range of benefits, including convenience, portability, and ease of use. By embedding the sensors directly within the bottle, users can obtain immediate feedback on water quality, enhancing their decision-making process and potentially preventing exposure to harmful contaminants. The integration of technology into an everyday item like a water bottle underscores the project's user-centric approach and real-world applicability.

**Keywords:** IOT sensors, Arduino, Node MCU, Microcontroller.

# CHAPTER 1
# INTRODUCTION

## 1.1 Introduction to Project

Water exerts an indescribable influence on all living organisms. The management of water resources is emerging as an increasingly pressing concern, particularly in the face of rapid global population growth, with specific ramifications for sectors such as industry and agriculture. Access to safe drinking water remains a challenge for a significant portion of the world's population, resulting in numerous fatalities from waterborne diseases annually. Research has consistently demonstrated that the consumption of contaminated water is the leading cause of approximately 5 million deaths each year. Furthermore, investigations carried out by the World Health Organization (WHO) have shown that ensuring children have access to clean drinking water could prevent more than 1.4 million child fatalities. In the realm of water quality monitoring systems, the 2023 paper titled "A Novel Sensor-based Water Quality Monitoring System using Internet of Things (IoT)" stands as a pioneering work. This paper offers a comprehensive discussion on the integration and harmonization of various migration theories within the domain of water quality monitoring. The focal point of this research is a Smart Water Quality Monitoring (SWQM) device capable of discerning distinct physical water characteristics, specifically pH and turbidity. These parameters are evaluated using well-suited machine learning techniques.[1][2]

The foundation of this IoT based Smart Water Quality Monitoring system comprises a network of sensors, including those designed for measuring pH and turbidity. These sensors are strategically deployed at key junctures in the water system, encompassing locations like reservoirs, treatment facilities, and distribution systems, where they consistently collect data. Subsequent to data acquisition, a microcontroller or processor, such as an Arduino, undertakes the critical task of digitizing analog sensor data. This digitized data is then relayed to a cloud-based platform for further analysis. All these new advancement in various applications allows more machines to be more intelligent and more easily accessible from various remote locations. Also, the ability to share information and keep track of the changes in various fields helps to avoid future unexpected problems. In various applications and fields, the main principals and models of Industry 4.0 has found its way All the systems which are equipped with the Internet of Things (IoT) capabilities can be adopted in the new industry models. This Internet of Things (IoT) helps to connect with a cloud environment. As a result, we can send and store data and connect different devices remotely. Also, with IoT we can integrate different types of sensors and devices to collect various types of data. Later this collected data can be used to compare with the decisions which are already has been loaded to a database. With the help of the IoT it will be easier to monitor and improve the sustainability of the environmental resources in an optimized way, and in this case, it is water source.

As the aquaculture industry is growing rapidly and technologies are getting more advanced, various quality of water like turbidity, pH, temperature are becoming most important factors to be monitored and measured.

Like, the growth of fish gets affected by the quantity of dissolved oxygen in water and this quantity is less in warm water compared to cold water[4,5]. When water plays such a crucial role in living organisms it is very essential to make sure that the water we are drinking is safe. Our model here achieve this by making use of multiple sensors and using advanced computations to calculate whether the water is portable ie. Safe to drink or not.

### 1.2 Motivation behind project topic

The implementation of water quality monitoring systems using IoT (Internet of Things) technology is driven by the growing need to ensure safe, clean, and sustainable water sources. As populations expand and industrialization progresses, the risk of water contamination from pollutants, chemicals, and pathogens also increases. This poses a significant threat to public health, environmental sustainability, and economic stability. IoT-based water quality monitoring systems offer a proactive approach to addressing these concerns by providing real-time data and analytics. These systems utilize a network of interconnected sensors placed at various points within a water supply chain, from reservoirs and rivers to treatment facilities and distribution networks. By collecting continuous data on key water quality parameters such as pH, turbidity, dissolved oxygen, and contaminant levels, IoT systems can quickly detect anomalies and potential risks. This real-time feedback allows for immediate action to mitigate issues, ensuring that harmful substances are identified and addressed before they pose a threat to humans or ecosystems. Moreover, IoT-based monitoring systems offer significant efficiency and scalability benefits. Traditional methods of water quality assessment often rely on periodic sampling and laboratory analysis, which can be time-consuming and limited in scope. IoT systems, by contrast, provide a comprehensive and continuous view of water quality, enabling quicker response times and more informed decision-making. These systems also facilitate improved regulatory compliance and public transparency. By sharing data with regulatory bodies and the public, stakeholders can maintain accountability and build trust in water quality management practices. Ultimately, the motivation behind adopting IoT technology in water quality monitoring lies in its potential to enhance safety, foster sustainability, and promote confidence in the quality of water resources for present and future generations.

### 1.3 Aim of the project

**Aim:** The overarching aim of this project is to develop an integrated and sustainable smart water quality monitoring system tailored for the specific needs of the Dhule region. By leveraging Internet of Things (IoT) technologies, sensors, and Arduino boards, the system aims to provide real-time, accurate, andaccessible information on the quality of water in the region.

# CHAPTER 2
# LITERATURE SURVEY

In the twenty-first century, human life has become more easier and safer because of numerous advances in various technological fields. But at the same time various urban development, poorly designed sewage systems, radioactive and industrial wastes, the oil spills caused by offshore drilling, and various other forms of pollution are forming day by day, and because of this, the quantity of safe drinking water is reducing day by day. In present days various factors like exponential population growth, increasing water scarcity, groundwater pollution, and because of other factors water quality monitoring in real-time is more required. As a result, monitoring water quality metrics in real-time need better approaches [1,2]. We measure the acidic or alkaline nature of water by pH metric and this scale ranges from 0 to 14[].Pure water has a pH metrics of 7which is neutral in nature. Safe drinking water should have pH metrics between 6.5 and 8.5 ph. Water clarity is measured by the turbidity scale. [3,4] Higher turbidity means there are more unseen and suspended particles are present in water, which increases the chances of diarrhea, cholera, etc. diseases caused by polluted water. If the turbidity is low or in a safe range, then the water is safe to drink. Wireless communication is getting more and more common and helping people in their daily life and duties. Also, because of Industry 4.0 various new advanced and more optimized technologies are getting introduced. [5,6]

Table 2.1 Water Quality Parameter

| **Water Quality Parameter** | **Permissible limit for surface waters** |
|---|---|
| pH | 6.5 – 9.0 |
| Temperature | Increase of 10degreeC affects aquatic life |
| Dissolved oxygen | Fresh water: 7mg/-9mg/L |
| Ammonium | Greater than 0.1mg/L and less than 1mg/L |
| Nitrate | 50 mg |
| Turbidity | Based on dissolved solids |
| Phosphates | Less than 50pg/L at entry point and less than 25ug/L within lake |
| Dissolved organic carbon | 10mg/L threshold |
| Conductivity | Fresh water streams 150uS/cm to 500/cm |

All these new advancement in various applications allows more machines to be more intelligent and more easily accessible from various remote locations. Also, the ability to share information and keep track of the changes in various fields helps to avoid future unexpected problems. In various applications and fields, the main principals and models of Industry 4.0 has found its way. All the system which are equipped with the Internet of Things (IoT) capabilities can be adopted in the new industry models.

This Internet of Things (IoT) helps to connect with a cloud environment. As a result, we can send and store data and connect different devices remotely. Also, with IoT we can integrate different types of sensors and devices to collect various types of data. Later this collected data can be used to compare with the decisions which are already has been loaded to a database. With the help of the IoT it will be easier to monitor and improve the sustainability of the environmental resources in an optimized way, and in this case, it is water source. As the aquaculture industry is growing rapidly and technologies are getting more advanced, various quality of water like turbidity, pH, temperature are becoming most important factors to be monitored and measured. Like, the growth of fish gets affected by the quantity of dissolved oxygen in water and this quantity is less in warm water compared to cold water the research underscores the adoption of a decision tree-based classification model as the linchpin of water quality analysis. This approach, leveraging a diverse set of input features, demonstrates its potential in forecasting water quality. Its pivotal role in facilitating decision-making and enhancing water management practices aligns with the goal of ensuring clean, safe water for human consumption while bolstering environmental sustainability. [7,8]

The study encompasses a spectrum of decision tree algorithms, including Random Forest, LMT, Hoefflin Tree, J48, and Decision Stump, all of which are instrumental in constructing classification models for water quality assessment. The proposed system's workflow involves data acquisition and preprocessing, the segregation of datasets into training and testing subsets, the creation of a decision tree model, performance evaluation and optimization, deployment onto a fitting platform, and ongoing monitoring and updates. the utilization of a decision tree-based classification model for assessing water quality.[9,10] This approach, driven by various input features, holds the potential to predict water quality effectively. Its application in decision-making processes and enhanced water management practices contributes to ensuring clean, safe water for human consumption and environmental sustainability. Multiple decision tree algorithms, such as Random Forest, LMT, Hoefflin Tree, J48, and Decision Stump, are employed for constructing water quality classification models. The proposed methodology involves data collection and preprocessing, partitioning into training and testing sets, constructing a decision tree model, evaluating and optimizing its performance, deploying it onto a suitable platform, and implementing continuous monitoring and updates.

Notably, the accuracy and reliability of classification models hinge on factors like data quality and quantity, feature selection, algorithm choice, and parameter optimization. Further enhancements can be achieved by integrating deep learning and ensemble techniques into classification models, offering the potential to improve the quality of life for countless individuals worldwide through advanced water quality analysis methodologies.

It is crucial to underscore that the precision and dependability of a classification model hinge upon a multitude of factors encompassing data quality and quantity, feature selection, algorithmic choices, and parameter fine-tuning. Further strides in the field of water quality analysis can be attained by incorporating advanced techniques such as deep learning and ensemble methods into classification models. Ultimately, these approaches hold the potential to enhance the quality of life for millions worldwide by refining water quality assessment methodologies. In research work of reference[9], the authors have utilized Arduino Mega microcontroller. The process of programming various sensor modules becomes easy and time saving with the help of this microcontroller.

Also, authors have managed to get accurate result using various sensor modules. But Arduino Mega does not have inbuild wireless module, so they have to use NodeMCU to enable wireless data transfer. This can cause propagation delay while transmitting large amount of data to the cloud server. To resolve this issue our proposed model uses Raspberry Pi microcontroller which have inbuild wireless model. This helps to reduce propagation delay as data from raspberry pi can get transmitted directly to the server. In research work of reference authors have proposed a Water-Quality Monitoring System which consumes very low power and maximizes the throughput rate. Authors have used low-powered microcontroller and sensor modules to ensure energy efficiency. Authors have been successfully archived more optimized and error free data of fairness index among various sensor node sand high data transmission throughput rate between sensor nodes by utilizing new data collecting algorithms. But to monitor transmitted data in real time from remote places we need a IoT cloud space which will fetch various data from sensor nodes in real time. To enable this real time data monitoring the proposed system utilizes cloud database which will store and fetch data transmitted from sensor nodes and user can monitor the data in real time.[10]

**2.1 Survey Existing system**

An entirely new paradigm for monitoring water quality has been made possible by the development of Internet of Things (IoT) technology. IoT-based smart water quality monitoring systems provide numerous benefits, including real-time monitoring, data transmission, and data analysis. In order to overcome the difficulties and restrictions of conventional water quality monitoring systems, recent research has concentrated on creating and enhancing IoT based smart water quality monitoring systems [1].

The numerous IoT-based water quality monitoring systems are covered in this review study, together with their architectures, parts, and communication protocols, as well as their benefits and drawbacks. [2] The most recent developments in smart water quality monitoring systems—including their sensors, data collecting and processing methods, and applications in many fields—are outlined in this review paper. [3] This review paper gives a general overview of several smart water quality monitoring systems, including their parts, methods for gathering and analyzing data, and uses in environmental, industrial, and agricultural monitoring. [4] The numerous IoT-based water quality monitoring systems are surveyed in this review paper, together with their sensor technologies, communication protocols, and applications in smart cities and agriculture. [5]

In-depth information about IoT-based water quality monitoring systems, including their architectures, sensor technologies, data collecting and analysis techniques, and applications in a range of industries, including agricultural, environmental monitoring, and public health, is provided in this review paper. [6] The current state of wireless sensor network and IoT-based water quality monitoring systems, including their topologies, sensor technologies, data analysis methods, and applications in various areas, is outlined in this review paper. [7] An overview of wireless sensor network-based smart water quality monitoring systems is given in this review paper, together with information on the sensor technologies, communication protocols, data processing methods, and applications in environmental monitoring, aquaculture, and public health. These papers examine the most recent advancements in IoT-based smart water quality monitoring systems [8-10], including their sensor technologies, communication protocols, data acquisition and analysis methods, and applications in various industries and monitoring domains like agriculture and industry. Overall, the research points to the significant potential for IoT-based smart water quality monitoring systems to enhance water management procedures and safeguard both human health and the environment. The requirement for trustworthy sensors, standardized communication protocols, and efficient data management systems are just a few of the obstacles that still need to be overcome. Future studies can concentrate on resolving these issues and enhancing the development and use of IoT-based smart water quality monitoring systems. By enabling real-time, thorough, and continuous monitoring, an IoT-based smart water quality monitoring system can address the drawbacks of conventional techniques. Researchers hope to improve water quality management through rapid variation detection, early warning systems, and the capacity to conduct prompt corrective actions by combining IoT technology, such as sensors, data analytics, and communication networks. For the benefit of ecosystems and human populations, this research aims to ensure safe and sustainable water supplies, enhance environmental monitoring, and enable effective water treatment procedures.

