Indian Institute of Technology Kanpur

PIL-logo.png

SURGE INTERNSHIP REPORT

Water Quality Estimation Device

Student Name	**Student ID**
Naina	2430527

Guide:

Dr. Tushar Sandhan

Submission Date: 13/07/2024

1 Abstract

The Water Quality Estimation Device project aims to develop a portable device for monitoring key water quality parameters.This device is designed to be easily transportable, ensuring practical utility in real-life situations. Our approach involved conducting extensive research on essential water quality parameters. Subsequently, we carefully selected the most pertinent and suitable characteristics to assess water quality effectively. We also included air quality characteristics to gain insights into the underlying water quality. The device uses Arduino programming to connect with sensors and process data, ensuring accurate measurements through calibration. Its user-friendly interface makes it easy for both professionals and non-experts to interpret data in water quality monitoring. Currently, the device experiences a computation delay of 1 second, which we aim to minimize using machine learning models.

2 Introduction

Access to clean and safe water is essential for human health and well-being. According to the World Health Organization (WHO), approximately 2.2 billion people worldwide lack access to safely managed drinking water services, and 785 million still lack a basic one. Contaminated water significantly contributes to waterborne diseases and is responsible for an estimated 485,000 deaths yearly. The report suggests improving how governments manage water, investing more money, teaching people new skills, making better data systems, and encouraging new ideas. It asks governments to focus on fair and long-lasting water services, deal with climate change effects, and make sure everyone gets the help they need.

3 Literature Survey

Previous studies and projects have explored various methods for monitoring water quality. Traditional laboratory-based methods, although accurate, are time-consuming and expensive. Portable devices have been developed to provide quicker results, but they often lack comprehensive analysis and affordability. Recent advancements in sensor technology and machine learning offer new opportunities for developing cost-effective and efficient water quality monitoring devices. By integrating multiple sensors and leveraging data analysis techniques, it is possible to create a device that provides reliable real-time water quality assessments.

4 Equipments Used

5 Equipments Used

- pH sensor
- Temperature Sensor (DS18B20)
- MQ135 Air Quality Sensor

- TDS Sensor
- Conductivity Sensor
- Arduino Mega
- 16x2 LCD Display
- Multimeter
- Arduino IDE
- Power Supply (9V battery)
- Push Buttons
- Buck Converter

Calibration Solutions

- pH 4.0 and pH 7.0 buffer solutions
- 332 ppm NaCl Solution
- Standard Conductivity Solution

6 Methodology

6.1 Sensors and their calibration

6.1.1 pH Sensor

A pH sensor is used to measure the hydrogen-ion activity in water-based solutions, indicating its acidity or alkalinity.

Figure 1: pH Sensor

- Its Calibration:

  The pH sensor needs regular calibration using standard buffer solutions to ensure accuracy. The calibration process involves adjusting the sensor to known pH values.

The sensor was first immersed in a neutral buffer solution (pH 7.0) until the reading stabilized. The meter was then adjusted to match this known pH value. Next, the sensor was rinsed thoroughly and immersed in a second buffer solution (pH 4.0). After the reading stabilized, the meter was again adjusted to match this known pH value.

To determine the relationship between pH and voltage, the slope (m) was calculated using the formula:

$$m = \frac{(pH_2 - pH_1)}{(V_2 - V_1)}$$

where $pH_1 = 7$ and $V_1 = 3.232\,V$, $pH_2 = 4$ and $V_2 = 3.615\,V$. This results in:

$$m = \frac{(4-7)}{(3.615-3.232)} = \frac{-3}{0.383} = -7.8328\,\mathrm{pH/V}$$

This calibration ensures the sensor's readings are accurate and reliable.

6.1.2 MQ135 Sensor

The MQ135 is a gas sensor that detects various pollutants in the air. It's commonly used to measure air quality in environments such as homes, workplaces, and industrial settings.

Figure 2: MQ135

- Its Calibration:

  To determine the relationship between the analog output and gas concentration, the slope (m) was calculated using known gas concentrations and corresponding output voltages.

