SMART WATER QUALITY MONITORING USING IOT

Minor project-II report submitted
in partial fulfillment of the requirement for award of the degree of

Bachelor of Technology
in
Information Technology

By

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DEPARTMENT OF INFORMATION TECHNOLOGY
SCHOOL OF COMPUTING

VEL TECH RANGARAJAN DR. SAGUNTHALA R&D INSTITUTE OF SCIENCE & TECHNOLOGY

(Deemed to be University Estd u/s 3 of UGC Act, 1956)
Accredited by NAAC with A++ Grade
CHENNAI 600 062, TAMILNADU, INDIA

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CERTIFICATE

It is certified that the work contained in the project report titled "SMART WATER QUALITY MONITORING USING IOT" by "MANIKANTA NAIDU.M (21UTIT0028), R.CHANDU DILEEP (21UT IT0046), K.SHARATH KUMAR (21UTIT0016)" has been carried out under my supervision and that this work has not been submitted elsewhere for a degree.

Signature of Supervisor	**Signature of Professor In-charge**
Information Technology	**Information Technology**
School of Computing	**School of Computing**
Vel Tech Rangarajan Dr. Sagunthala R&D	**Vel Tech Rangarajan Dr. Sagunthala R&D**
Institute of Science & Technology	**Institute of Science & Technology**
May, 2024	**May, 2024**

DECLARATION

We declare that this written submission represents our ideas in our own words and where others' 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 in our submission. We understand that any violation of the above will be 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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APPROVAL SHEET

This project report entitled SMART WATER QUALITY MONITORING USING IOT by MANIKANTA NAIDU.M (21UTIT0028), R.CHANDU DILEEP (21UTIT0046), K.SHARATH KUMAR (21UTIT0016) is approved for the degree of B.Tech in Information Technology.

Examiners **Supervisor**

Ms. D RAMYA, M Tech.,

Date: / /

Place:

ACKNOWLEDGEMENT

We express our deepest gratitude to our respected **Founder Chancellor and President Col. Prof. Dr. R. RANGARAJAN B.E. (EEE), B.E. (MECH), M.S (AUTO),D.Sc., Foundress President Dr. R. SAGUNTHALA RANGARAJAN M.B.B.S.** Chairperson Managing Trustee and Vice President.

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ABSTRACT

Water is the most precious element in the world. All the living things on the earth must need water for their livelihood. So need to safeguard water. Due to various chemicals, plastic and unwanted elements usage increase water pollution. Once water gets polluted then, it is very hard for living on the earth. To prevent water pollution nowadays it becomes very essential to monitor water pollution. The IOT-based system is one of the most automated and applicable tools for water pollution monitoring. The system measures the live values and it may be applicable for the current situations. The designed system is very active and capable of applying modifications based on water contaminated. The precautionary measures will be taken derived from the system. The system analyzes the current contamination and makes decisions. Water is used for various purposes and it has a strong impact on public health and the environment. Drinking contaminated water can cause many diseases. Even some of the packaged water that is available does not have the appropriate mineral content which in turn leads to an adverse health effect. The proposed system is to check whether the given water sample is eligible for drinking by checking the water quality using a microcontroller, Arduino UNO, and Turbidity Sensor.

Keywords:

Water, IoT, Arduino UNO, Turbidity Sensor, Water Quality, Contamination, Microcontroller

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

S.NO	ABBREVIATION	DEFINITION
1	IDE	Integrated Development Environment
2	IoT	Internet of Things
3	MCU	Micro Controller Unit
4	pH	potential of Hydrogen
5	SWQM	Smart Water Quality Monitoring

TABLE OF CONTENTS

Chapter 1

INTRODUCTION

1.1 Introduction

Freshwater is a world resource that is a gift of nature and important to farming, manufacturing, and the life of human beings on earth. Currently, drinking water facilities face new real-world problems. Due to the limited drinking water resources, intensive money requirements, growing population, urban change in rural areas, and the excessive use of sea resources for salt extraction has significantly worsened the water quality available to people. The high use of chemicals in manufacturing, construction, and other industries, fertilizers in farms, and also directly leaving the polluted water from industries into nearby water bodies have made a huge contribution to the global water quality reduction, which has become an important problem. Even due to containment water various water born are increasing day by day, due to which many human beings are losing their lives. Traditionally, detection of water quality was manually performed where water samples were obtained and sent for examination to the the laboratories which is time taking process, cost and human resources. Such techniques do not provide data in real time. The proposed water quality monitoring system consists of a microcontroller (Arduino UNO) and a basic Turbidity Sensor. The system can detect the water quality using the turbidity sensor.

1.2 Aim of the project

The aim of the water quality detection project employing an Arduino Uno and a turbidity sensor is to develop a cost-effective and system for monitoring and assessing water quality. By measuring turbidity levels, this project seeks to detect suspended particles, sediments, or pollutants in water, contributing to environmental conservation efforts by identifying potential pollution sources or changes in water quality. This project also aims to address public health concerns associated with contaminated water by providing a tool to detect harmful substances or bacterial growth.

1.3 Project Domain

An IoT-based water quality detection project is situated within the intersection of environmental monitoring, sensor technology, data analytics, and IoT connectivity. Its primary focus is on employing connected sensor devices, like turbidity sensors, pH meters, and temperature gauges, to continuously measure and assess crucial water quality parameters in real time. By leveraging wireless communication protocols, such as these sensors relay data to a central system or cloud-based platform. Through data analytics and processing techniques, patterns, trends, and anomalies in water quality metrics are interpreted, aiding in the detection of contaminants or variations in parameters.

The project aims to develop user-friendly interfaces, possibly web or mobile applications, to visualize and disseminate this information to users, enabling informed decisions about water usage and contributing to environmental conservation efforts, and safeguarding public health against waterborne diseases. Ultimately, this project domain strives to create a comprehensive and accessible solution for continual water quality monitoring, offering valuable insights for environmental sustainability and human well-being.

1.4 Scope of the Project

An IoT-based water quality detection system utilizing an Arduino Uno and a turbidity sensor presents a scope including technical, environmental, and societal dimensions. The project involves integrating turbidity sensors with the Arduino Uno to enable real-time measurement of water turbidity levels. Environmental scope includes deploying the system across diverse water bodies to monitor changes in quality, assess environmental impacts, and detect pollution events promptly. Societal, the project contributes to public health by ensuring access to safe drinking water and engaging communities in water resource management. Challenges include sensor calibration, maintenance, data security, and optimizing power consumption, while future enhancements may involve multi-parameter monitoring, machine learning integration, and scalability for broader implementation. Overall, this project's scope extends beyond technical functionalities, touching on environmental sustainability, societal well-being, and the potential for technological advancement in water quality management.

Chapter 2

LITERATURE REVIEW

[1]Pasika and Gandla (2023) proposed a monitoring system which consists of a number of sensors used to measure several quality parameters like turbidity, pH value, water level in the tank, dampness of the adjoining environment and temperature of the water. The sensors are interfaced with the Microcontroller Unit (MCU) and additional processing is executed by the Personal Computer (PC). The acquired data will be directed to the cloud by means of Internet of Things (IoT) based ThinkSpeak application for monitoring the quality of the water under test. As a future directive, work should be extended for analyzing some other parameters such as nitrates, electrical conductivity, dissolved oxygen in the water, and free residual chlorine.

[2]Mukta et al. (2023) developed an IoT-based Smart Water Quality Monitoring (SWQM) system which helps in incessant measurement of quality of water on the basis of four different parameters of water quality i.e., pH, temperature, turbidity, and electric conductivity. Four different sensors are coupled to Arduino Uno in order to sense the quality parameters. The data collected from all the four sensors are communicated to a desktop application which is developed in .NET platform and the extracted data are matched with the standard values. On the basis of the collected data from sensors, the developed SWQM model will effica- ciously examine the water quality parameters by employing fast forest binary classifier for classification of the sample of water under test is whether potable or not.

[3]Konde and Deosarkar (2022) proposed a method for developing a Smart Water Quality Monitoring (SWQM) system with reconfigurable sensor interface device using IoT environment. Sensors, Field Programmable Gate Array (FPGA) board, and a Zigbee-based wireless communication module were used in the proposed model. Six different water quality parameters like turbidity, pH, humidity, water level, water temperature and carbon dioxide (CO_2) on the surface of water were considered in real-time. The proposed method will provide assistance in guarding the safer and balanced environment of water bodies. The SWQM system reduces the cost and time in determining the quality of water in water resources as part of managing environmental and ecological balance. In the suggested future work, WSN network will be

developed involving of additional number of nodes to encompass the coverage area.