### 2.2 Limitation of existing system

Existing water quality monitoring systems face several limitations that hinder their ability to ensure safe drinking water. One significant drawback is the lack of portability, as carrying monitoring devices is often cumbersome and impractical for individuals on-the-go. Unlike the proposed solution, which integrates sensors directly into a portable water bottle, existing systems do not offer real-time information right before consumption. This leaves users unaware of potential risks, as they must rely on periodic assessments conducted at fixed monitoring points.

Furthermore, existing systems typically focus on monitoring water sources rather than the container itself. This neglects the possibility of contamination during storage or transportation, which can occur due to various factors such as improper handling or leaching from packaging materials. Without monitoring container integrity, users may unknowingly consume water that has been compromised by external contaminants. Another limitation lies in the complexity of existing systems, which may require specialized knowledge to operate and interpret results accurately. This complexity can be a barrier for users who are not familiar with technical equipment or data analysis. Additionally, existing systems may not provide comprehensive assessments of water quality, as they may lack sensors for key parameters such as turbidity, salinity, and residual chlorine. This limits their ability to detect certain contaminants or assess overall water safety effectively. Addressing these limitations is crucial for ensuring widespread access to safe drinking water, particularly in situations where real-time monitoring and immediate feedback are essential for informed decision-making. By developing more portable, user-friendly, and comprehensive water quality monitoring solutions, we can empower individuals to make informed choices about their drinking water and take proactive measures to protect their health. This underscores the importance of innovation in water quality monitoring technology to meet the evolving needs of communities and ensure access to clean and safe drinking water for all.

# CHAPTER 3
# PROBLEM STATEMENT

## 3.1 Problem Statement

The problem statement of the project is to "Developing an integrated sensors based portable water quality monitoring system for humans". As we know that access to safe and clean drinking water is fundamental human right, and ensuring the quality of drinking water is crucial for public health. The water quality monitoring system for safe drinking is a sophisticated solution that is designed to monitor and ensure the safety of drinking water. This comprehensive system integrates sensor technologies and real time data analysis capabilities to monitor essential water quality parameters at every stage of the drinking water supply.

The system's primary objective is to swiftly detect any deviations from established safety standards. This water quality monitoring system for safe drinking water is crucial for ensuring the accessibility and safety of clean drinking water for communities. This system aims to address the challenges associated with monitoring quality at every stage of the drinking water supply. The system plays a crucial role in safeguarding public health. The objective of that project is to design and implement Internet of things (IOT) based water quality monitoring system using various sensors including PH sensor, turbidity sensor, temperature sensor, etc.

## 3.2 Scope of the Project

The scope of this project encompasses the development and implementation of a comprehensive water quality monitoring system that addresses the limitations of existing systems while leveraging advancements in sensor technology and Internet of Things (IoT) connectivity. The primary objective is to create a user-friendly, portable, and real-time monitoring solution that empowers individuals to assess the safety of their drinking water accurately. Key components of the project include integrating a variety of sensors, such as pH, ORP, conductivity, dissolved oxygen, residual chlorine, turbidity, and salinity sensors, into a compact and portable device. These sensors will be strategically placed within a specially designed water bottle to ensure direct contact with the water and facilitate immediate measurements. An Arduino board will serve as the central processing unit, collecting data from the sensors and analyzing it to determine water quality parameters.

The scope also encompasses the development of a user-friendly interface that provides real-time feedback on water quality to the user. This interface will communicate whether the water is safe for consumption or if it falls below acceptable quality standards based on predefined thresholds. Additionally, the system will have the capability to alert users to potential contamination events, enabling them to take appropriate actions to mitigate risks. Furthermore, the project aims to explore the feasibility of integrating cloud-based storage and data analysis capabilities to enhance the functionality of the monitoring system. This would allow for remote monitoring and data access, enabling users to track water quality trends over time and make informed decisions about water usage and consumption.

Overall, the scope of this project is to develop a versatile and scalable water quality monitoring solution that can be easily deployed in various settings, including households, outdoor activities, and emergency situations. By addressing the limitations of existing systems and leveraging emerging technologies, this project aims to contribute to the advancement of water quality monitoring practices and promote access to clean and safe drinking water for all.

# CHAPTER 4
# PROPOSED SYSTEM

## 4.1 System Architecture:

This is the integrated sensor based portable water quality monitoring system for humans. This is the system which can detect the quality of water at the time of drinking the water. When the user can drink the water at that time the user can pour the water into the vessel in which the water quality monitoring system is embedded. When water get poured then system should predict the quality of the water that is water is portable or it is safe for drinking or not. This is the main objective of the project that detect the quality of safe drinking water.

## 4.2 System Methodology:

**Woking of the system:**

The working of water quality detection system includes steps to continuously monitor, analyze and interpret key parameters that define the quality of water. When the system get embedded into the water then it can detect the quality of water and give the output that the water is safe for drinking.

Step by step process of how the water quality detection system operates:

- Parameter Selection: It is important to identify the specific water quality parameters to be monitored. These may include physical parameters such as temperature, turbidity etc., chemical parameters such as pH of water. Select the parameters that are required to measure the quality of drinking water.

- Sensors Deployment: Collect all the sensors that are required for measuring the water quality, connect all of them together with Arduino Uno and embed it into the system. Set the levels of the all the sensors which are already set by government for safe and clean drinking water.

- The code is get embedded into the Arduino Uno by which whole system will work. All the sensors are connected to the Arduino and then it will get perform and work accordingly.

- When all the sensors are deploy into the water then all the sensors measure the water parameters accordingly after that data should pass to the Arduino , it will check all the parameters according to the code embedded into it and then it will generate the output.

- The LCD display is connected to that Arduino which can display the output. The message is displayed on the display that Water is portable or water is not portable. It can also display the values of the parameters detected by the sensors.

Table 4.1 Permittable range for drinking water

| **Parameter** | **Range for Portable Drinking Water** |
|---|---|
| pH | 6.5-8.5 |
| Hardness | 50-100mg/L |
| Sulphate(SO4) | Below 250mg/L |
| Conductivity | Less than 800S/cm |
| Organic Carbon(TOC) | Below 2mg/L |
| Turbidity | Less than 5 Nephelometric Turbidity Units(NTU) |
| Chloramines | Up to 4.0mg/L |

# CHAPTER 5

## Details of Hardware and software requirements

**Hardware requirements:**

The hardware components which are used in the system are as follows:

1. pH Sensor:- The water pH sensor is a simple device that makes it easy to measure the quality of the water. One of the most important instrument for measuring the quality of water is the pH sensor. The pH sensor often made of glass and has rod like structure with a bulb at the bottom that holds the sensor. A glass bulb is used to measure pH level of the water. This pH sensor determine whether a solution is naturally acidic or alkaline. pH levels can be detected between 0 and 14 by the sensor set. pH sensor offer greater accuracy for measuring the acidity or alkalinity of water.

Fig 5.1 pH Sensor
Source: https://th.bing.com/th/id/OIP.KidsOey1xk_fEzdbttotgHaHa?rs=1&pid=ImgDetMain

2. Turbidity Sensor:- Turbidity sensor measure the amount of light that is scattered by suspended solids in a liquid, such as water. When the concentration of total sulphate solid and total dissolved solids in water increases then the turbidity also increases.

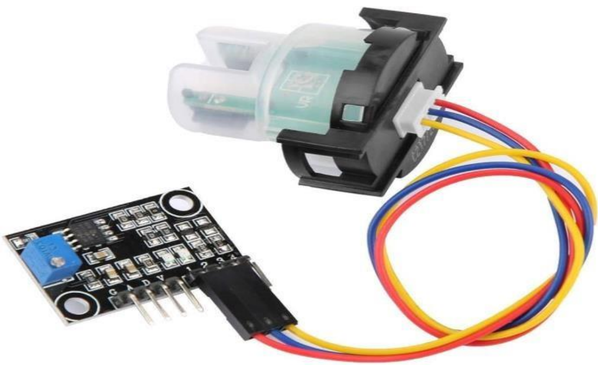

Fig 5.2 Turbidity Sensor
Sourcehttps://th.bing.com/th/id/OIP.PhhnCB_QJsUY2PdvYDjkdwHaHa?w=1360&h=1360&rs=1&pid=ImgDetMain

3. Temperature Sensor:- Temperature sensors provide data about the water such as changes in temperature patterns, water mixing and thermal pollution which can impact the quality of water. This helps the water quality professionals to determine whether the water is safe for consumption or not. Monitoring water temperature ensures that the water is being treated effectively and within the regulatory limits. By monitoring temperature changes , it is possible to ensure that the water you consume is safe.

Fig 5.3 Temperature Sensor
Source: https://th.bing.com/th/id/OIP.KidsOey1xk_fEzdbttotgHaHa?rs=1&pid=ImgDetMain

4. LCD display:- The liquid crystal library allows you to control LCD display that are compatible the driver. The LCD's have a parallel interface, that the microcontroller has to manipulate several interface pins at once to control the display. The process of controlling the display involves putting the data that form the image of what you want to display into
the data registers, then putting instructions in the instruction register.

Fig 5.4 LCD Display
Source: https://th.bing.com/th/id/OIP.Q3uDq_Napv89G4yxk7L8ZgHaH6?rs=1&pid=ImgDetMain

5. Arduino UNO:- Arduino is an open source electronics platform based on easy to use hardware and software. This platform allows you to create different types of single board microcomputers to which the community of creators can give different types of use.

Fig 5.5 Arduino UNO

Source: https://th.bing.com/th/id/OIP.KidsOey1xk_fEzdbttotgHaHa?rs=1&pid=ImgDetMain

6. ESP32 wifi module:- ESP32 is an electronic prototyping diverse platform that can control multiple hardware and executes code according to the instructions. ESP32 is comes with pre-installed Wi-Fi drivers and dual Bluetooth module to provide it with wireless connectivity.


Fig 5.6 ESP32
Source: https://th.bing.com/th/id/OIP.KidsOey1xk_fEzdbttotgHaHa?rs=1&pid=ImgDetMain

7. Jumper wires:- Jumper wires are used for making connections between items on your breadboard and your Arduino's header pins. They are simply wires that have connector pins at each end, allowing them to be used to connect two points to each other without soldering.

Fig 5.7 Jumper Wires
Source: https://th.bing.com/th/id/OIP.KidsOey1xk_fEzdbttotgHaHa?rs=1&pid=ImgDetMain

8. TDS Sensor:- TDS is a small hand held device used to indicate the total dissolved solid. Dissolved ionized solids such as salts and minerals increases the conductivity of the water. TDS meter measures the conductivity of the water and estimates the TDS from that reading. This measurement is important in various fields such as water quality monitoring, aquaculture, hydroponics, and industrial processes. TDS includes inorganic salts (such as calcium, magnesium, potassium, sodium, bicarbonates, chlorides, and sulfates) as well as some organic matter that may be present in the liquid. TDS sensors typically work by measuring the electrical conductivity of the liquid, as dissolved solids in water increase its conductivity. The sensor usually consists of two electrodes placed in the liquid. When an electrical current is applied across the electrodes, the conductivity of the liquid is measured. This measurement is then converted into a TDS value, usually expressed in parts per million (ppm) or milligrams per liter (mg/L).