  The sensor was exposed to a standard gas with a known concentration of 400 ppm CO2, giving an output voltage of 0.1 V. It was then exposed to a concentration of 1000 ppm air (which was muddy algae-covered standing water air behind Hall 6), resulting in an output voltage of 2.0 V.

  Using these values, the slope was calculated with the following formula:

$$m = \frac{(C_2 - C_1)}{(V_2 - V_1)}$$

  where: - $C_1 = 400\,\mathrm{ppm}$, $V_1 = 0.1\,\mathrm{V}$ - $C_2 = 1000\,\mathrm{ppm}$, $V_2 = 2.0\,\mathrm{V}$

  Substituting the values:

$$m = \frac{(1000-400)}{(2.0-0.1)} = \frac{600}{1.9} = 315.79\,\mathrm{ppm/V}$$

  This calibration ensures that the sensor accurately converts its analog output voltage to the corresponding gas concentration.

6.1.3 TDS Sensor

A TDS (Total Dissolved Solids) sensor measures the concentration of dissolved solids in water. These solids can include salts, minerals, metals, and other substances.

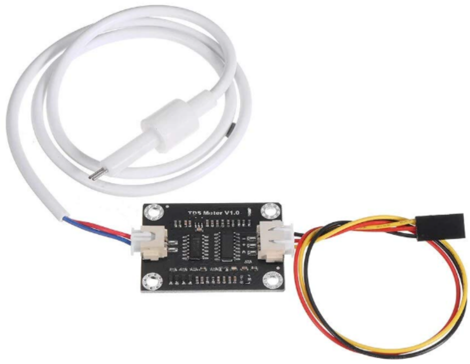

Figure 3: TDS Sensor

- Its Calibration:

  The TDS sensor was calibrated using a 332 ppm NaCl (sodium chloride) solution. During calibration, the analog values produced by the sensor were recorded and compared with the known concentration of the NaCl solution. A calibration factor of 342/462 was calculated to adjust the sensor's analog output to accurately reflect the actual TDS (Total Dissolved Solids) value in water.

6.1.4 Temperature Sensor(DS18B20)

The DS18B20 temperature sensor measures water temperature, which is critical for monitoring chemical reactions, dissolved oxygen levels, and the metabolism of aquatic life.

Figure 4: Temperature Sensor

- Its Calibration:

  The DS18B20 temperature sensor is usually already calibrated by the manufacturer, so users typically don't need to calibrate it themselves.

6.1.5 Conductivity Sensor

A conductivity sensor measures a solution's electrical conductivity, indicating the presence of dissolved ions, such as salts, acids, and bases.

- Its Calibration:

  The calibration factor for the conductivity sensor, based on the 332 ppm NaCl solution with an estimated conductivity of 664 µS/cm, was determined to be 664 µS/cm. This factor is used to calibrate the sensor's readings to measure the conductivity of solutions in various applications accurately. *conductivity calibration factor : 664* $\mu S/cm$

7 Our Prototype and Results

The sensors will be enclosed in a compact, portable casing. The device is designed to provide a user-friendly interface for real-time monitoring of water quality.

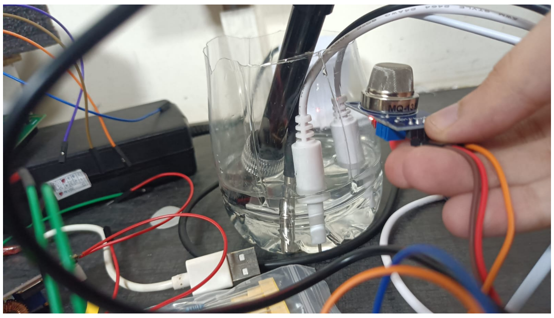

Figure 5: All sensor together

Figure 6: ST 7735 display

8 Future Improvements

- Further testing with a broader range of water samples will enhance the device's reliability and usability, ensuring it meets diverse water quality monitoring needs.
- By using machine learning models, we can speed up data processing and improve sensor accuracy by predicting values based on past data and trends. This allows for faster analysis and real-time monitoring.