[4]Unnikrishna Menon et al. (2022) proposed a method for water quality monitoring in rivers which is developed based on wireless sensor networks that aids in incessant and remote monitoring of water quality parameters. In this system, a wireless sensor node is designed to monitor the pH of water continuously, which is the key parameter that affects the water quality. The sensor node design primarily consists of a programming module, signal conditioning module, power module, and wireless communication module. The sensed data from the pH sensor is communicated to the base station with the use wireless communication module i.e., using a Zigbee module after the necessary signal processing and signal conditioning techniques. The circuit is developed for the sensor node by designing, and simulating and the hardware prototype is built with the use of suitable circuit components. This minimizes the requirement of power for the system and a low-cost platform is provided for monitoring the water quality of water resources.

[5]Prasad et al. (2022) developed a method for smart water quality monitoring system in Fiji, by employing remote sensing and IoT technology. The quality parameters used to analyze water are Oxidation and Reduction potential (ORP) and Potential Hydrogen (pH). With efficacious implementation of this approach of monitoring, an early warning system for water pollution will be developed with a completely implemented system using numerous monitoring stations. The study of water quality in Fiji Islands is also presented which necessitates recurrent data collection network for water quality monitoring using IoT and Remote Sensing. The comparative study is presented for various parameters like Turbidity, pH, temperature and Conductivity. The developed system has demonstrated its effectiveness by providing precise and reliable values in real-time water monitoring. Four water sources were examined at hourly intervals over a stipulated time interval of 12 hours for validating the accuracy of measurement of the developed system. The obtained results are compared with the probable values. The relationship between temperature with conductivity and pH are also witnessed for samples of all four water sources. GSM technology was efficaciously implemented for sending alarm on the basis of reference parameters to the end user for instant action intended for ensuring water quality. Furthermore, the reference parameters acquired from all the four various water sources are used for building classifiers that are used for performing automated analysis of water through Neural Network Analysis.

[6]Geetha and Gouthami (2022) developed a low powered and naiver solution for

monitoring quality of in-pipe water based on IoT. The de- developed model is used to test samples of water and the data collected from the sensors is uploaded over the internet is analyzed. This model is less complex and low-cost smart water quality monitoring system with a core controller having a built-in module for monitoring quality parameters like turbidity, conductivity and pH. The developed system comprises of an alerting facility for informing the users on deviance of water quality parameters. The implementation facilitates sensors to provide data over the internet to the end customers. The setup used for the experiment can be enhanced by integrating algorithms for incongruity detection in the quality of water.

[7]Sengupta et al.(2021) proposed a cost-effective technique for monitoring water quality and controlling in real time using IoT. The proposed system comprises of different sensors like temperature sensor, turbidity sensor, and pH sensor that are interfaced with Raspberry Pi via an Analog-to-Digital Converter (ADC). Based on the data obtained from various sensors and processing of data by the Raspberry Pi, the solenoid valve will be directed to either continue or stop the flow of water from the overhead tank to houses using a relay mechanism. This entire process takes place automatically without human intervention thus saving the time to handle the situation manually. Finally, it checks for whether water quality parameters are desired range or not. These all devices are low cost flexible and high efficiency.

[8]Kumar and Samalla (2021) proposed a cost effective system to monitor quality of water in real-time using IoT. The designed system used various sensors to measure the chemical and physical parameters of the water. This smart water quality system consists of a Raspberry pi controller interfaced with various sensors like CO 2 sensor, pH sensor, turbidity sensors, temperature sensor, and water level sensors. These sensors control the entire operation and monitoring is done by Cloud-based wireless communication devices.

[9]Gupta et al.(2020) proposed a model which automatically evaluates water quality parameters such as turbidity, pH, and temperature. For underwater communication, ESP32 was used due to its low power consumption and inbuilt. Communication modules, turbidity meter, and pH sensor were integrated to develop the IoT-based model. In addition, a machine understanding algorithm using K Means was used to analyze the quality of water based on precogitated values. The developed model is a locomotive and it monitors the water quality continuously in large and local water bodies.

Chapter 3

SMART WATER MONITORING

3.1 Existing System

Traditionally, detection of water quality was manually performed where water samples were obtained and sent for examination to the laboratories which is time taking process, cost and human resources. Such techniques do not provide data in real-time. After that, some microprocessors and sensors are used to collect the sensor data from the water. The water quality is tested using the sensors.

One significant drawback lies in their tendency to focus on a limited set of parameters, potentially overlooking other vital indicators crucial for comprehensive water quality assessment. The accuracy and reliability of sensor readings remain a concern, often requiring frequent calibration and maintenance to ensure precise measurements. External environmental factors, such as temperature fluctuations, pH variations, or the presence of contaminants, can interfere with sensor accuracy, impacting the integrity of collected data. Additionally, some systems might lack the capability for real-time monitoring, exhibiting slower response times that could lead to delayed detection of sudden water quality changes or pollution incidents. Maintenance costs, including sensor replacements and operational expenses, pose financial challenges, especially for widespread deployment.

3.2 Proposed Smart water monitoring System

Integrating turbidity sensors within IoT-based water quality detection systems have many advantages that enhance the efficiency and precision of water quality monitoring. These sensors facilitate continuous and real-time monitoring, offering immediate insights into changes in water clarity or suspended particle levels. Their high sensitivity enables the detection of even minor variations in turbidity, serving as an effective indicator of potential contamination, sedimentation, or alterations in water composition.

Moreover, turbidity measurements indirectly assess overall water quality, providing valuable data on suspended solids, pathogens, or pollutants present in the water. They serve as an early warning system for pollution events, quickly detecting abrupt increases in turbidity levels that might signal contamination incidents. This rapid detection capability allows for prompt response measures to mitigate potential risks. Additionally, turbidity sensors, when integrated with IoT technology, enable the seamless transmission of data to centralized systems or cloud platforms, supporting data analysis, visualization, and informed decision-making for water resource management. Their cost-effectiveness, compatibility with IoT devices, and compliance with regulatory standards further underline their significance in ensuring safe drinking water, protecting public health, and fostering sustainable environmental stewardship. Overall, the integration of turbidity sensors in IoT-based water quality systems stands as a pivotal step toward efficient, real-time monitoring and management of water resources.

3.3 Feasibility Study

Feasibility study is determined whether this method is practical, efficient, and appropriate for the particular dataset and research question at hand by taking into account the availability and quality of the data, the suitability of the passive aggressive classifier, performance evaluation, the interpret ability of the results, and the computational resources.A feasibility study is a preliminary exploration of a proposed project or undertaking to determine its merits and viability. It aims to provide an independent assessment that examines all aspects of a proposed project, including technical, economic, financial, legal, and environmental considerations.
The key considerations involved in the feasibility analysis of this project are

- Economic feasibility
- Technical feasibility
- Social feasibility

3.3.1 Economic Feasibility against SWM

The economic feasibility of implementing an IoT-based water quality detection system utilizing turbidity sensors involves an analysis of costs, benefits, and long-term implications. Initial investments involve the procurement of turbidity sensors, Arduino boards, IoT modules, and ancillary components, with sensor prices varying based on quality and features. Essential considerations extend beyond upfront costs to include ongoing expenses such as maintenance, calibration, data transmission, and potential scalability needs. Long-term benefits, including improved water management, early pollution detection, and potential cost savings through proactive measures, should be factored into the evaluation.

Assessing return on investment involves weighing the accrued benefits—such as reduced health risks and regulatory compliance—against initial and recurring costs. Market dynamics, competition among sensor manufacturers, and technological advancements can influence component prices, impacting the system's viability. Compliance with water quality regulations and associated costs should also be considered. Ultimately, conducting a comprehensive cost-benefit analysis aids in determining the system's economic viability, ensuring informed decision-making regarding investment and implementation strategies. Should be described related to project only

3.3.2 Technical Feasibility against SWM

An IoT-based water quality detection system utilizing turbidity sensors is technically viable, having sensor technology that measures water clarity by detecting suspended particles. These sensors, employing light scattering or absorption techniques, vary from analog to more advanced digital versions. Integration with IoT involves connecting these sensors to microcontrollers equipped with communication modules, enabling data transmission to centralized systems or the cloud. The collected data undergoes preprocessing before transmission using protocols like MQTT or HTTP. Cloud platforms analyze this data in real-time or batches, employing algorithms to detect patterns and anomalies, thus providing insights into water health

Optimizing power consumption, ensuring sensor accuracy through regular calibration, compliance with regulatory standards, and addressing connectivity and security challenges are crucial aspects in the development and deployment of this IoT-based water quality monitoring system.