Fig 5.8 TDS Sensor
Source: https://th.bing.com/th/id/OIP.KidsOey1xk_fEzdbttotgHaHa?rs=1&pid=ImgDetMain

# Chapter 6

# System Design Details

## 6.1 Use-case Diagram:

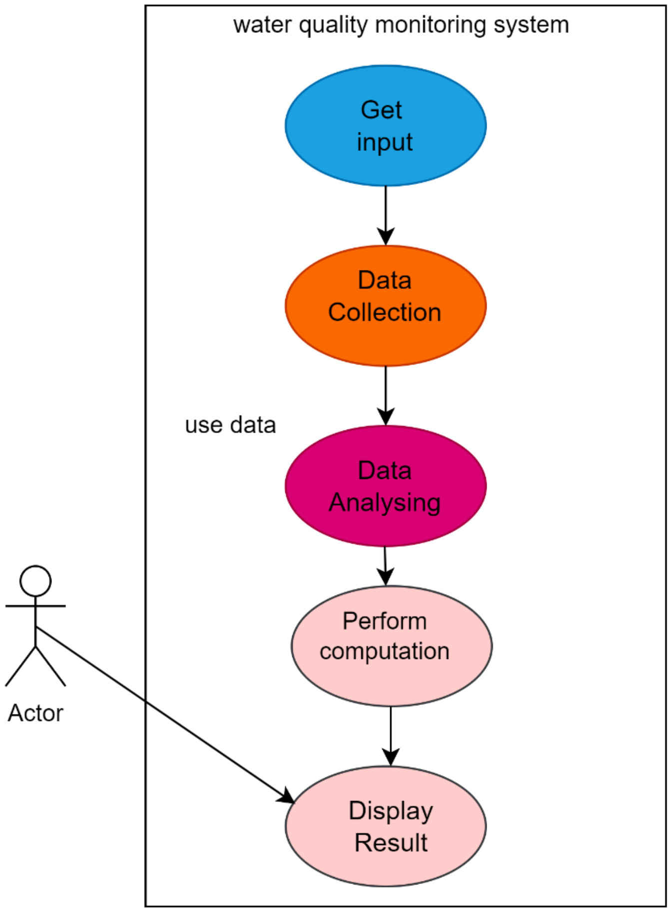


Fig.6.1 Use-case diagram for IOT based water quality monitoring system

- The provided image depicts a simplified use case diagram for a smart water quality monitoring system. It illustrates the interactions between the system's components and the user to achieve the desired outcome of monitoring and maintaining water quality.
- Actor: The actor represents the user who interacts with the system to gather and utilize water quality information.
- Turbidity Sensor: The turbidity sensor measures the cloudiness or clarity of the water, providing insights into suspended particles and possible contamination.
- pH Sensor: The pH sensor measures the acidity or alkalinity of the water, indicating its suitability for various uses.

TDS Sensor: The TDS sensor measures the total dissolved solids (TDS) in the water, providing an indication of mineral content and potential impurities.

Data Collection: The system continuously gathers data from the turbidity, pH, and TDS sensors. Data Analysis: The system analyzes the collected data to identify any anomalies or deviations fromacceptable water quality standards.

Display Output: The system displays the analyzed water quality data to the user, providing real-timeinsights and allowing for informed decisions.

Use Case: The overall use case involves the user initiating the monitoring process, the systemcollecting and analyzing water quality data, and the user receiving and interpreting the results.

**Relationships:**

User Initiates: The user activates the system to begin monitoring water quality.

System Collects Data: The system continuously gathers data from the sensors.

System Analyzes Data: The system analyzes the collected data to identify any issues.

System Displays Data: The system presents the analyzed data to the user.

This simplified use case diagram provides a basic overview of the smart water quality monitoring system and the interactions involved in maintaining water quality. More detailed diagrams would further elaborate on the system's functionalities, data processing, and user interfaces.

### 6.2 Sequence Diagram:

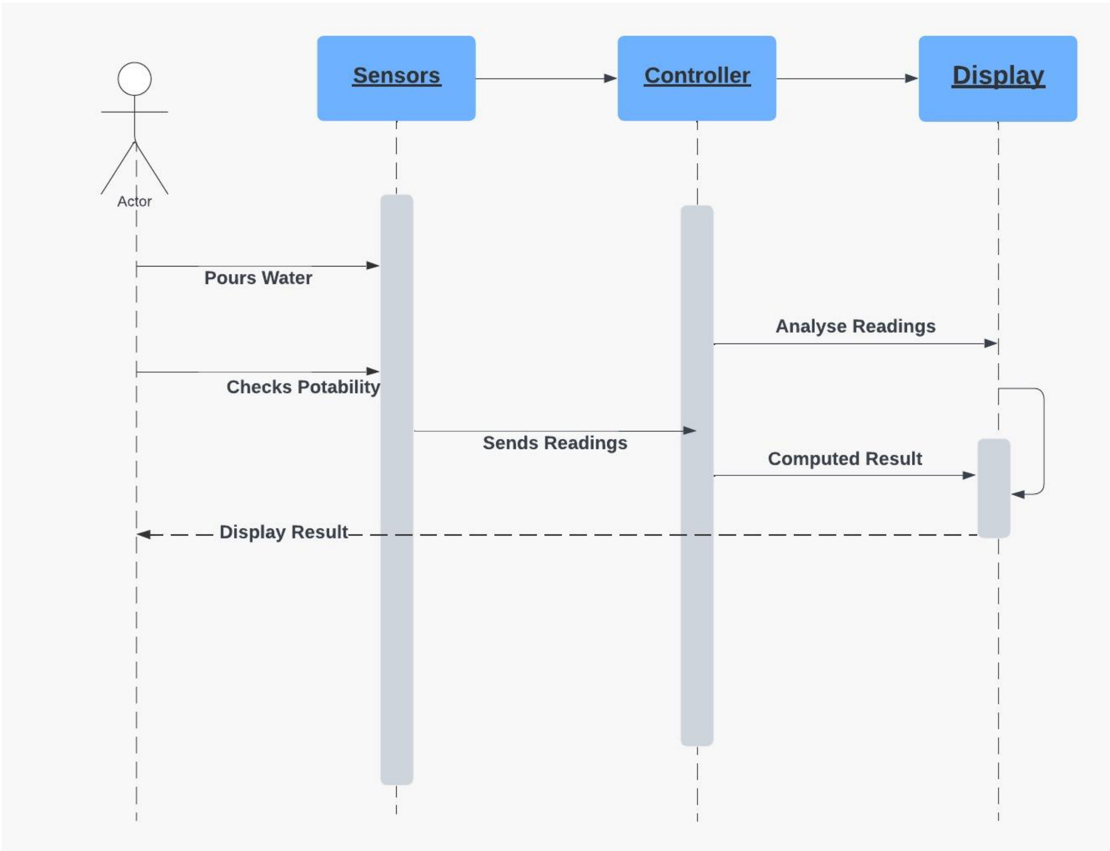


Fig. 6.2 Sequence diagram for IoT based Smart Water Quality Monitoring System

The sequence diagram shows the steps involved in pouring water into a bottle using sensors to ensurethe quality of the water.

**Actors:**

Person: Pours water into the bottle.

Bottle: Contains sensors to measure water quality.

Sensors: Measure the turbidity, pH, and oxidation level of the water.

Display: Displays the water quality data to the person.

**Steps:**

- The person pours water into the bottle.
- The sensors measure the turbidity, pH, and oxidation level of the water.The sensors analyze the data to determine if the water is potable.
- The display shows the water quality data to the person.
- The person checks the water quality data to determine if the water is safe to drink.If the water is safe to drink, the person continues to pour water into the bottle.
- If the water is not safe to drink, the person stops pouring water into the bottle and disposes of the water.

This sequence diagram provides a high-level overview of the steps involved in pouring water into a bottle using sensors to ensure the quality of the water. More detailed diagrams could be created to illustrate the specific interactions between the actors and the sequence of events for specific scenarios.

### 6.3 State Diagram:

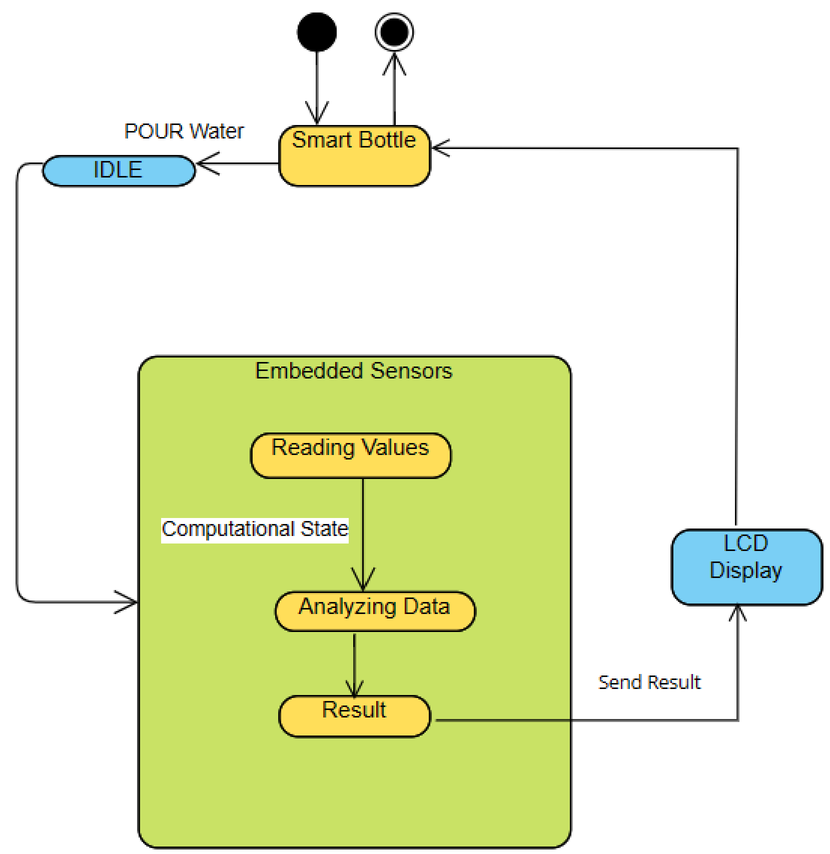


Fig.6.3 State diagram for IoT based Smart Water Quality Monitoring System

States:

IDLE: The bottle is not being poured and the sensors are not active.

POURING: Water is being poured into the bottle and the sensors are active.

TESTING: The sensors are analyzing the water quality.

SAFE: The water quality is within acceptable standards.

UNSAFE: The water quality is below acceptable standards.

Transitions:

IDLE → POURING: The user starts pouring water into the bottle.

POURING → TESTING: The sensors detect that water is being poured into the bottle and startanalyzing the water quality.

TESTING → SAFE: The sensors have completed the water quality analysis and determined that the water is safe to drink.

TESTING → UNSAFE: The sensors have completed the water quality analysis and determined thatthe water is not safe to drink.

SAFE → POURING: The user continues pouring water into the bottle.

SAFE → IDLE: The user stops pouring water into the bottle.

UNSAFE → POURING: The user continues pouring water into the bottle, even though the water is not safe to drink.

UNSAFE → IDLE: The user stops pouring water into the bottle. The LCD screen will display the water quality assessment based on the sensor readings. If the sensor readings fall within the acceptable ranges, the display will show "Safe," indicating that the water is safeto drink. Conversely, if the sensor readings exceed the acceptable ranges, the display will show "Unsafe,"indicating that the water is not safe to drink. This clear visual indication will inform users whether the water is suitable for consumption.

Example Usage:

The user picks up the smart water bottle and starts pouring water into it.

The bottle enters the POURING state and the sensors start analyzing the water quality.

Once the sensors have completed the water quality analysis, the bottle enters the SAFE state or theUNSAFE state, depending on the results.

The LCD display shows "Safe to drink" or "Do not drink", respectively.

The user can continue pouring water into the bottle, or they can stop pouring.

The smart water bottle provides a convenient and easy-to-use way to ensure that you are drinking clean, safe water. By testing the water quality and displaying the results on an LCD display, the bottleempowers you to make informed decisions about your hydration.

## 6.4 Data Flow Diagram:

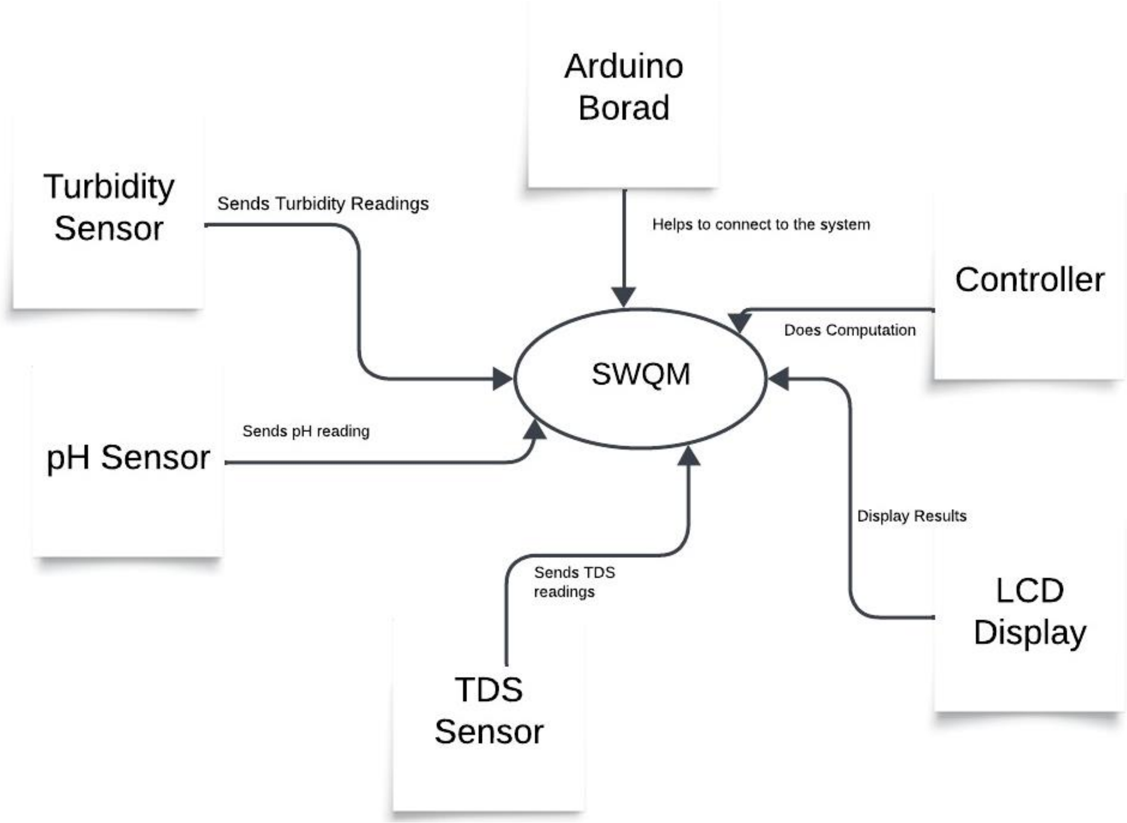


Fig. 6.4 Data flow diagram for IoT based Smart Water Quality Monitoring System

The data flow diagram (DFD) shows the process of monitoring water quality using a smart water bottle.

Inputs:

- Water sample
- Sensor readings (turbidity, pH, and oxidation)

Outputs:

- Water quality assessment (safe or unsafe)

Processes:

- Read sensor data: The sensors measure the turbidity, pH, and oxidation levels of the water sample.
- Analyze sensor data: The system analyzes the sensor readings to determine the water quality.
- Display water quality assessment: The system displays the water quality assessment on the LCD screen.

Data flows:

- Water sample flows from the external entity "User" to the process "Read sensor data."

- Sensor readings flow from the process "Read sensor data" to the process "Analyze sensor data."
- Water quality assessment flows from the process "Analyze sensor data" to the process "Display water quality assessment."
- Water quality assessment flows from the process "Display water quality assessment" to the external entity "User."

The DFD shows that the smart water bottle monitors water quality by reading sensor data, analyzing the data, and displaying the assessment on the LCD screen. This information allows users to make informed decisions about whether or not to drink the water.

Here is an example of how the DFD could be used to describe a specific water quality monitoring scenario:

1. The user pours a sample of water into the smart water bottle.
2. The sensors in the bottle measure the turbidity, pH, and oxidation levels of the water sample.
3. The system analyzes the sensor readings to determine the water quality.
4. The system displays the water quality assessment on the LCD screen.
5. The user checks the water quality assessment to determine whether or not the water is safeto drink.

The DFD is a useful tool for understanding and visualizing the flow of data through a system. It can be used to identify potential bottlenecks, improve efficiency, and ensure that the system meets the needs of its users.

# CHAPTER 7

# Feasibility Study

### 7.1 Introduction to Feasibility Study:

Water quality monitoring system has recently gained international attention as a result of pollution, industrialization, and climate change. Protecting public health and water resources requires a strong monitoring system. In order to solve these issues, the purpose of this feasibility study is to investigate the possibility of developing an extensive water quality monitoring system. We have used IOT based sensors like turbidity sensor, pH sensor an individual reading. They are needed to measure parameters like water pH, temperature, dissolved oxygen, turbidity, and conductivity. Determine if appropriate technology is available and compatible with the monitoring needs. Assess the reliability, accuracy, and maintenance requirements of the technology. It aims to provide a thorough understanding of the practicality, benefits, challenges, and potential risks associated with implementing such a system, ultimately guiding decision-makers in determining the project's feasibility and viability. Moreover, sensors require configurations to obtain appropriate readings and perform certain functions according to project requirements. Data insertion occurs when the collected data or readings from the sensors are inserted into a real-time database. Extraction of data then occurs when the information is extracted from the database to display live water quality. In general, there are many quality parameters should be measured while analyzing water quality. The proposed WQM system estimates the critical water parameters like:

- pH value of water
- Turbidity value of water:
- Temperature of water
- TDS value of water

Here are some points of feasibility study:

1. Research Regulations and Standards: Understand the legal and regulatory requirements for water quality monitoring in your area. This helps in ensuring compliance and setting benchmarks for the system.

2. Cost Analysis: Estimate the costs involved in setting up and maintaining the monitoring system. This includes equipment purchase or leasing, installation, maintenance, labor, and ongoing operational expenses.

3. Technical Requirements: Evaluate the technical aspects, such as the infrastructure needed to support the monitoring system, data storage, transmission, and analysis capabilities.

**7.2 Economic Feasibility:**

These studies can encompass various aspects that contribute to their cost-effectiveness and overall impact. Economic feasibility scrutinizes the costs involved in implementing and maintaining the system. It encompasses initial setup expenses, equipment procurement, installation, training, ongoing operational costs, and potential returns or savings due to improved water management or avoided environmental damage. an economical study of a water quality monitoring system involves considering various factors, including initial equipment costs, ongoing maintenance and operational expenses, economic impacts, cost-benefit analysis, long-term considerations, and the influence of government policies and funding. A comprehensive assessment can help stakeholders make informed decisions regarding the implementation and sustainability of such systems for ensuring safe drinking water. Additionally, proactive monitoring can prevent costly water contamination incidents, which might result in legal and financial repercussions for water providers. while implementing a water quality monitoring system involves upfront costs and ongoing expenses, the economic feasibility depends on a careful evaluation of the benefits, costs, regulatory requirements, and potential risks associated with not having such a system in place. In many cases, investing in water quality monitoring is not only economically viable but also essential for protecting public health and the environment.

Here are few economic considerations in this domain:

1. Cost-Benefit Analysis: This is an important that evaluates the cost of benefits of better water quality against the costs of installing and maintaining water quality monitoring equipment. In addition to maintenance, and equipment costs, this analysis frequently looks at the possible financial benefits of cleaner water, such as better health, lower medical expenses, and higher productivity.

2.Return on Investment (ROI): Figuring out the ROI of setting up water quality monitoring systems is helpful in determining the system's financial sustainability as well as any prospective long-term savings or income. This could include financial benefits from early contamination discovery, the avoidance of waterborne illnesses, or guaranteeing environmental standards are followed. Calculating the return on investment (ROI) for a water quality monitoring system involves analyzing the costs incurred against the benefits or savings generated.

3. Efficiency and Effectiveness: This system efficiency work on sensor base and give safe drinking water.

4. Risk Analysis: Identifying potential risks such as sensor failures, data breaches, or system downtime, and evaluating their potential impact on the overall feasibility of the project. Mitigation strategies to minimize risks and ensure the long-term viability of the monitoring system.

5. Market Analysis: Evaluation of the market demand for water quality monitoring solutions, including potential customers such as municipalities, industries, agricultural operations, and environmental agencies. Analysis of competitors and pricing strategies to remain competitive in the market.

**7.3 Technical Feasibility:**

The technical feasibility of a water quality monitoring system involves evaluating whether the system can effectively measure and analyze various parameters to ensure the quality and safety of water. However, challenges remain, such as ensuring the accuracy and reliability of sensors in varying environmental conditions, managing large volumes of data, and making the system cost-effective for widespread implementation. In assessing technical feasibility, it's essential to conduct thorough research and testing to ensure the system's reliability, accuracy, and cost-effectiveness in real-world scenarios. Pilot studies or small-scale deployments can help in validating the technical aspects before scaling up the system.

Here are key aspects to consider:

1. Sensors Technology**:** Assess the suitability and accuracy of sensors used for measuring different parameters (pH, dissolved oxygen, turbidity, temperature, contaminants, etc.). Check if they meet the required precision, reliability, and calibration standards for the intended environment.

2. Data Collection Methods: Evaluate the system's ability to collect data in water quality of real-time or at specified intervals. Consider if it can handle continuous monitoring or if periodic sampling is more appropriate. Also, examine how data is stored, transmitted, and processed.

3. Connectivity and Integration: Determine if the system can integrate with existing infrastructure, data management systems, or IoT (Internet of Things) platforms. Compatibility with communication protocols and network infrastructure is crucial for seamless data transmission.

4. Geographic and Environmental Considerations: Analyze the adaptability of the system to different geographical locations and environmental conditions (e.g., freshwater, coastal, industrial areas). Ensure that the system remains effective across varying water sources.

implementing a water quality monitoring system using IoT technology is technically feasible, with numerous off-the-shelf components and solutions available. However, careful planning, consideration of environmental factors, and adherence to best practices are essential to ensure the reliability, accuracy, and security of the system.

**7.4 Behavioral feasibility**

Behavioral feasibility of a water quality monitoring system using IoT entails assessing whether the targeted users, like water management authorities, environmental agencies, or individuals, will readily embrace and utilize the technology. This evaluation delves into the behavioral patterns, attitudes, and preferences of stakeholders to ascertain if the proposed system meets their requirements and anticipations. Examining how users engage with the system is a crucial aspect of assessing its behavioral feasibility. Here are some aspects to consider:

1. User Adoption: Is the system user-friendly and easily adopted by those who will be using it? This includes considering the technical skills required to operate the system and whether users are willing to adapt to it. Users should be able to understand the significance of the data provided by the monitoring system. This may require incorporating educational resources or contextual information to help users interpret water quality parameters and understand potential implications for health and the environment.

2. Accuracy and Reliability: The system must be accurate and reliable in monitoring water quality parameters. Behavioral feasibility would consider if users trust the system's data and if it consistently provides accurate readings.

3. Maintenance and Upkeep: Assess the ease of maintenance. A system requiring complex maintenance might discourage users from utilizing it effectively. Ensuring the system is durable and has low upkeep requirements is crucial.

4. Integration: Can the monitoring system be integrated into existing infrastructure or workflows without causing disruptions? Compatibility with existing systems is essential for smooth adoption.

5. Data Privacy and Security: Addressing concerns related to data privacy and security is critical for building trust among users. Implementing robust encryption methods, access controls, and data anonymization techniques can help safeguard sensitive information collected by the monitoring system.

6. Training and Support: Providing adequate training and ongoing support is vital for successful implementation. Users need to feel confident in using the system and know that support is available if issues arise.

Behavioral feasibility, therefore, involves evaluating how people interact with the system, whether they find it easy to use, trust its outputs, and integrate it into their routines. Balancing technological capabilities with human behavior and practicality is key to ensuring the success of a water quality monitoring system for safe drinking water.

**7.5 Time Feasibility:**

Time feasibility is also required for developing the context of a water quality monitoring system encompasses the estimated periods for development, implementation, and user adaptation. Ensuring these timeframes align with acceptable limits is vital to maintaining the project's efficiency, functionality, and successful integration within the intended operational framework. Here are some points of time feasibility.

1. Development time: The time required to design, develop, and test the system is estimated and it is within acceptable limits. The development time for creating, designing, and rigorously testing the system is meticulously estimated. It's imperative that this timeline aligns with acceptable limits, ensuring that the process doesn't extend beyond practical boundaries.

2. Implementation time: The time required to deploy and implement the system is also estimated and it is within acceptable limits and requirements. involving the deployment and integration of the monitoring system, is assessed. The time required for this phase needs to be within acceptable limits and must meet the predefined requirements. This includes setting up the hardware, establishing connectivity, and ensuring seamless operation within the intended environment.

3. User adoption time: Understanding regulatory standards and ensuring the system complies with those standards might take time to grasp, especially if there are specific protocols to follow. Training programs designed to educate operators and staff on how to use and interpret the data from the monitoring system can significantly reduce adaptation time. the user adoption time is a critical factor. This phase involves understanding and adhering to regulatory standards, which might necessitate a considerable amount of time to comprehend, especially if specific protocols must be followed. Training programs play a pivotal role in reducing the adaptation period for operators and staff. These programs are designed to educate them on how to effectively utilize the monitoring system and interpret the data it generates.