3.3.3 Social Feasibility against SWM

The implementation of an IoT-based water quality detection system using turbidity sensors holds substantial social feasibility, presenting numerous positive societal impacts. This technology significantly improves public health by enabling real-time monitoring of water quality, thereby preventing waterborne diseases through timely detection of contamination.It fosters environmental conservation by safeguarding natural water bodies, preserving aquatic life, and maintaining overall ecosystem health.

Furthermore, deploying these systems in communities empowers residents by providing transparent information about the water they consume, encouraging collective action for water conservation and pollution prevention. In regions facing water scarcity or inadequate access to clean water, such systems play a crucial role in identifying issues promptly and ensuring safe drinking water.

3.4 System Specification

3.4.1 Hardware Specification

- Solderless Breadboard
- Arduino UNO
- 16×2 LCD Display
- Turbidity Sensor Module
- 10k Variable Resistor
- Male to Male Jumper Wires
- Male to Female Jumper Wires
- Hard Jumper Wire
- Battery Clip

3.4.2 Software Specification

- Operating System: Windows 7 or higher
- Programming language:C++
- Platform :Arduino IDE

3.4.3 Standards and Policies

Arduino IDE

The Arduino Integrated Development Environment (IDE) is a software platform used to write, compile, and upload code to Arduino microcontrollers like the Arduino Uno. It provides an easy-to-use interface for programming and developing projects for various Arduino-compatible boards.

Standard Used: ISO 5667-11

Chapter 4

SMART WATER MONITORING METHODOLOGY

4.1 General Monitoring Architecture

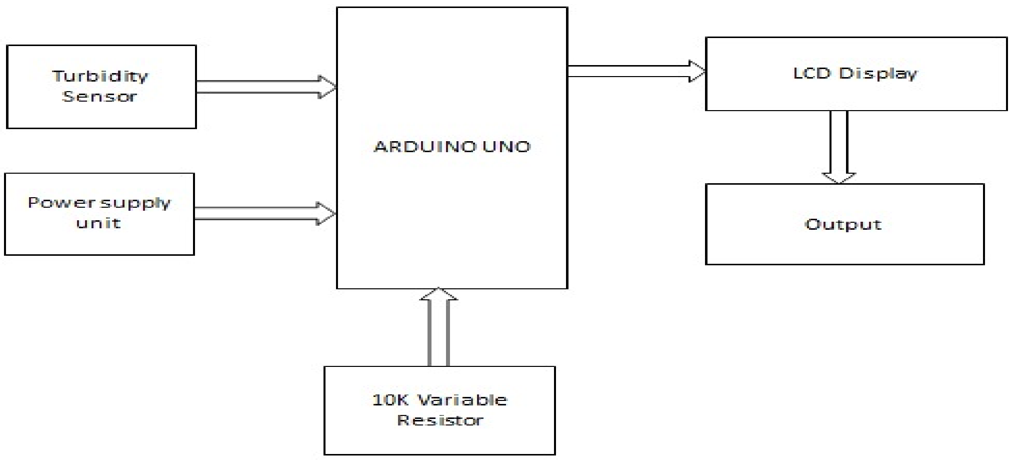


Figure 4.1: Architecture Diagram for smart water monitoring

The architecture diagram for an IoT-based water quality detection system using a turbidity sensor offers a visualization of the system's structural design and the interactions among its integral components. The diagram features components like the Turbidity Sensor responsible for gathering water quality data, the Microcontroller or Processor serving as the central unit for data processing and decision-making, and the Communication Module enabling connectivity with external systems. It showcases the connections and pathways of data flow, illustrating the transmission of raw data from the sensor to the processing unit, internal operations within the microcontroller for data analysis and decision triggers, and the potential communication paths between the system and external entities. This diagram also highlights security measures, communication protocols, and interfaces employed for secure data transmission and system integrity.

4.2 Design Phase

4.2.1 Data Flow Diagram for SWM

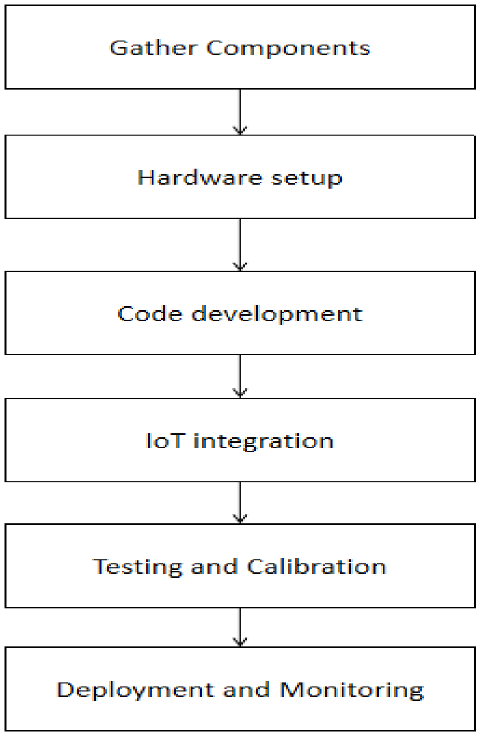


Figure 4.2: Data Flow diagram for smart water monitoring

A data flow diagram representing an IoT-based water quality detection system utilizing a turbidity sensor illustrates the flow of data among key components within the system. The diagram typically includes external entities like the Turbidity Sensor, Microcontroller, Communication Module and potential data stores. The flow of data begins with the Turbidity Sensor, which collects raw data regarding water quality, including turbidity levels. This data flows into the Microcontroller or Processor for processing and analysis, encompassing tasks such as calibration, data conversion, and algorithmic computations to derive meaningful water quality measurements. Subsequently, the processed data moves through the system, potentially triggering actions like alerts or corrective measures if specific thresholds are surpassed.The diagram illustrates these data flows using arrows to indicate the direction of data movement between components and processes, helping visualize the pathways and interactions involved in monitoring water quality using the IoT system and turbidity sensor.

4.2.2 Use Case Diagram for SWM

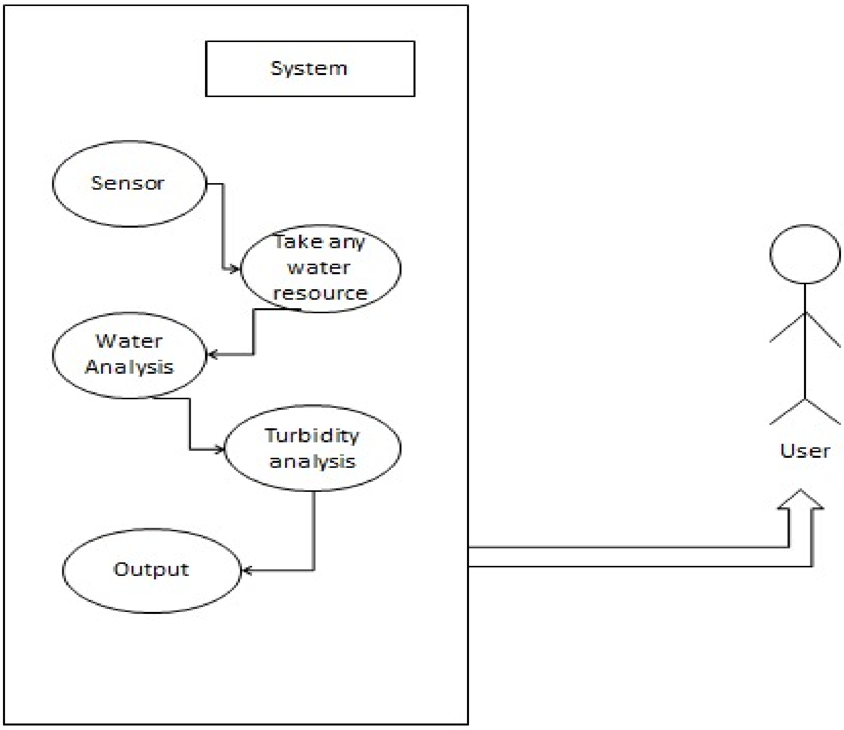


Figure 4.3: Use case diagram for smart water monitoring

A use case diagram for an IoT-based water quality detection system integrating a turbidity sensor illustrates the system's functionalities and interactions between different actors and the system itself. Typically, this diagram features two primary actors: the User and the External System. The User actor represents individuals or roles interacting with the system, such as technicians, administrators, or maintenance personnel, while the External System actor embodies external entities like databases or cloud servers that interact with the IoT system. The diagram highlights various use cases representing distinct functionalities: "Monitor Water Quality" encompasses actions related to real-time monitoring, data analysis, and alert triggering based on turbidity measurements; "Calibrate Sensor" denotes the process of adjusting the sensor settings for accuracy; and "Data Transmission" delineates the exchange of data between the IoT system and external entities.

4.2.3 Class Diagram for SWM

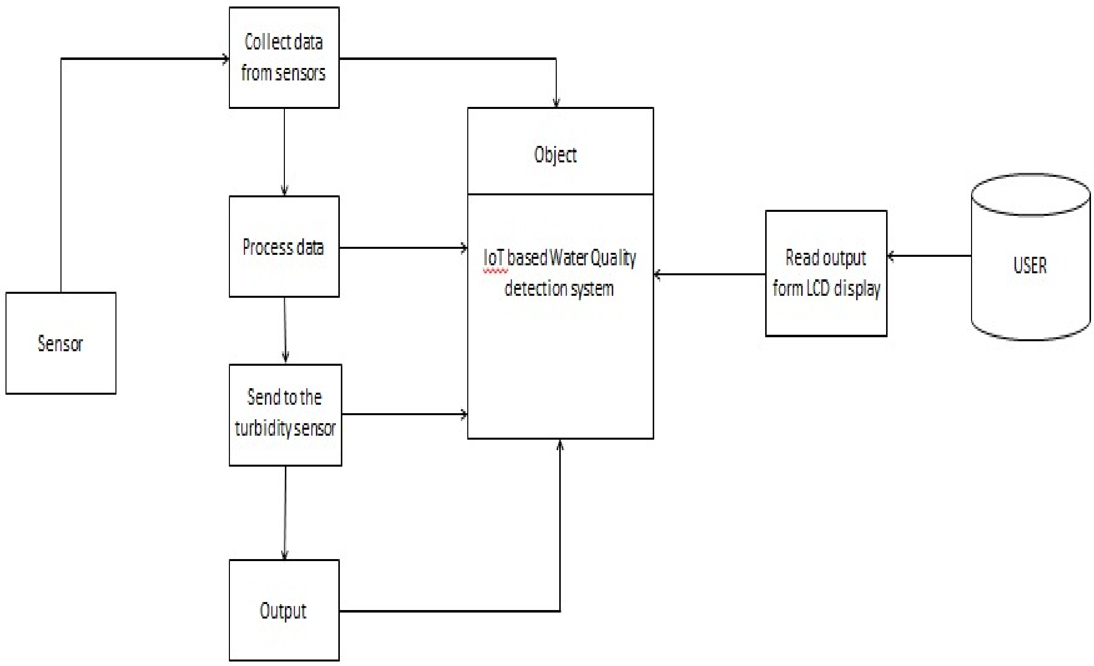


Figure 4.4: Class Diagram for smart water monitoring

A class diagram for an IoT-based water quality detection system utilizing a turbidity sensor is a visual representation showcasing the various classes or components involved in the system and their relationships. At its core, the diagram typically includes classes like TurbiditySensor, Microcontroller, CommunicationModule, and ExternalSystem. The TurbiditySensor class represents the sensor device responsible for measuring turbidity levels in the water, often holding attributes like TurbidityLevel and CalibrationData along with methods such as MeasureTurbidity() and CalibrateSensor(). The Microcontroller class manages the received sensor data, with attributes like SensorData, and performs tasks like data processing via methods like ProcessData() and TriggerActions() to make decisions based on analyzed information. If present, the CommunicationModule class facilitates data transmission to and from external systems, denoted by methods like TransmitData() and ReceiveData().

4.2.4 Sequence Diagram for SWM

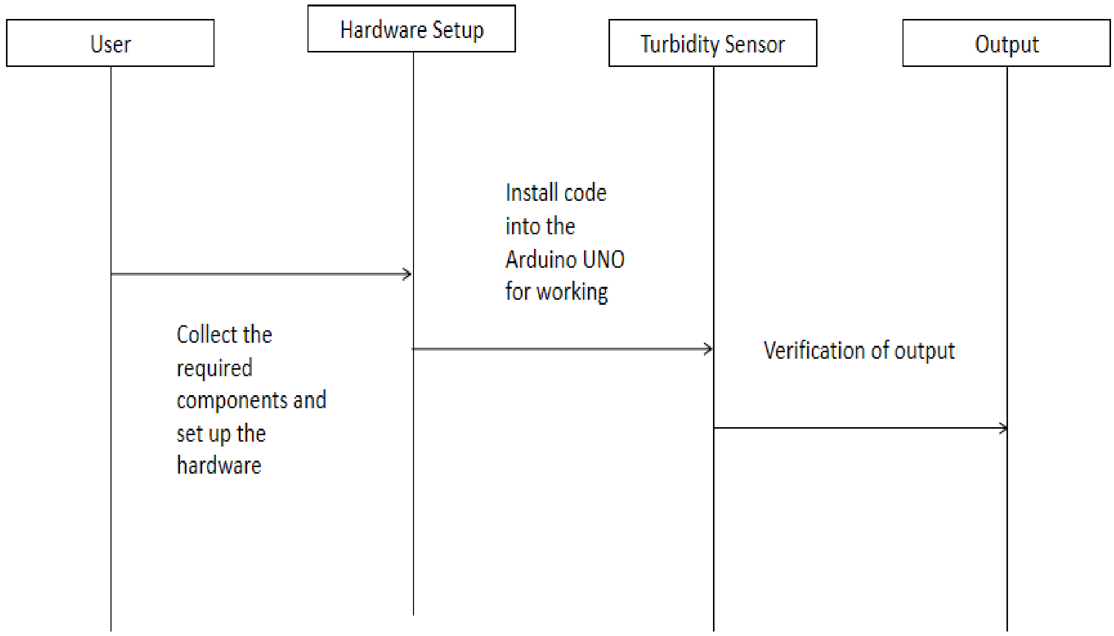


Figure 4.5: Sequence Diagram for smart water monitoring

A sequence diagram depicting an IoT-based water quality detection system utilizing a turbidity sensor outlines the step-by-step interactions and communications among the key components involved in monitoring and assessing water quality. The diagram typically portrays the sequence of events initiated by the turbidity sensor, which measures the turbidity levels within the water. Initially, the sensor transmits the collected data to the microcontroller or processing unit. Upon receiving this data, the microcontroller undertakes processing tasks such as data interpretation, calibration, and potentially applying algorithms to convert raw sensor readings into meaningful water quality metrics. Based on the processed information, the microcontroller may trigger specific actions, such as activating alerts or initiating corrective measures if the detected water quality levels breach predefined thresholds.

4.2.5 Activity Diagram for SWM

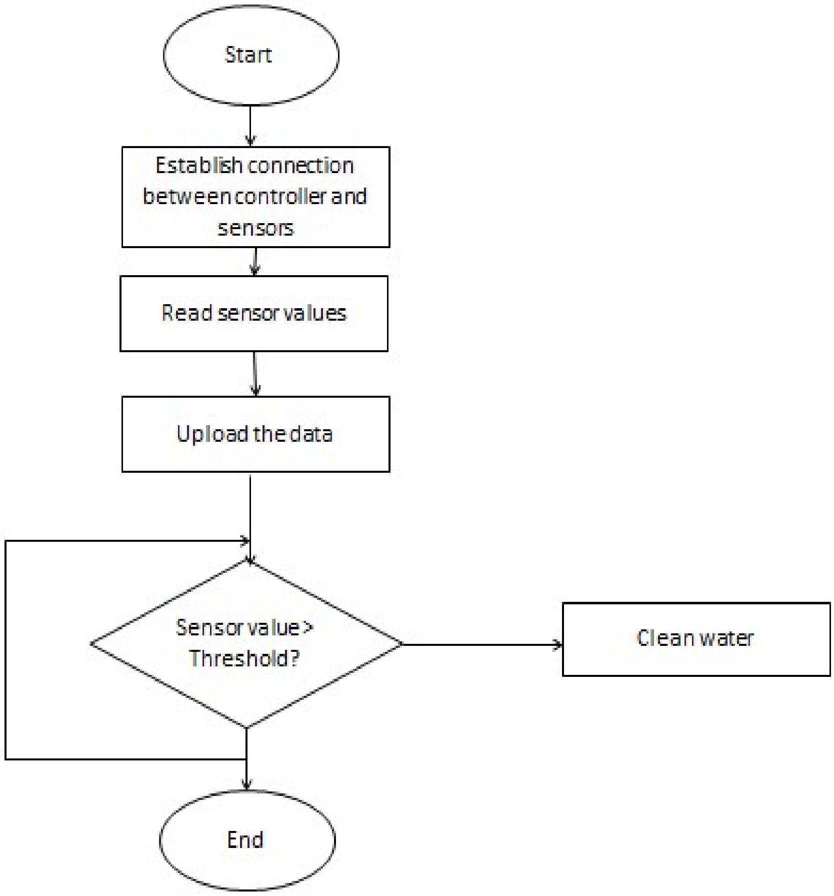


Figure 4.6: Activity diagram for smart water monitoring

4.3 Algorithm & Pseudo Code

4.3.1 Algorithm for Water quality monitoring:

- Collect all the required components such as Arduino UNO, Turbidity sensor, wires and breadboard for connections and internet connectivity module.
- Connect the turbidity sensor to the Arduino UNO using a breadboard.
- Write the Arduino code to interface with the turbidity sensor. The code involves reading sensor values and calibrating them to represent water quality metrics.
- Set up the IoT platform to receive and store data from the Arduino Uno.
- Create visualization tools or dashboards on the IoT platform to display the received data.