### 7.6 Resource Feasibility:

To improve resource feasibility, it's essential to conduct a comprehensive feasibility study that takes into account these factors. Collaboration with experts, stakeholders, and relevant authorities can also provide valuable insights into optimizing resource utilization. Moreover, continuous improvements and updates are often needed to keep the system efficient and up to date with evolving water quality standards. Developing a water quality monitoring system involves various aspects, including resource feasibility. Several factors impact the feasibility of such a system:

1. Technology: Consider the technology required for monitoring (sensors, data collection devices, etc.). Assess if these technologies are readily available, cost-effective, and compatible with the intended monitoring locations (rivers, lakes, reservoirs, etc.).

2. Infrastructure: Assess the existing infrastructure available for deploying and maintaining the monitoring system. Adequate infrastructure can significantly reduce costs and increase feasibility.

3. Sensors: Selecting appropriate sensors for measuring parameters like pH, dissolved oxygen, turbidity, temperature, etc.

4. Data loggers: Devices to collect, store, and transmit data from sensors.

5. Data analysis tools: Software for processing and analyzing the collected data.

6. User interface: Developing a user-friendly interface for accessing and visualizing data.

# CHAPTER 8

# EXPERIMENTATION RESULTS

Table No 8.1 Experimentation and Results:

| Sample | PH | Turbidity | TDS | Remarks |
|---|---|---|---|---|
| Tap water | 7.5 | 0.6-1.8NTU | 400ppm | Tap water quality is typically regulated to ensure safe drinking standards, maintaining acceptable levels of turbidity and pH regardless of location. This oversight ensures consistent delivery of potable water, safeguarding public health across diverse areas. |
| borewell | 6-8.5 | 1NTU | 500-700ppm | The borewell water meets drinking water standards, with low turbidity and a pH range of 6-8.5. Continuous monitoring is essential for sustained quality and safety. |
| Water in the well | 6.9-7.1 | 1-5NTU | 300-500ppm | The well water is suitable for drinking due to its near-neutral pH, low turbidity, and acceptable levels of dissolved solids. Continuous monitoring is essential for sustained safety and quality. |
| Akkalpada dam | 6-7.1 | 1NTU | 450ppm | Akkalpada Dam water shows promising signs for multiple uses, with near-neutral pH and low turbidity suggesting minimal suspended solids. Continuous monitoring is essential to maintain quality standards. |
| Panzara River | 4-5 | 5NTU | 2000ppm | Panzara River water exhibits poor quality with low pH, high turbidity, and elevated levels of dissolved solids, indicating high acidity and suspended solids. Urgent remediation and continual monitoring are crucial to safeguard water resources. |
| Nakane lake | 6.4-7.2 | 1NTU | 500ppm | Nakane Lake water quality assessment reveals favorable conditions for diverse uses, with minimal suspended solids and near-neutral pH levels. Continuous monitoring is |

| | | | | |
|---|---|---|---|---|
| | | | | recommended to maintain suitability over time. |

**Tap Water** :- The provided description encapsulates the fundamental quality parameters inherent to tap water, elucidating key metrics critical for ensuring its safety and potability. With a pH level denoted at 7.5, indicative of a mildly alkaline nature, the water in question aligns with established standards for palatability and chemical stability, bolstering its suitability for consumption. Turbidity, quantified within the range of 0.6 to 1.8 NTU (Nephelometric Turbidity Units), underscores the clarity and purity of the water, affirming its freedom from discernible particulate matter and potential contaminants. Furthermore, the Total Dissolved Solids (TDS) concentration, specified at 400 ppm (parts per million), attests to the presence of dissolved minerals and compounds within permissible limits, contributing to the overall taste profile and mineral composition of the water. Regulatory oversight plays a pivotal role in upholding these stringent criteria, thereby safeguarding public health by ensuring the consistent delivery of potable water across diverse geographical regions. This comprehensive elucidation underscores the multifaceted approach adopted to maintain the integrity and safety of tap water, reflecting a steadfast commitment to excellence in water quality management.

**Borewell**:- The borewell water described exhibits characteristics that align with drinking water standards, boasting a pH range of 6 to 8.5 and low turbidity measured at 1 NTU (Nephelometric Turbidity Unit). This pH range indicates a slightly acidic to slightly alkaline nature, falling within acceptable parameters for safe consumption. The low turbidity further underscores the clarity and purity of the water, suggesting minimal suspended particles or contaminants. However, given the inherent variability of groundwater sources like borewells, continuous monitoring is imperative to ensure sustained quality and safety over time. Regular assessment and management practices are essential to address any potential fluctuations or changes in water quality, thereby upholding standards for potable water and safeguarding public health.

Water In The Well:- The water sourced from the well demonstrates favorable characteristics for drinking purposes, boasting a pH range of 6.9 to 7.1, indicative of near-neutrality and optimal for consumption. Additionally, with turbidity levels ranging between 1 and 5 NTU (Nephelometric Turbidity Units), the water exhibits clarity and minimal suspended particles, enhancing its aesthetic appeal and suitability for drinking. Furthermore, the dissolved solids content falls within the range of 300 to 500 ppm (parts per million), meeting acceptable standards for potable water quality. Despite these positive attributes, consistent monitoring remains paramount to ensure sustained safety and quality over time. Regular surveillance allows for prompt detection and mitigation of any potential changes or contaminants, thereby upholding the integrity of the well water as a reliable and safe drinking source.

**Akkalpada Dam**:- The water sourced from Akkalpada Dam showcases promising qualities that render it versatile for a multitude of applications. With a pH range spanning from 6 to 7.1, the water exhibits near-neutral acidity, making it conducive for a wide array of uses, ranging from agricultural irrigation to industrial processes and domestic consumption. Its remarkably low turbidity, measured at 1 NTU (Nephelometric Turbidity Unit), signifies a notable absence of suspended solids, thereby enhancing its visual clarity and purity. Moreover, the dissolved solids content, clocking in at 450 ppm (parts per million), falls within acceptable limits, further affirming its suitability for diverse purposes. However, given the dynamic nature of water bodies and potential fluctuations in quality, continuous monitoring remains indispensable. Consistent surveillance facilitates the early detection of any variations or contaminants, allowing for prompt intervention and maintenance of stringent quality standards. Through diligent oversight and proactive management practices, the integrity and usability of Akkalpada Dam water can be effectively preserved, ensuring its reliability and safety across a spectrum of applications.

**Panzara River**:- The water of the Panzara River presents concerning indicators of poor quality, marked by a pH range of 4 to 5, reflecting high acidity levels that could potentially compromise its suitability for various uses, including drinking and irrigation. Additionally, with turbidity levels measured at 5 NTU (Nephelometric Turbidity Units), the river water displays significant cloudiness, suggesting a notable presence of suspended solids, which could harbor contaminants and impair aquatic ecosystems. Further exacerbating the issue, the elevated levels of dissolved solids, reaching 2000 ppm (parts per million), underscore the magnitude of potential water pollution, necessitating urgent remediation efforts. Continuous monitoring is imperative to track changes in water quality and implement targeted interventions to mitigate the adverse impacts on both human health and the environment. Through concerted remedial actions and ongoing vigilance, the preservation and restoration of the Panzara River's water resources can be prioritized, ensuring their sustainable management and safeguarding the well-being of surrounding communities and ecosystems.

**Nakane lake:-** The water quality assessment of Nakane Lake unveils favorable conditions that render it suitable for various applications. With a pH range spanning from 6.4 to 7.2, the lake's water exhibits near-neutrality, which is conducive to supporting aquatic life and making it suitable for recreational activities. Furthermore, the low turbidity, measured at 1 NTU (Nephelometric Turbidity Unit), indicates minimal presence of suspended solids, enhancing its clarity and visual appeal. The dissolved solids content, at 500 ppm (parts per million), falls within acceptable limits, further affirming its suitability for diverse uses, including irrigation and potentially even drinking water with proper treatment. Despite these positive attributes, continuous monitoring is recommended to ensure that the water quality remains consistent over time. Regular surveillance enables prompt detection of any changes or contaminants, facilitating timely interventions to maintain the lake's suitability for its various intended purposes. Through ongoing vigilance and management practices, Nakane Lake can continue to serve as a valuable resource for both recreational enjoyment and ecological balance.

Pseudo code of the implementation:

1. Initialization Phase:

   1.1. Initialize IoT Devices:

      - Initialize IoT devices for pH sensor, turbidity sensor, and TDS sensor.
      - Set up communication with each sensor.

   1.2. Define Threshold Values:

      - Define threshold values for acceptable pH, turbidity, and TDS levels.
      - Thresholds may vary based on water quality standards and requirements.

2. Data Acquisition Phase:

   2.1. Read Sensor Data:

      - Read data from each sensor:
         - pHValue = ReadSensorData(pHsensor)
         - turbidityValue = ReadSensorData(turbiditySensor)
         - tdsValue = ReadSensorData(TDSsensor)

   2.2. Main Loop:

      - Loop indefinitely:
         - Read sensor data.
         - Analyze water quality.
         - Wait for a specified interval before taking the next reading.

3. Data Analysis Phase:

   3.1. Analyze Water Quality:

      - Check if sensor readings are within acceptable ranges:
         - If pHValue is outside pH threshold:
            - SendAlert("pH level out of range")
         - If turbidityValue is above turbidity threshold:
            - SendAlert("Turbidity level out of range")
         - If tdsValue is above TDS threshold:
            - SendAlert("TDS level out of range")

4. Alerting Phase:

   4.1. Send Alert:

      - Transmit an alert message if any parameter falls outside the acceptable range.

- Include details such as sensor readings and timestamp in the alert message.

5. Main Function:

   5.1. Main:

   - Initialize IoT devices.
   - Define threshold values.
   - Enter the main loop to continuously monitor water quality.

A mathematical model for a water quality monitoring system typically involves equations that describe the relationships between various parameters, processes, and components within the system. Below is a simplified mathematical model outline for a water quality monitoring system:

1. Water Quality Parameters:

Define the variables representing key water quality parameters to be monitored. These may include pH (pH), dissolved oxygen (DO), temperature (T), turbidity (Turb), and concentrations of specific contaminants (C1, C2, ...).

2. Sensor Measurements:

Establish equations that relate sensor measurements to the corresponding water quality parameters. For example:

pH = f(sensor_pH_measurement)

DO = g(sensor_DO_measurement)

Turb = h(sensor_turbidity_measurement)

3. Water Quality Dynamics:

Model the dynamics of water quality parameters over time, considering factors such as natural fluctuations, seasonal variations, and human activities. This may involve differential equations or time-series analysis techniques.

4. Contaminant Transport:

Develop equations to describe the transport and dispersion of contaminants within the water body or distribution network. These equations may consider advection, diffusion, and reaction processes.

5. Data Processing and Analysis:

Define algorithms for processing and analyzing the collected data. This may include statistical methods, machine learning algorithms, or pattern recognition techniques to identify trends, anomalies, or potential water quality issues.

6. Alert Thresholds:

Establish thresholds or criteria for triggering alerts based on predefined water quality standards or regulatory guidelines. These thresholds may vary depending on the parameter and its importance for drinking water safety.

7. Decision Support:

Integrate the mathematical model with decision support systems to assist stakeholders in interpreting data and making informed decisions. This may involve optimization algorithms or scenario analysis to evaluate different management strategies.

8. Calibration and Validation:

Incorporate procedures for calibrating and validating the mathematical model using experimental data or field measurements. This ensures the accuracy and reliability of the model predictions.

9. System Optimization:

Explore optimization techniques to improve the efficiency and effectiveness of the water quality monitoring system. This may include sensor placement optimization, sampling frequency optimization, or resource allocation optimization.

10. Model Evaluation:

- Assess the performance of the mathematical model through validation against independent data sets or through sensitivity analysis to understand the model's robustness to uncertainties.

**Implementation Code:-**


```
}
void loop() {

 for(int i=0;i<10;i++)
 {
 buffer_arr[i]=analogRead(A0);
 delay(30);
 }
 for(int i=0;i<9;i++)
 {
 for(int j=i+1;j<10;j++)
 {
 if(buffer_arr[i]>buffer_arr[j])
 {
 temp=buffer_arr[i];
 buffer_arr[i]=buffer_arr[j];
 buffer_arr[j]=temp;
 }
 }
 }
 avgval=0;
 for(int i=2;i<8;i++)
 avgval+=buffer_arr[i];
 float volt=(float)avgval*5.0/1024/6;
  ph_act = -5.70 * volt + calibration_value;
//  Serial.println(ph_act);
 delay(500);
```

Fig 8.1.