- Implement alerts or notifications based on predefined thresholds for water quality parameters.
- Test the entire system to ensure that sensor readings are accurately transmitted to the IoT platform.
- Deploy the system in the desired location (e.g., a water body, a water treatment facility, etc.).

4.3.2 Pseudo Code for water quality checking process

- Initialize Arduino Pins and Variables:
  a.Setup pin connections for the turbidity sensor
  b.Initialize variables for sensor readings and thresholds
  c.Set up communication with IoT platform
- Setup():
  a.Initialize the serial communication for debugging
  b.Connect to network establish through Ethernet connection
- Loop(): Read turbidity sensor data
  - Read analog values from the turbidity sensor
  - Convert analog values to turbidity readings using calibration
- Check water quality:
  - Compare turbidity readings to predefined thresholds for water quality
  - Determine water quality based on turbidity levels (e.g., clear, slightly cloudy, very cloudy)
- Transmit data to IoT platform:
  - Prepare data payload with timestamp and turbidity readings
  - Send data to the IoT platform using the chosen protocol (e.g., MQTT, HTTP)
- Delay for a specific interval before the next reading:
  - Implement a delay to control the frequency of readings (e.g., every 5 minutes)

Pseudo code

```
    Serial.begin(9600);
lcd.begin();
pinMode(2, OUTPUT);
pinMode(3, OUTPUT);
pinMode(4, OUTPUT);
```

```
}
void loop() {
  int sensorValue = analogRead(sensorPin);
  Serial.println(sensorValue);
  int turbidity = map(sensorValue, 0, 750, 100, 0);
  delay(100);
  lcd.setCursor(0, 0);
  lcd.print("turbidity:");
  lcd.print("   ");
```

4.4 Module Description

4.4.1 Sensing Module

The sensing module within an IoT-based water quality detection system is a pivotal component responsible for acquiring, interpreting, and processing data from the turbidity sensor. This module primarily relies on the turbidity sensor, which serves as the key input device. The turbidity sensor operates by emitting light and detecting the amount of light scattered by particles suspended in the water, thus measuring its cloudiness or turbidity. Interfacing with an Arduino Uno, the sensor provides either analog or digital signals that the microcontroller reads and translates into turbidity levels. Calibration is essential to ensure accuracy, involving mapping sensor readings to established turbidity standards. The Arduino processes these readings, applying calibration factors and converting raw data into meaningful turbidity values. By comparing these values against predefined thresholds, the module can determine the water's quality status based on turbidity levels. Ultimately, the sensing module plays a crucial role in collecting and analyzing data, forming the foundation for assessing water quality within the IoT system.

4.4.2 Data gathering and processing module

The data gathering and processing module in an IoT-based water quality detection system serves as a pivotal intermediary between the sensor inputs and the IoT platform, facilitating the collection, refinement, and organization of sensor data for subsequent analysis. Initially, the module interfaces with the Arduino Uno or a microcontroller, which receives raw data from the turbidity sensor. This raw data undergoes a series of crucial processes within the module, including filtering out noise or inconsistencies, applying calibration parameters to ensure accurate measurements, and converting the raw sensor readings into standardized units representative of turbidity levels. Timestamps are incorporated into the data to maintain a chronological record of measurements, crucial for tracking changes over time. Additionally, the module manages the temporary storage and buffering of processed data, optimizing its integrity before transmission to the IoT platform. This module's responsibilities are fundamental in refining sensor data into a usable format, enabling the subsequent analysis, visualization, and interpretation necessary for assessing water quality in the IoT system.

4.4.3 Wireless Transmission module

The wireless transmission module in an IoT-based water quality detection system serves as the crucial link responsible for enabling communication between the local sensor components, such as the Arduino Uno or microcontroller, and the remote IoT platform. This module incorporates a wireless communication interface, such as facilitating connectivity based on the specific network requirements. Its primary function involves establishing a wireless connection to an available network, allowing the processed sensor data to be transmitted securely and efficiently to the designated IoT platform. Once connected, the module transmits the refined sensor data using designated communication protocols over the wireless network. Additionally, it may include error detection mechanisms and retry strategies to ensure the integrity of the transmitted data, thus guaranteeing reliable delivery.

4.5 Project Implementation

4.5.1 Components and Hardware setup

- Collect and gather the required components for the hardware setup.
- Connect the turbidity sensor to the Arduino Uno following the architecture diagram.
- Connect the internet connectivity module (Ethernet shield) to the Arduino Uno .

4.5.2 Code development and IoT integration

- To write the Arduino code to interface with the turbidity sensor. This code involves reading sensor values and calibrating them to represent water quality metrics.
- To ensure the code collects reliable data from the sensor and can output it through the serial monitor for testing purposes.
- Integrate code to connect the Arduino Uno to the LCD Display.
- Include libraries and code necessary for sending sensor data to the IoT platform.

4.5.3 Testing and Calibration

- Test the entire system to ensure that sensor readings are accurately transmitted to the IoT platform.
- Calibrate the sensor if necessary to match real-world water quality standards or expected values.

4.5.4 Deployment and Monitoring

- Deploy the system in the desired location (e.g., a water body, a water treatment facility, etc.).
- Monitor the system regularly to ensure it functions properly and accurately measures water quality parameters.

Chapter 5

IMPLEMENTATION AND TESTING

5.1 Input and Output Design

5.1.1 Samples

Figure 5.1: Water samples for smart water monitoring

Here we have taken two samples,one having clean water and other having the mud water with impurities. Now we need to place the turbidity sensor inside the two samples and check the accuracy of the designed model.

5.1.2 Output

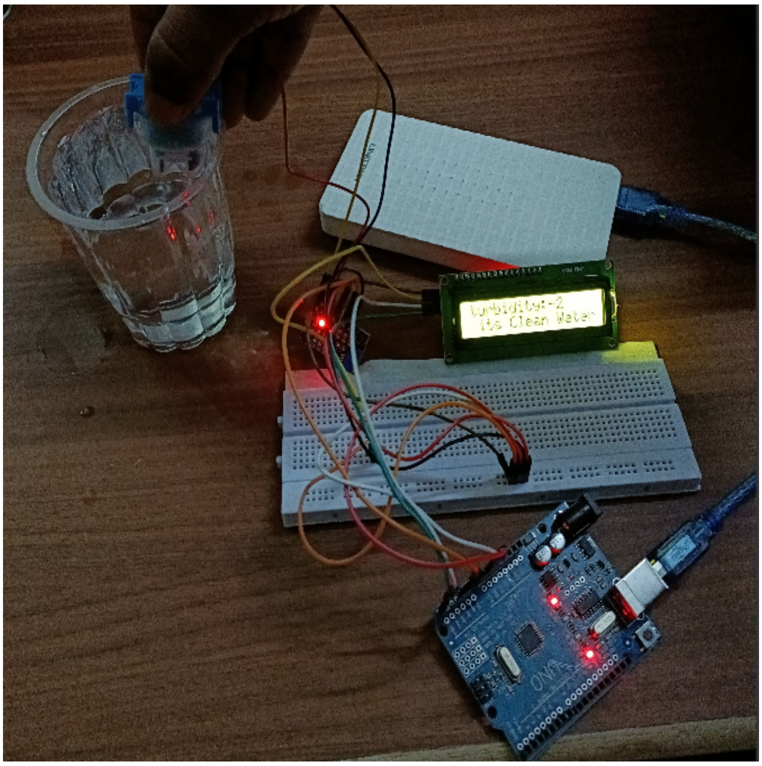


Figure 5.2: Hardware design for smart water monitoring

Here the LCD screen is showing the output as clean water when the turbidity sensor is placed in the first glass. So we can say that the designed model is working well.

5.2 Testing

5.3 Types of Testing

5.3.1 Unit testing for sensing module

Unit testing is a crucial part of ensuring the reliability and accuracy of an IoT-based water quality detection system that utilizes a turbidity sensor. This testing process involves breaking down the system into smaller, testable components or units, and verifying their functionality in isolation. The first step in unit testing this system is to understand its components. Identify the different modules or sections of code responsible for tasks such as interfacing with the turbidity sensor and storing the results. After component identification, create comprehensive test cases that cover various scenarios. For the module responsible for reading sensor data, test cases should encompass normal operating conditions with different turbidity levels, and boundary conditions with minimum and maximum values. Automation is key in unit testing. Utilize testing frameworks compatible with the programming language to automate the execution of test cases. Automated tests can be repeatedly run without manual intervention, providing confidence in the system's reliability.

Test result

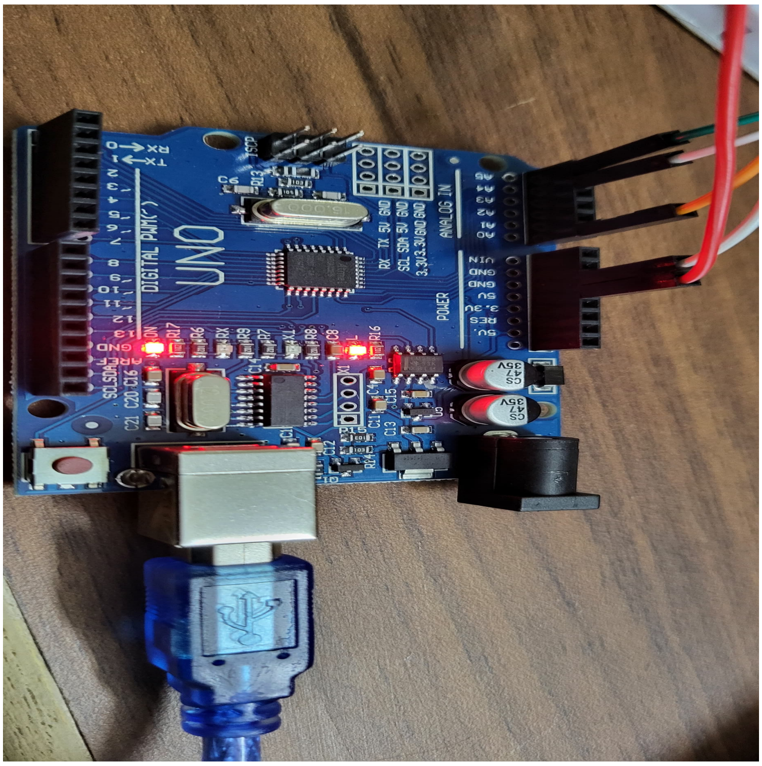


Figure 5.3: Individual component testing

The unit test is carried out for checking each and every component of the hardware. Here the Arduino UNO is checked when connected with the power supply. Here the lights are on so,the UNO is working properly.

5.3.2 System testing for Data gathering and processing module

System testing for an IoT-based water quality detection system employing a turbidity sensor involves comprehensive validation of the entire integrated system to ensure it meets predefined requirements and functions effectively in real-world conditions. This testing process encompasses several critical aspects. Functional testing examines the end-to-end process, including sensor data acquisition, processing, analysis, and result presentation or transmission. Testing at this stage involves assessing sensor calibration, accuracy of readings across various turbidity levels, and the reliability of data processing algorithms. Performance testing evaluates the system's response time, stability, reliability, and scalability under different loads. Interoperability testing ensures smooth integration with external systems or platforms. Security testing focuses on safeguarding data during transmission and preventing unauthorized access or vulnerabilities.

System Test Result

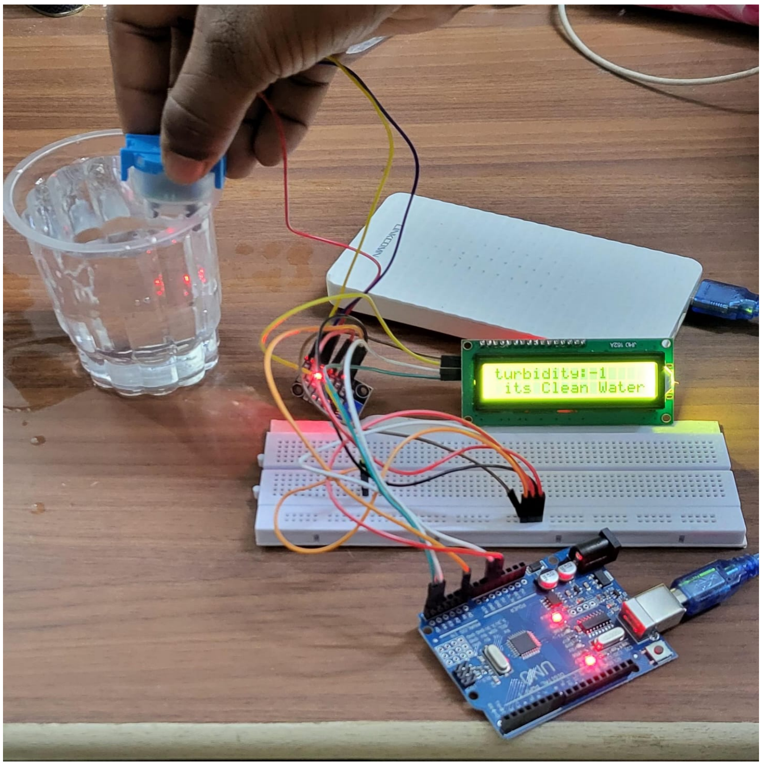


Figure 5.4: System Test

The system test is carried out to check the whole system when all the hardware components are integrated together. When all the components are integrated together and given a power supply the whole system works properly and gives an accurate result

5.3.3 Test Result

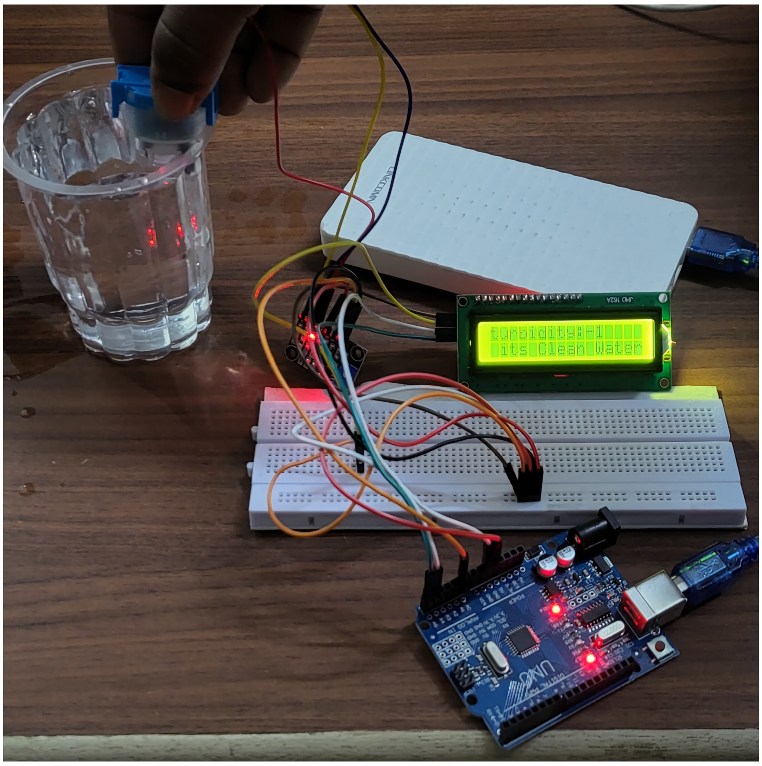


Figure 5.5: Test Image showing the output of clean water

Here the test result is showing whether the water is clean or dirty when the turbidity sensor is inserted in the water. The turbidity sensor passes a beam of light into the water,if the light scatters fast then we can say that there are no dissolved impurities in the water and the water is clean. If the the does not scatter then we can say that the water is not clear and there are many dissolved impurities and hence the water is dirty.

Chapter 6

RESULTS AND DISCUSSIONS

6.1 Proposed System efficiency analysis

The efficiency of the proposed IoT-based water quality detection system using turbidity sensors has its capability to provide accurate, reliable, and real-time data while ensuring seamless functionality across various aspects. The system's effectiveness is intricately tied to the precision and consistency of turbidity sensors in capturing water quality parameters, ensuring that the collected data is trustworthy and reflective of the actual conditions. Swift data processing and analysis by the microcontroller or processing unit are imperative to derive actionable insights promptly. Energy efficiency is crucial for sustainable operation, extending sensor longevity, and minimizing maintenance needs. Intuitive user interfaces or mobile applications enable easy access to comprehensive data, streamlining decision-making processes for stakeholders.