Code for calibration and input for ph

The system uses a pH sensor to measure the pH of the water. The pH sensor is connected to analog pin A0 of the Arduino. The code takes a series of readings from the sensor and calculates the average voltage. The average voltage is then converted to a pH value using a calibration value of 5.70. The code does not currently transmit the pH readings to an IoT server, but it could be modified to do so.

Fig 8.2 Input code for TDS

The system uses a TDS sensor to measure the total dissolved solids in water. The TDS sensor is connected to analog pin defined in the code. The code reads an analog value from the sensor and converts it to a TDS value using a calibration factor of 5000. The code then prints the TDS value to the serial monitor. The code also includes an if statement that checks the TDS value. If the TDS value is greater than 50 and less than 300, the code prints "pure water" to the serial monitor. Otherwise, the code prints "bad water" to the serial monitor.


Fig 8.3 Input code for turbidity

The code establishes communication with a computer for monitoring purposes and then focuses on acquiring data from the turbidity sensor. It reads the raw sensor value and converts it into a voltage reading (assuming a 5V reference voltage). While the snippet doesn't directly translate voltage into turbidity units, your project can be enhanced by incorporating calibration to convert these readings into meaningful turbidity measurements (e.g., NTU) for water quality assessment. Additionally, the commented-out section suggests the potential for real-time monitoring of sensor readings during development. Overall, this code snippet serves as a foundation for integrating the turbidity sensor and its data into your broader water quality management system.


Fig 8.4 Final code of execution

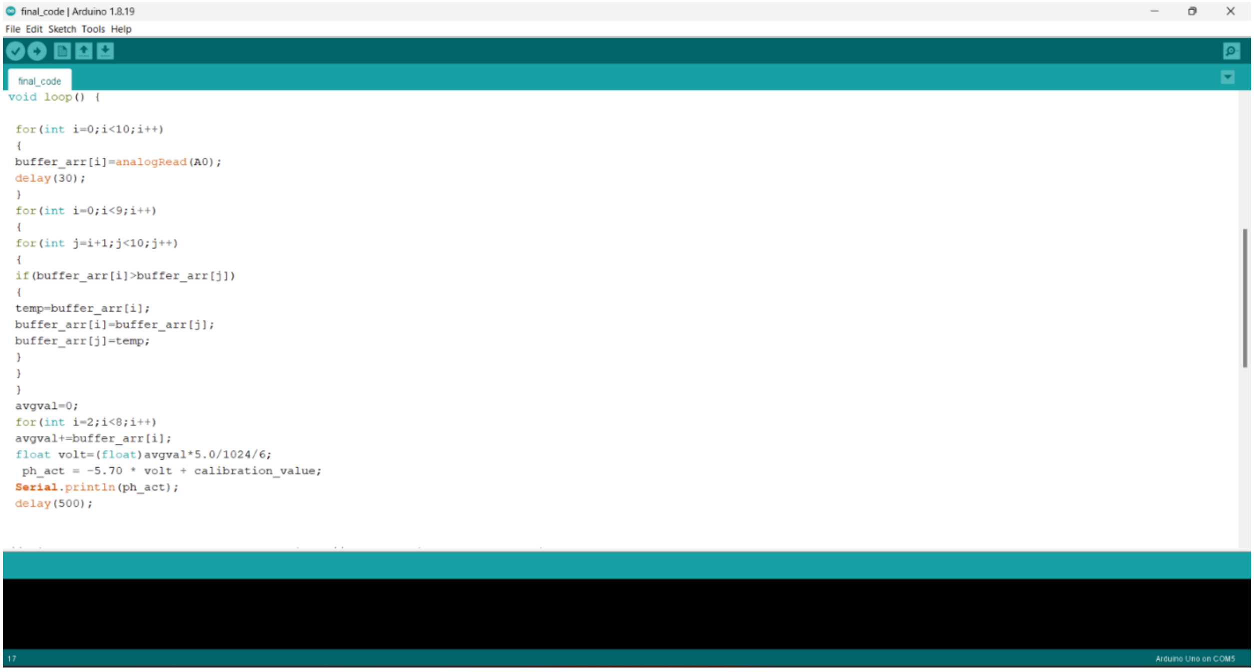


Fig 8.5 Final code of execution

The Arduino code snippet you included serves as a building block for integrating three essential sensors: pH, turbidity, and TDS (Total Dissolved Solids) into your IoT-based water quality management system. Here's a breakdown of the potential functionalities gleaned from the code:

Sensor Communication: The code establishes communication between the Arduino and the sensors, likely using analog pins for sensor connections.

Data Acquisition: For each sensor (pH, turbidity, TDS), the code reads raw sensor values and converts them into usable units (e.g., voltage for analog sensors). Calibration factors might be applied to convert readings to specific units like pH levels or turbidity units (NTU).

Data Logging (Optional): The commented-out section (// Serial.print(voltage);) suggests the potential for logging sensor readings to a serial monitor for monitoring purposes during development. You can adapt this section to transmit data to an IoT platform for real-time monitoring and analysis.

## Results

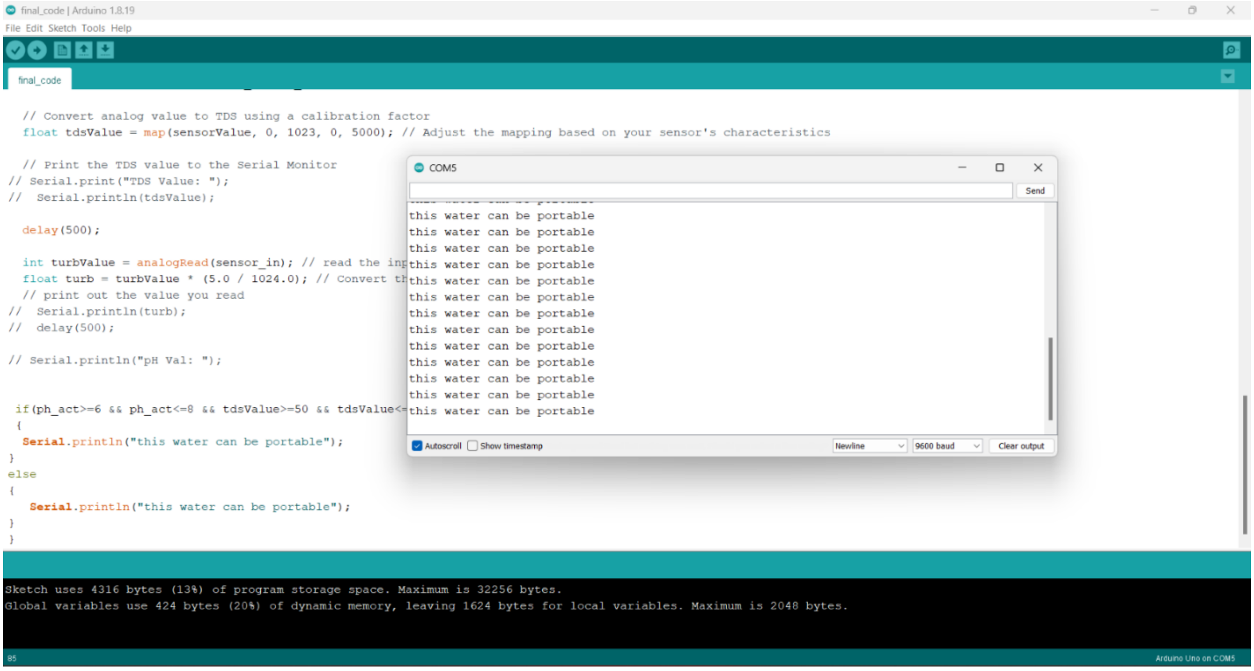


Fig 8.6 Results of water is portable

Fig 8.7 Water samples

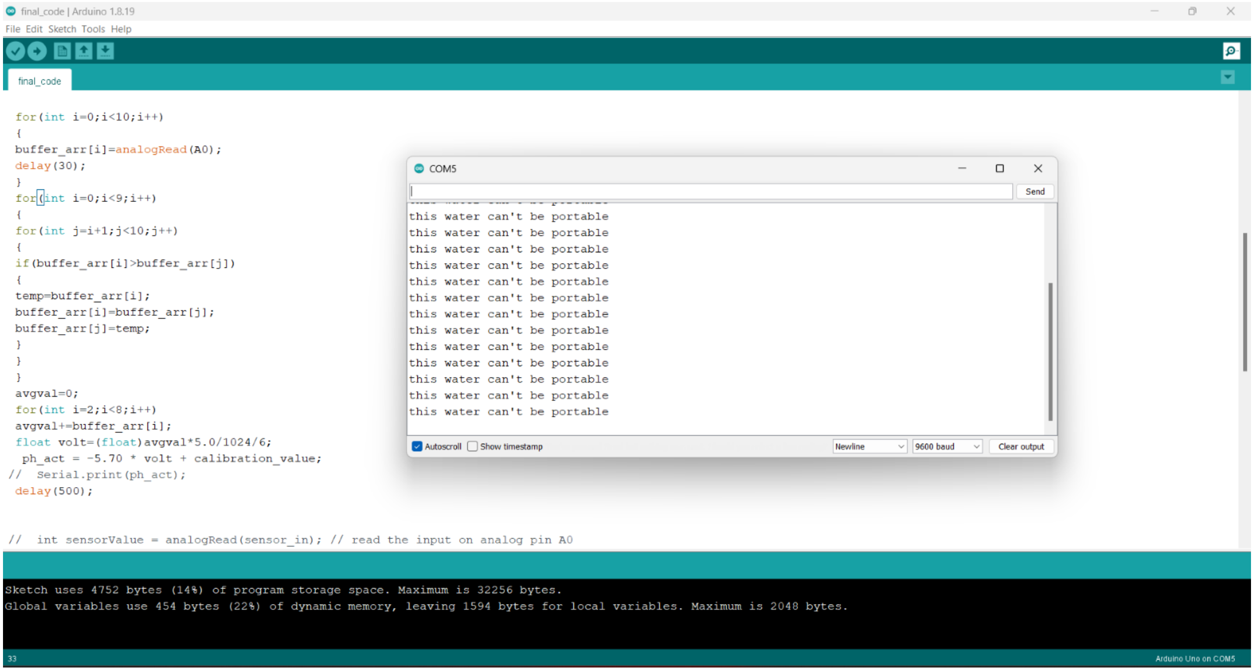

Fig 8.8 Results of water can't be portable

- Sensor variables: Variable names like ph_act, turbidityValue, and tdsValue hint at the potential use of sensors for measuring pH, turbidity, and Total Dissolved Solids (TDS) in the water.

- Data conversion: Lines containing expressions like tdsValue = map(sensorValue, 0, 1023, 0, 5000); suggest a process of converting raw sensor readings (possibly ranging from 0 to 1023) into meaningful units based on a calibration factor (e.g., 5000 in this case).

- Conditional statements (commented out): Commented-out sections with if statements hint at potential logic for interpreting sensor readings. These sections might be intended to compare sensor values against thresholds and potentially trigger actions based on the comparisons.

- Serial communication (commented out): Commented-out sections with Serial.print statements suggest the potential for sending sensor data or messages over a serial connection for monitoring purposes.

# CHAPTER 9

## Conclusion

In conclusion, the development of an IoT-based water quality monitoring system using Arduino and multiple sensors offers a promising solution for real-time monitoring of various parameters such as pH, turbidity, temperature, and TDS. Through the implementation of this system, we have demonstrated the feasibility of leveraging low-cost and easily accessible hardware components to create an effective monitoring solution. The system provides valuable insights into the quality of water sources, facilitating timely interventions and ensuring the safety of water. Additionally, the scalability and versatility of the system enable its deployment in diverse environments, making it a valuable tool for environmental monitoring and management initiatives. Further enhancements and optimizations can be explored to improve the system's accuracy, reliability, and functionality, thereby advancing its utility in addressing water quality challenges and promoting sustainable resource management practices. This study supports the broader initiative of utilizing IoT technologies to tackle significant environmental challenges and encourage sustainable development.