Furthermore, cost-effectiveness, including sensor expenses and maintenance requirements, influences the system's long-term viability and widespread adoption. Addressing environmental impacts, from production to disposal, is vital for ensuring the system's overall efficiency and sustainability. Thus, achieving a balance between accuracy, real-time monitoring, scalability, user accessibility, cost-effectiveness, and environmental considerations will define the efficiency and efficacy of this IoT-based water quality detection system using turbidity sensors. Continued advancements and fine-tuning across these facets will be key in realizing its full potential for effective water quality monitoring and management.

6.2 Proposed System Comparision

Existing system for water quality detection encompass a multifaceted approach integrating diverse methods to evaluate the safety and purity of water sources. These systems rely on a combination of physical, chemical, and biological parameters for comprehensive assessment. Physical parameters such as temperature, turbidity, conductivity, and pH levels are measured using specialized sensors and meters, while chemical analysis involves assessing dissolved oxygen, heavy metals, nutrients, and contaminants through spectrophotometers, chromatographs, and chemical reagents.Biological monitoring includes tests for microbial contaminants and pathogens, determining potential health risks associated with water. Integration of IoT technologies has modernized monitoring by deploying sensors and data collection devices for real-time assessment and transmitting data wirelessly to centralized systems. Regulatory compliance based on set standards by governmental bodies ensures adherence to water quality guidelines. Public awareness initiatives further disseminate information on water quality, contributing to ensuring the suitability of water for various purposes like drinking, agriculture, industry, and environmental conservation.

The proposed IoT-based water quality detection system, combining a turbidity sensor and an LCD display, offers a comprehensive solution for real-time monitoring of water clarity. This system integrates a turbidity sensor to measure suspended particle levels, providing precise data on water quality. Using an IoT-enabled microcontroller Arduino , the system processes sensor data and transmits it to a centralized server.The LCD display serves as the output interface, presenting real-time turbidity measurements in a user-friendly format, either through numerical values or graphical representations. Additionally, an alert mechanism can be incorporated to notify users when turbidity surpasses predetermined thresholds, prompting timely responses. Efficient power management ensures prolonged battery life, especially in remote deployment scenarios. With a user-friendly interface and potential features for data logging and analysis, this system aims to empower users to monitor water quality, make informed decisions, and take proactive measures to maintain safe and clear water sources.

6.3 Arduino Code

```
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 2, 16);
int sensorPin = A0;
void setup()
{
```

```
  Serial.begin(9600);
  lcd.begin();
  pinMode(2, OUTPUT);
  pinMode(3, OUTPUT);
  pinMode(4, OUTPUT);
}
void loop() {
  int sensorValue = analogRead(sensorPin);
  Serial.println(sensorValue);
  int turbidity = map(sensorValue, 0, 750, 100, 0);
  delay(100);
  lcd.setCursor(0, 0);
  lcd.print("turbidity:");
  lcd.print("   ");
  lcd.setCursor(10, 0);
  lcd.print(turbidity);
  delay(100);
  if (turbidity < 15) {
    digitalWrite(2, HIGH);
    digitalWrite(3, LOW);
    digitalWrite(4, LOW);
    lcd.setCursor(0, 1);
    lcd.print(" its Clean Water ");
  }
  if ((turbidity > 15) && (turbidity < 40)) {
    digitalWrite(2, LOW);
    digitalWrite(3, HIGH);
    digitalWrite(4, LOW);
    lcd.setCursor(0, 1);
    lcd.print(" its Normal Water ");
  }
  if (turbidity > 40) {
    digitalWrite(2, LOW);
    digitalWrite(3, LOW);
    digitalWrite(4, HIGH);
    lcd.setCursor(0, 1);
    lcd.print(" its Dirty Water ");
  }
}
```

Output

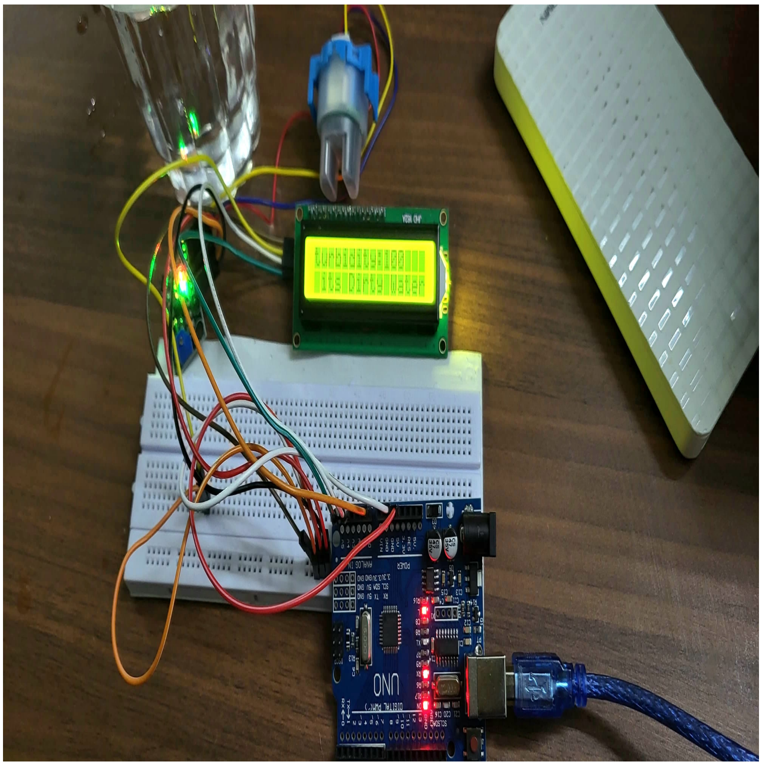


Figure 6.1: Impure water analysis for smart water monitoring

Here we have placed the turbidity sensor into the glass which contains the dirty water. The turbidity sensor shows the turbidity present in the water and says the water is dirty. If the turbidity value is more, then the water is dirty and vice versa.

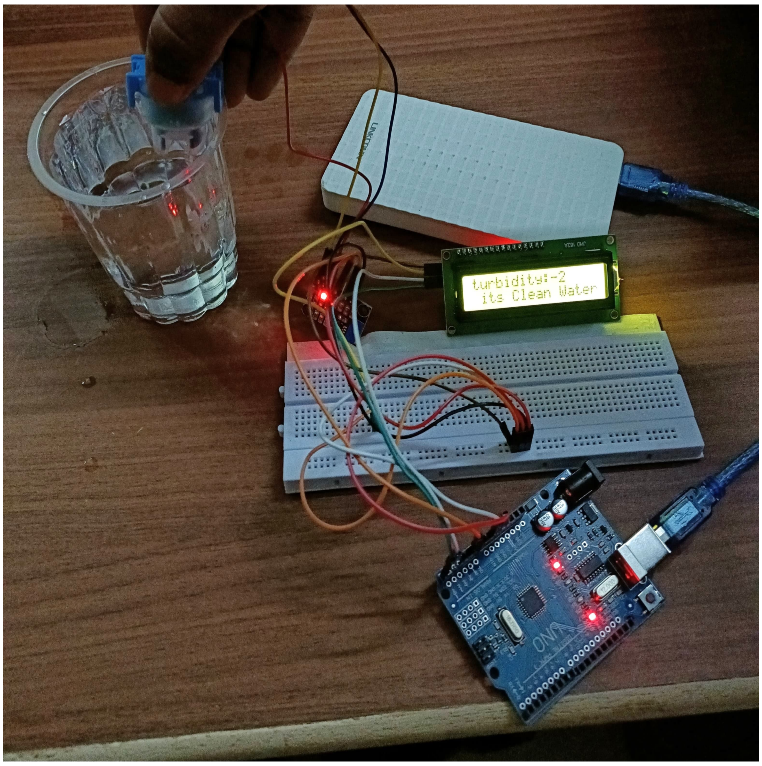


Figure 6.2: Pure water analysis for smart water monitoring

Here we have placed the turbidity sensor into the glass which contains the clean water. The turbidity sensor shows the turbidity present in the water and says the water is clean. If the turbidity value is less, then the water is clean and vice versa.

Chapter 7

CONCLUSION AND FUTURE ENHANCEMENTS

7.1 Conclusion

The implementation of an IoT-based water quality detection system involving a turbidity sensor presents a promising and innovative approach to monitor and assess water quality in various environments. Integrating IoT technology with sensors capable of measuring turbidity levels allows for real-time data collection, processing, and analysis, enabling prompt responses to changes in water quality conditions. This system offers numerous advantages, including enhanced accuracy in measuring turbidity, the ability to remotely monitor and manage water quality parameters, and the potential for early detection of contamination or anomalies.

The effectiveness of this system lies in its capacity to gather raw data from the turbidity sensor, process it using microcontrollers or processors, and trigger appropriate actions based on the analyzed information. However, while IoT-based water quality detection systems offer numerous benefits, challenges such as ensuring sensor accuracy, managing data security, addressing connectivity issues, and integrating seamlessly with existing infrastructure remain important considerations. Overcoming these challenges through continuous improvement in sensor technology, robust data encryption methods, and reliable communication protocols will be crucial in advancing the effectiveness and reliability of these systems.

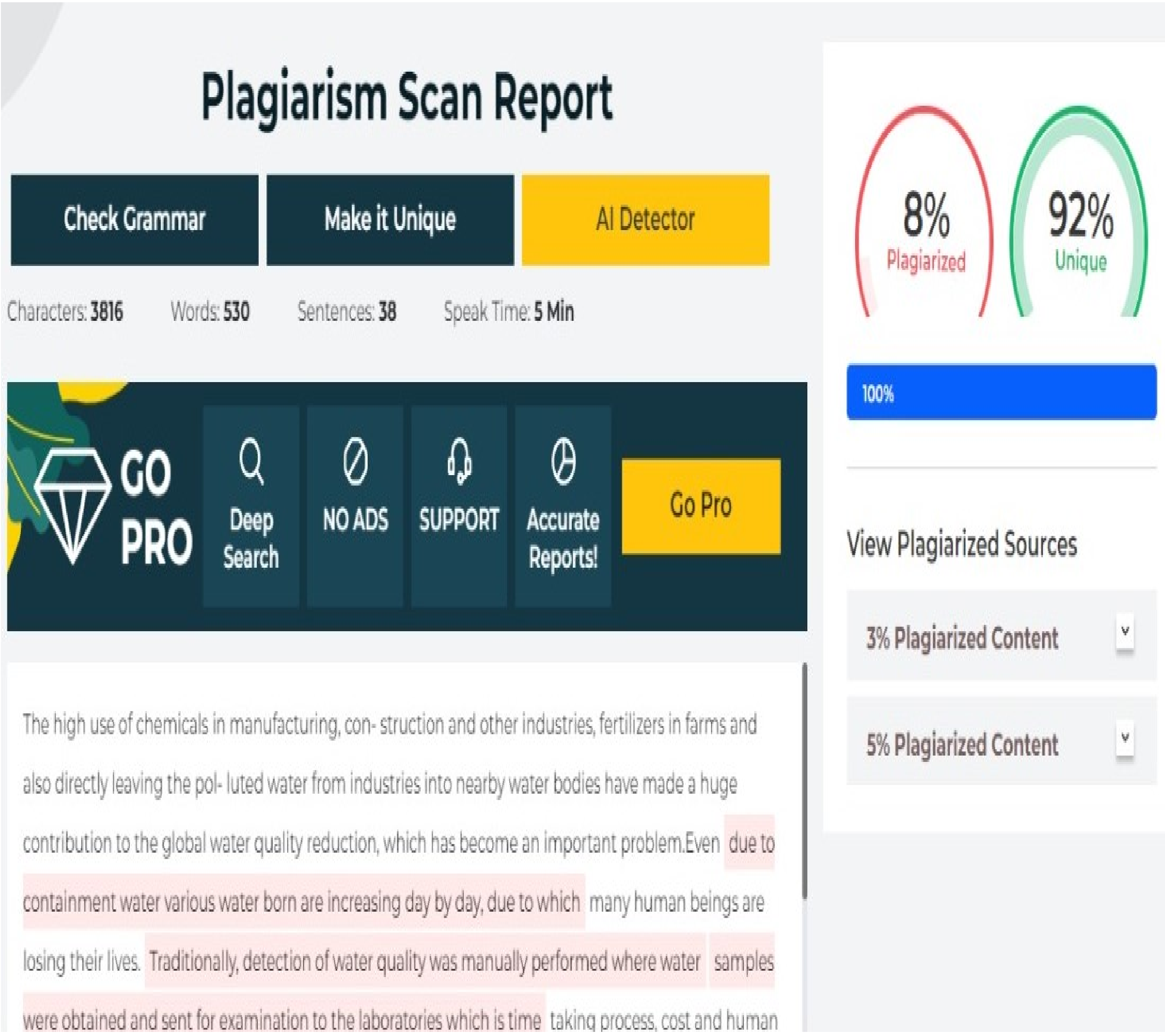
7.2 Future Enhancements

Future enhancements in IoT-based water quality detection systems including turbidity sensors perform well in environmental monitoring. Advancements in sensor technology will prioritize increased precision, sensitivity, and durability, potentially extending the sensor capabilities beyond turbidity measurement of water quality parameters. Integrating machine learning and artificial intelligence will enable predictive analytics, anomaly detection, and real-time insights, empowering these systems to forecast water quality trends and identify emerging issues swiftly. Edge computing adoption within sensors or controllers will facilitate rapid data processing at the source, reducing reliance on cloud-based analysis and enabling quicker decision-making.

Wireless power transmission innovations might enable self-sustaining sensors in remote areas, while blockchain integration could fortify data security and transparency. The expansion of distributed sensor networks over wider geographical scopes and the development of user-friendly interfaces and mobile applications will democratize access to real-time water quality data, engaging communities in monitoring efforts. Furthermore, interdisciplinary collaborations and standardization efforts are critical to ensuring interoperability and consistency across systems. These strides collectively aim to optimize accuracy, accessibility, and usability, empowering stakeholders to make informed decisions crucial for safeguarding water resources and environmental sustainability.

Chapter 8

PLAGIARISM REPORT



Chapter 9

SOURCE CODE & POSTER PRESENTATION

9.1 Source Code

```
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 2, 16);
int sensorPin = A0;
void setup()
{
  Serial.begin(9600);
  lcd.begin();
  pinMode(2, OUTPUT);
  pinMode(3, OUTPUT);
  pinMode(4, OUTPUT);
}
void loop() {
  int sensorValue = analogRead(sensorPin);
  Serial.println(sensorValue);
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  delay(100);
  lcd.setCursor(0, 0);
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  lcd.setCursor(10, 0);
  lcd.print(turbidity);
  delay(100);
  if (turbidity < 15) {
    digitalWrite(2, HIGH);
    digitalWrite(3, LOW);
    digitalWrite(4, LOW);
    lcd.setCursor(0, 1);
    lcd.print(" its Clean Water ");
  }
  if ((turbidity > 15) && (turbidity < 40)) {
    digitalWrite(2, LOW);
    digitalWrite(3, HIGH);
    digitalWrite(4, LOW);
    lcd.setCursor(0, 1);
    lcd.print(" its Normal Water ");
```

```
  }
  if (turbidity > 40) {
    digitalWrite(2, LOW);
    digitalWrite(3, LOW);
    digitalWrite(4, HIGH);
    lcd.setCursor(0, 1);
    lcd.print(" its Dirty Water ");
  }
}
```

9.2 Poster Presentation

Figure 9.1: Poster Presentation

References

[1] Nikhil Kedia, Water Quality Monitoring for Rural Areas- A Sensor Cloud Based Economical Project, in 1st International Conference on Next Generation Computing Technologies (NGCT-2022) Dehradun, India, 4-5 September 2022. 978-1-4673-6809-4/15 ©2022 IEEE

[2] Jayti Bhatt, Jignesh Patoliya, Iot Based Water Quality Monitoring System, IRFIC, 21feb,2019.

[3] Michal lom, ondrej priby miroslav svitek, Internet 4.0 as a part of smart cities, 978-1-5090-1116-2/16/31.00 ©2020 IEEE

[4] Zhanwei Sun, Chi Harold Liu, Chatschik Bisdikia_, Joel W. Branch and Bo Yang, 2020 9th Annual IEEE Communications Society Conference on Sensor, Mesh and Ad Hoc Communications and Networks

[5] Sokratis Kartakis, Weiren Yu, Reza Akhavan, and Julie A. McCann, 2021 IEEE First International Conference on Internet-of-Things Design and Implementation, 978-1-4673-9948-7/16 © 2021IEEE

[6] Mithaila Barabde, shruti Danve, Real Time Water Quality Monitoring System,IJIRCCE, vol 3, June 2019.

[7] Akanksha Purohit, Ulhaskumar Gokhale, Real Time Water Quality Measurement System based on GSM , IOSR (IOSR-JECE) Volume 9, Issue 3, Ver. V (May - Jun. 2022)

[8] Eoin O'Connell, Michael Healy, Sinead O'Keeffe, Thomas Newe, and Elfed Lewis, IEEE sensors journal, vol. 13, no. 7, July 2021, 1530-437x/ © 2021 IEEE

[9] Nidal Nasser, Asmaa Ali, Lutful Karim, Samir Belhaouari, 978-1-4799-0792-2/13/ ©2019 IEEE