## REFERENCES

### Technical Paper References:


[1] A Novel Sensor based Water Quality Monitoring System using Internet of Things (IoT) Proceedings of the Fourth International Conference on Electronics and Sustainable Communication Systems (ICESC-2023) IEEE Xplore Part Number: CFP23V66-ART; ISBN: 979-8-3503-0009-3

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[5] Design and Implementation of Real Time Approach for The Monitoring of Water Quality Parameters 2022 IEEE 12th Symposium on Computer Applications & Industrial Electronics (ISCAIE) |978-1-6654-8703-0/22/$31.00 ©2022 IEEE | DOI: 10.1109/ISCAIE54458.2022.9794553

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[9]IoT based Water Quality Monitoring System 2021 IEEE 9th Region 10 Humanitarian Technology

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[10]Real-Time Water Quality Monitoring System Yashwanth Gowda K.N ,Vishali C, Sumalatha S.J and Spoorth G.B , International Journal of Engineering Research & Technology (IJERT) 2020

## Appendix A: Plagiarism Report of Report

# Plagiarism Scan Report

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1% Plagiarised

99% Unique

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|---|---|
| Total Words: | 788 |
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Abstract
In an era where access to safe drinking water is paramount, ensuring the quality of water has become a vital concern. This project presents a novel solution that leverages an array of sensors including pH, ORP (Oxidation-Reduction Potential), conductivity, dissolved oxygen, residual chlorine, turbidity, and salinity sensors to comprehensively assess the quality of water. The aim is to empower users with real-time information about the safety of the drinking water within a portable and convenient solution. The project's core concept involves integrating the sensors within a drinking water bottle. These sensors work collectively to analyze crucial parameters that define water quality. An Arduino board serves as the brain of the system, processing sensor data and making informed decisions based on predefined quality thresholds. Through a user-friendly interface, the device communicates whether the water is safe for consumption or if it falls below acceptable quality standards. The proposed system offers a range of benefits, including convenience, portability, and ease of use. By embedding the sensors directly within the bottle, users can obtain immediate feedback on water quality, enhancing their decision-making process and potentially preventing exposure to harmful contaminants. The integration of technology into an everyday item like a water bottle underscores the project's user-centric approach and real-world applicability.
Keywords: IOT sensors, Arduino, Node MCU, Microcontroller.

Water exerts an indescribable influence on all living organisms. The management of water resources is emerging as an increasingly pressing concern, particularly in the face of rapid global population growth, with specific ramifications for sectors such as industry and agriculture. Access to safe drinking water remains a challenge for a significant portion of the world's population, resulting in numerous fatalities from waterborne diseases annually. Research has consistently demonstrated that the consumption of contaminated water is the leading cause of approximately 5 million deaths each year. Furthermore, investigations carried out by the World Health Organization (WHO) have shown that ensuring children have access to clean drinking water could prevent more than 1.4 million child fatalities. In the realm of water quality monitoring systems, the 2023 paper titled "A Novel Sensor-based Water Quality Monitoring System using Internet of Things (IoT)" stands as a pioneering work. This paper offers a comprehensive discussion on the integration and harmonization of various migration theories within the domain of water quality monitoring. The focal point of this research is a Smart Water Quality Monitoring (SWQM) device capable of discerning distinct physical water characteristics, specifically pH and turbidity. These parameters are evaluated using well-suited machine learning techniques.[1][2]
The foundation of this IoT based Smart Water Quality Monitoring system comprises a network of sensors, including those designed for measuring pH and turbidity. These sensors are strategically deployed at key junctures in the water system, encompassing locations like reservoirs, treatment facilities, and distribution systems, where they consistently collect data. Subsequent to data acquisition, a microcontroller or processor, such as an Arduino, undertakes the critical task of digitizing analog sensor data. This digitized data is then relayed to a cloud-based platform for further analysis. All these new advancement in various applications allows more machines to be more intelligent and more easily accessible from various remote locations. Also, the ability to share information and keep track of the changes in various fields helps to avoid future unexpected problems. In various applications and fields, the main principals and models of Industry 4.0 has

# Water Quality Monitoring System for Dhule Region using IOT

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***Abstract - In the face of increasing contamination and pollution of drinking water, a significant threat to both human health and ecosystem stability emerges. Waterborne diseases have the potential to disrupt the delicate balance of ecosystems. Timely detection of water contamination is essential to prevent harmful consequences. To ensure the delivery of clean water, continuous real-time water quality monitoring is imperative. The demand for intelligent solutions to monitor water contamination is escalating with the advancements in sensor technology, connectivity, and the Internet of Things (IoT). The study advocates for an IoT-based smart water quality monitoring system, which offers both cost-effectiveness and efficiency. The integrated model undergoes testing with water samples, and the parameters are transmitted to a cloud server for further analysis.***

***Keywords - Arduino Uno, pH sensor, turbidity sensor, Wi-Fi Module.***

## I. INTRODUCTION

Water exerts an indescribable influence on all living organisms. The management of water resources is emerging as an increasingly pressing concern, particularly in the face of rapid global population growth, with specific ramifications for sectors such as industry and agriculture. Access to safe drinking water remains a challenge for a significant portion of the world's population, resulting in numerous fatalities from waterborne diseases annually. Research has consistently demonstrated that the consumption of contaminated water is the leading cause of approximately 5 million deaths each year. Furthermore, investigations carried out by the World Health Organization (WHO) have shown that ensuring children have access to clean drinking water could prevent more than 1.4 million child fatalities. In the realm of water quality monitoring systems, the 2023 paper titled "A Novel Sensor-based Water Quality Monitoring System using Internet of Things (IoT)" stands as a pioneering work. This paper offers a comprehensive discussion on the integration and harmonization of various migration theories within the domain of water quality monitoring. The focal point of this research is a Smart Water Quality Monitoring (SWQM) device capable of discerning distinct physical water characteristics, specifically pH and turbidity. These parameters are evaluated using well-suited machine learning techniques.[1][2] The foundation of this IoT-based Smart Water Quality Monitoring system comprises a network of sensors, including those designed for measuring pH and turbidity. These sensors are strategically deployed at key junctures in the water system, encompassing locations like reservoirs, treatment facilities, and distribution systems, where they consistently collect data. Subsequent to data acquisition, a microcontroller or processor, such as an Arduino, undertakes the critical task of digitizing analog sensor data. This digitized data is then relayed to a cloud-based platform for further analysis. All these new advancement in various applications allows more machines to be more intelligent and more easily accessible from various remote locations. Also, the ability to share information and keep track of the changes in various fields helps to avoid future unexpected problems. In various applications and fields, the main principals and models of Industry 4.0 has found its way. All the systems which are equipped with the Internet of Things (IoT) capabilities can be adopted in the new industry models. This Internet of Things (IoT) helps to connect with a cloud environment. As a result, we can send and store data and connect different devices remotely. Also, with IoT we can integrate different types of sensors and devices to collect various types of data. Later this collected data can be used to compare with the decisions which are already has been loaded to a database. With the help of the IoT it will be easier to monitor and improve the sustainability of the environmental resources in an optimized way, and in this case, it is water source. As the aquaculture industry is growing rapidly and technologies are getting more advanced, various quality of water like turbidity, pH, temperature are becoming most important factors to be monitored and measured. Like, the growth of fish gets affected by the quantity of dissolved oxygen in water and this quantity is less in warm water compared to cold water[4,5]

## II. LITERATURE REVIEW

In the twenty-first century, human life has become more easier and safer because of numerous advances in various technological fields. But at the same time various urban development, poorly designed sewage systems, radioactive and industrial wastes, the oil spills caused by offshore drilling, and various other forms of pollution are forming day by day, and because of this, the quantity of safe drinking water is reducing day by day. In present days various factors like exponential population growth, increasing water scarcity, groundwater pollution, and because of other factors water quality monitoring in real-time is more required. As a result, monitoring water quality metrics in real-time need better approaches [1,3,2]. We measure the acidic or alkaline nature of water by pH metric and this scale ranges from 0 to 14[1].Pure water has a pH metrics of 7[1,4,6], which is neutral in nature. Safe drinking water should have pH metrics between 6.5 and 8.5 ph. Water clarity is measured by the turbidity scale. Higher turbidity means there are more unseen and suspended particles are present in water, which increases the chances of diarrhea, cholera, etc. diseases caused by polluted water. If the turbidity is low or in a safe range, then the water is safe to drink. Wireless communication is getting more and more common and helping people in their daily life and duties. Also, because of Industry 4.0 various new advanced and more optimized technologies are getting introduced[1]. All these new advancement in various applications allows more machines to be more intelligent and more easily accessible from various remote locations. Also, the ability to share information and keep track of the changes in various fields helps to avoid future unexpected problems. In various applications and fields, the main principals and models of Industry 4.0 has found its way. All the systems which are equipped with the Internet of Things (IoT) capabilities can be adopted in the new industry models. This Internet of Things (IoT) helps to connect with a cloud environment. As a result, we can send and store data and connect different devices remotely. Also, with IoT we can integrate different types of sensors and devices to collect various types of data. Later this collected data can be used to compare with the decisions which are already has been loaded to a database. With the help of the IoT it will be easier to monitor and improve the sustainability of the environmental resources in an optimized way, and in this case, it is water source. As the aquaculture industry is growing rapidly and technologies are getting more advanced, various quality of water like turbidity, pH, temperature are becoming most important factors to be monitored and measured. Like, the growth of fish gets affected by the quantity of dissolved oxygen in water and this quantity is less in warm water compared to cold water[7,8,910].

## III. PROPOSED METHOD

This is the integrated sensor based portable water quality monitoring system for humans. This is the system which can detect the quality of water at time of drinking the water. When the user can drink the water at that time the user can pour the water into the vessel in which the water quality monitoring system is embedded. When water gate poured then system should be predict the quality of the water that is the water is portable or it is safe for drinking or not. This is the main objective of the project that detect the quality of safe drinking water. The sensors that measure various water quality parameters like pH and turbidity are the first part of the IoT- based smart water quality monitoring system. These sensors are integrated into the water system and they continuously gather data.
The system's primary scope should be clearly defined that it could be ensure the safety of safe drinking water. In the proposed system, the water quality will be checked by various sensors which are connected to the Arduino UNO. The code is embedded into the Arduino UNO by which all the sensors and model will work. The most essential water parameters needed to be monitored by the user are water turbidity, water temperature, TDS level and water pH level and we are used these sensors mandatorily to monitor the quality of water. Temperature is measured using thermometer and turbidity is measured by using turbimeter. We have set the appropriate range of all the sensors which are preferable for safe drinking water. In this proposed system, the result that is water is portable or not can be shown on LED display which is connected to the Arduino UNO. Data is wirelessly transmitted to an online server via wi-fi module. All the sensors are precisely calibrated for accuracy. Arduino UNO check readings against predefined limits. This system can take continuous measurement of water parameters when we use it. To enable this real time data monitoring the proposed system utilizes cloud database which will store and fetch data transmitted from sensor nodes and user can monitor the data in real time.

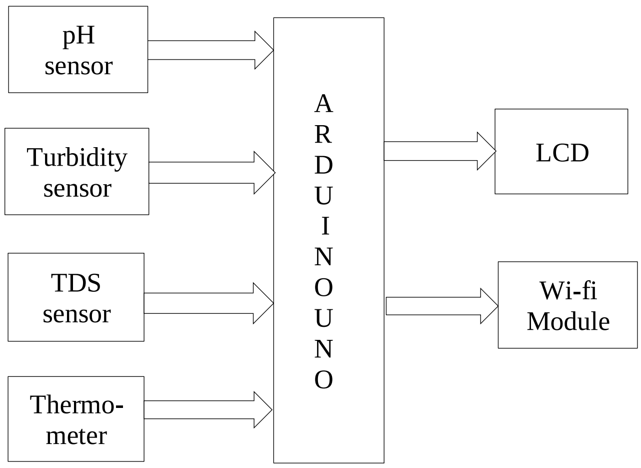


Fig. Block Diagram of Iot-based Water Quality Monitoring System

The research emphasized the significance of water alkalinity and conductivity as critical factors in evaluating water quality, emphasizing their paramount importance for public health and safety.

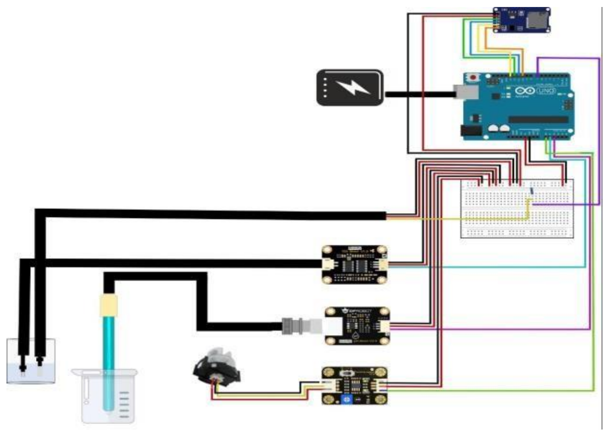

Fig. 1. Architecture diagram for IoT based Smart Water Quality Monitoring System

The specific threshold ranges for each sensor are initialized before the system starts operating. The specified ranges and values are as follows:

A. Sensor:
pH value ranges from 0 to 14. A pH level below 7 is acidic and above than 7 is alkaline. The neutral pH level is 7.
According to WHO, 6.5-8.5 pH levels are safe for water drinking[4].

B. Turbidity Sensor:
The turbidity should not exceed 5 NTU (Nephelometric Turbidity Unit)[4]

C. (TDS)Total Dissolved Solids Sensor:
The average water range that safe water drinking guidelines have approved is 50-150 ppm (parts per million)[4].

D. Temperature Sensor:
The expected water temperature is 25 Celsius but in the range of 24-30 Celsius are acceptable.

| Parameters | Quality Range | Units |
|---|---|---|
| pH Level | 6.5 – 8.5 | Ph |
| Turbidity | Below than 5 | NTU |
| TDS | 50 – 150 | PPM |
| Temperature | 24 – 30 | Degree Celsius |

Table 1. Parameters of IoT based smart water quality monitoring system source

Fig. Hardware Model of Iot-based Water Quality Monitoring System

A. pH Sensor:- The water pH sensor is a simple device that makes it easy to measure the quality of the water. One of the most important instrument for measuring the quality of water is the pH sensor.The pH sensor often made of glass and has rod like structure with a bulb at the bottom that holds thesensor. A glass bulb is used to measure pH level of the water. This pH sensor determine whether a solution is naturally acidic or alkaline. pH levels can be detected between 0 and14 by the sensor set. pH sensor offer greater accuracy for measuring the acidity or alkalinity of water.

B.Turbidity Sensor:- Turbidity sensor measure the amount of light that is scattered by suspended solids in a liquid,such as water. When the concentration of total sulphate solid and tptal dissolved solids in water increases then the turbidity also increases. Turbidity sensors are used to measure the cloudiness of a water to determine water quality.

C.Temperature Sensor:- Temperature sensors provide data about the water such as changes in temperature patterns, water mixing and thermal pollution which can impact the quality of water. Thishelps the water quality professionals to determine whether the water is safe for consumption or not. Monitoring water temperature ensures that the water is being treated effectively and within the regulatory limits. By monitoring temperature changes, it is possible to ensure that the water you consume is safe.

D.LCD display:- The liquid crystal library allows you to control LCD display that are compatible the driver. The LCD's have a parallel interface , that the microcontroller has to manipulate several interface pins at once to control the display. The process of controlling the display involves putting the data that form the image of what you want to display into the data registers, then putting instructions in the instruction register.

E.Arduino UNO:- Arduino is an open source electronics platform based on easy to use hardware andsoftware. This platform allows you to create different types of single board microcomputers to whichthe community of creators can give different types of use.

Five samples were collected from different water sources and tested to measure parameters such as pH, temperature, TDS, and turbidity for each sample. Each water sample will be tested five times on consecutive days to obtain accurate values for all four physical parameters. The average of each parameter is important for the system to predict whether it is drinkable or not. pH sensor results were collected daily for five days. The highest pH of the tap water was 7.7 on day 5, and the lowest was 7.1 on day 1. The second water sample is coway water, the pH of the filtered water is almost neutral. The highest pH in the third test was 7.1, and the lowest pH in the first test was 6.8. The pH of river water is relatively high, with a maximum of 8.3 and a minimum of 7.8. The pH of pond water is not much different from tap water. The most elevated pH was 7.7, and the lowest was 7.3. The lake water is moderate, with a maximum pH of 7.8 and a minimum pH of 7.5. Based on the five- day results shown in Table II, the water samples tested did not fall outside the threshold range.

High values of turbidity can affect the taste and quality of water, while high values of TDS are dangerous to humans due to high mineral content. In the long run, it can be concluded that not all clear water seen by the naked eye is safe to drink because it may be low or high in total dissolved solids, or too acidic or alkaline. These two parameters cannot be seen with the naked eye, and unlike turbidity, the colour of the water changes according to the value of turbidity. Temperature also influences chemical reactions in water. This project also successfully analyze several water samples and determine whether it is drinkable or unsafe for drinking. Before using drinking water or household water, it is essential to measure the water quality first.

Step by step process of how the water quality monitoring system operates:

1. Parameter Selection: It is important to identify the specific water quality parameter to be monitored this may includes physical parameters such as temperature turbulent etc., chemical parameters such as pH of water select parameters that are required to measure the quality of drinking water.

2. Sensor Deployment: Collect all the sensor that are required for measuring the water quality connect all of them together with Arduino UNO and embed into the system. Set the levels of the all the sensors which are already set by government for safe and clean drinking water.

3. The code is get embedded into the Arduino Uno by which whole system will work. All the sensor are connected to the Arduino and then it will get perform and work accordingly.

4. When all the sensors are deploy into the water then all the sensors measure the water parameters accordingly after that data should pass to the Arduino, it will check all the parameters according to the code embedded into it and then it will generate the output.

5. The LCD display is connected to that already Arduino which can display the output. The message is displayed on the display that water is portable or water is not portable. It can also display the values of parameters detected by the sensors.

A pseudo code for checking the potability was mentioned according to the following step:

Step 1: Initialization

- Set up sensor pins and variables for readings: Define pins for sensors and variables to store sensor readings.
- Initialize IoT communication: Set up communication with the IoT platform (e.g., Wi-Fi or GSM).

Step 2: Main Loop

- Read sensor values: Continuously retrieve data from pH, turbidity, temperature, and TDS sensors.
- Send data to IoT platform: Transmit sensor data to the IoT platform for further processing or storage.
- Wait: Pause execution for a defined interval before repeating the loop.

Step 3: Read Sensor Values

- Read pH, turbidity, temperature, and TDS: Obtain analog readings from each sensor.

Step 4: Send Sensor Data to IoT

- Send all sensor data: Transmit the collected sensor readings to the IoT platform for monitoring or analysis.

Step 5: Repeat

- Continue looping: Reiterate the main loop to continually monitor and send sensor data.

## IV. RESULTS AND DISCUSSION

The examination of various water samples from distinct sources, encompassing tap water, well water, river water, and bottled water, underscores the diverse spectrum of pH and turbidity levels observed. Tap water often registers pH levels within the recommended range of 6.5 to 8.5, considered suitable for human consumption, yet occasional fluctuations suggest potential shifts in water quality. Well water exhibits varying pH levels, with some falling within permissible limits while others display irregularities, possibly indicative of mineral content or impurities. Notably, river water samples consistently exhibit heightened turbidity levels compared to tap and well water, signaling increased presence of suspended particles or contaminants. Elevated turbidity underscores the imperative for thorough treatment measures to ensure water safety and clarity, a pivotal aspect in determining water quality suitability for various applications.

| Sample | PH | Turbidity | TDS | Remarks |
|---|---|---|---|---|
| Tap water | 7.5 | 0.6-1.8N TU | 400ppm | Tap water quality is typically regulated to ensure safe drinking standards, maintaining acceptable levels of turbidity and pH regardless of location. |
| bore well | 6-8.5 | 1NT U | 500-700ppm | The borewell water meets drinking water standards, with low turbidity and a pH range of 6-8.5. |
| Akkalpada dam | 6-7.1 | 1NTU | 450ppm | Akkalpada Dam water shows promising signs for multiple uses, with near-neutral pH and low turbidity suggesting minimal suspended solids. Continuous monitoring is essential to maintain quality standards. |
| Panzara River | 4-5 | 5NTU | 2000 ppm | Panzara River water exhibits poor quality with low pH, high turbidity, and elevated levels of dissolved solids, indicating high acidity and suspended solids. Urgent remediation and continual monitoring are crucial to safeguard water resources. |
| Nakane lake | 6.4-7.2 | 1NTU | 500ppm | Nakane Lake water quality assessment reveals favorable conditions for diverse uses, with minimal suspended solids and near-neutral pH levels. Continuous monitoring is recommended to maintain suitability over time. |

## V. CONCLUSION

In conclusion, the development of an IOT based water quality monitoring system using Arduino and multiple sensors offers a promising solution for real-time monitoring of various parameters such as pH, turbidity, temperature and TDS. Through the implementation of this system, we have demonstrated the feasibility of leveraging low cost and easily accessible hardware components to create an effective monitoring solution. The system provides valuable insights into the quality of water sources, facilitating timely interventions and ensuring the safety of water for various applications including drinking, agriculture, and industrial process. Additionally, the scalability and versatility of the system enable its deployment in diverse environments making it a valuable tool for environmental monitoring and management initiatives. Further enhancements and optimization can be exposed to improve the system accuracy, reliability, and functionality, thereby advancing its utility in addressing water quality challenges and permitting sustainable resource management practices. Overall, this research contributes to the ongoing effort towards leveraging IOT technologies for addressing critical environmental concerns and for fostering sustainable development water quality analysis, potentially benefiting millions worldwide.

## REFERENCES


[1] A Novel Sensor based Water Quality Monitoring System using Internet of Things(IoT). Proceedings of the Fourth International Conference on Electronics and Sustainable Communication Systems (ICESC-2023) IEEE Xplore Part Number: CFP23V66-ART; ISBN: 979-8-3503-0009-3

[2] A Prediction of Water Quality Analysis Using Machine Learning 023 International Conference on Distributed

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[5] Design and Implementation of Real Time Approach for The Monitoring of Water Quality Parameters 2022 IEEE 12th Symposium on Computer Applications & Industrial Electronics (ISCAIE) |978-1-6654-8703-0/22/$31.00 ©2022 IEEE | DOI: 10.1109/ISCAIE54458.2022.9794553

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[10] Time Water Quality Monitoring System Yashwanth Gowda K.N ,Vishali C, Sumalatha S.J and Spoorth G.B , International Journal of Engineering Research & Technology (IJERT) 2020

[11] Water Quality Monitoring Model using MachineLearning Prof. A. J. Kadam , Alex Sunny, Mitali Admuthe, Atharva Bhosale, Aashay Bhujbal International Journal of Advanced Research in Science, Communication and Technology (IJARSCT), Volume 2, Issue 1, December 2022

[12] Drinking water quality assessment and its effects on residents health in Wondo genet campus, Ethiopia, Yirdaw Meride and Bamlaku Ayenew, Environmental systems research, a SpringerOpen journal 2020

[13] Shanmugam, Kamalanathan, Muhammad Ehsan Rana, and Roshenpal Singh Jaspal Singh. "IoT-based smart water quality monitoring system for Malaysia." In 2021 Third International Sustainability and Resilience Conference: Climate Change, pp. 530-538. IEEE, 2021

[14] A. Atiast and K. D. Aljafaar, "Automation system for monitoring the quality of water sources to maintain their sustainability using microcontroller," 2022 International Conference on Electrical, Computer and Energy Technologies (ICECET), Prague, Czech Republic, 2022, pp. 1-4, doi: 10.1109/ICECET55527.2022.9873422.

**Appendix C: Plagiarism of Research Paper**

## Plagiarism Scan Report

Report Generated on: May 08,2024

7%

Plagiarised

93%

Unique

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|---|---|
| Total Words: | 30346 |
| Total Characters: | 90396 |
| Plagiarized Sentences: | 5.53 |
| Unique Sentences: | 73.47 (93%) |

### Content Checked for Plagiarism

Abstract - In the face of increasing contamination and pollution of drinking water, a significant threat to both human health and ecosystem stability emerges. Waterborne diseases have the potential to disrupt the delicate balance of ecosystems. Timely detection of water contamination is essential to prevent harmful consequences. To ensure the delivery of clean water, continuous real-time water quality monitoring is imperative. The demand for intelligent solutions to monitor water contamination is escalating with the advancements in sensor technology, connectivity, and the Internet of Things (IoT). The study advocates for an IoT-based smart water quality monitoring system, which offers both cost-effectiveness and efficiency. The integrated model undergoes testing with water samples, and the parameters are transmitted to a cloud server for further analysis.

Keywords - Arduino Uno, pH sensor, turbidity sensor, Wi-Fi Module.

I. INTRODUCTION

Water exerts an indescribable influence on all living

**Appendix D: Certificate of Avishkar**

Kottilthara Sreepriya Suresh (T2054491246055)

Dr. Babasaheb Ambedkar Technological University, Lonere

AVISHKAR 2023-24

This certificate is presented to

Kottilthara Sreepriya Suresh

for participation in Institute level **Avishkar 2023-24** (Research Competition) held at ***SVKM's Institute of Technology, Dhule*** on 03rd Nov. 2023.

Participation level: **UG**

Discipline :Agriculture and animal Husbandry

**Prof. Dattatray Doifode**
Institute coordinator

**Dr. Nilesh Salunke**
Principal
SVKM IOT, Dhule

Parag Ratilal Nikam(T2054491246035)

Dr. Babasaheb Ambedkar Technological University, Lonere

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Participation level: **UG**

Discipline :Engineering and Technology

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Discipline :Engineering and Technology

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