

IOT- Enabled Smart Water Quality Monitoring System

Aim of the Project

The aim of this project is to design and implement a water purity monitoring system using a turbidity sensor, Arduino, and LCD display. The system measures the turbidity of water in NTU (Nephelometric Turbidity Units), displays the result on an LCD, and triggers an LED and buzzer alarm when the water is unsafe for drinking.

Problem Statement and Solution

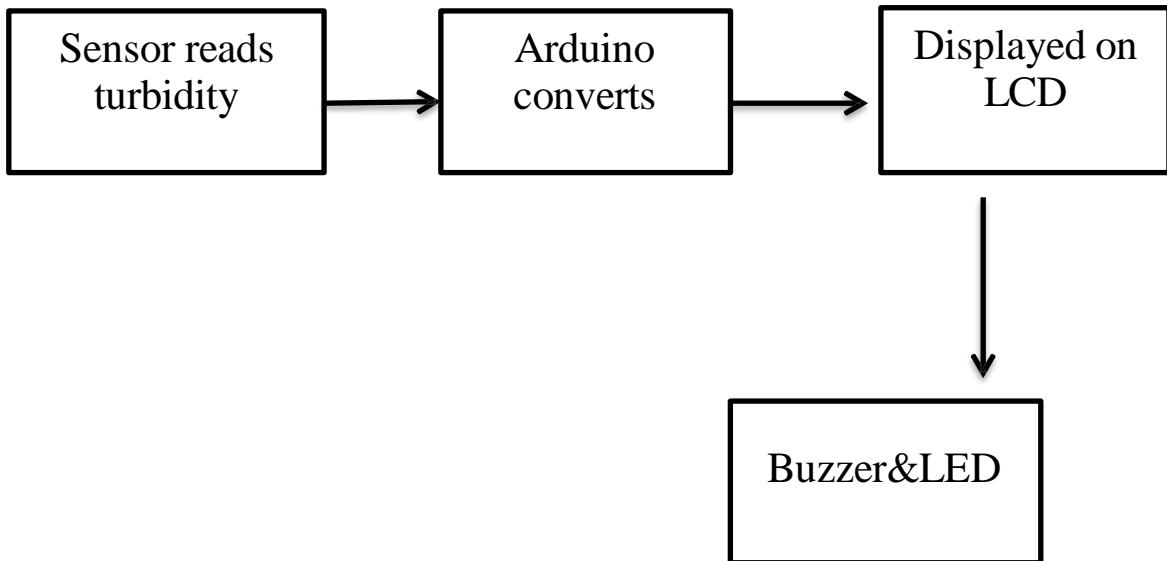
Problem Statement: Access to safe and clean drinking water is a major challenge in many regions. Traditional testing methods are slow and require laboratory facilities.

Solution: By using a turbidity sensor with a microcontroller (Arduino), this project provides a low-cost, real-time water purity check. The system instantly measures water turbidity, displays values on an LCD, and alerts users through buzzer/LED when water is impure.

Project Design and Architecture:

- **Turbidity Sensor** → Detects clarity of water and sends analog signal to Arduino.
- **Arduino UNO** → Processes sensor data and converts it into NTU values.
- **LCD Display (I2C)** → Shows NTU value and water status (Safe/Unsafe).
- **Buzzer & LED** → Provide alert signals when water is impure.
- **Power Supply** → Provides 5V power to Arduino and sensor.

Project Architecture:



Programming Solution:

```
#include <Wire.h>

#include <LiquidCrystal_I2C.h>

// Pin connections

const int turbidityPin = A0; // Sensor analog output to A0

const int buzzerPin = 8; // Buzzer to digital pin 8

const int ledPin = 7; // LED to digital pin 7

float voltage, turbidity;

// LCD setup (16x2 LCD, common I2C addresses: 0x27 or 0x3F)

LiquidCrystal_I2C lcd(0x27, 16, 2);

void setup() {

    Serial.begin(9600);
```

```
pinMode(buzzerPin, OUTPUT);

pinMode(ledPin, OUTPUT);

// Initialize LCD

lcd.init();

lcd.backlight();

lcd.setCursor(0, 0);

lcd.print("Initializing...");

delay(2000);

// Test LCD

lcd.clear();

lcd.setCursor(0, 0);

lcd.print("LCD Working");

Serial.println("LCD should display 'LCD Working'");

delay(2000);

lcd.clear();

}

void loop() {

// Read turbidity sensor

int sensorValue = analogRead(turbidityPin);

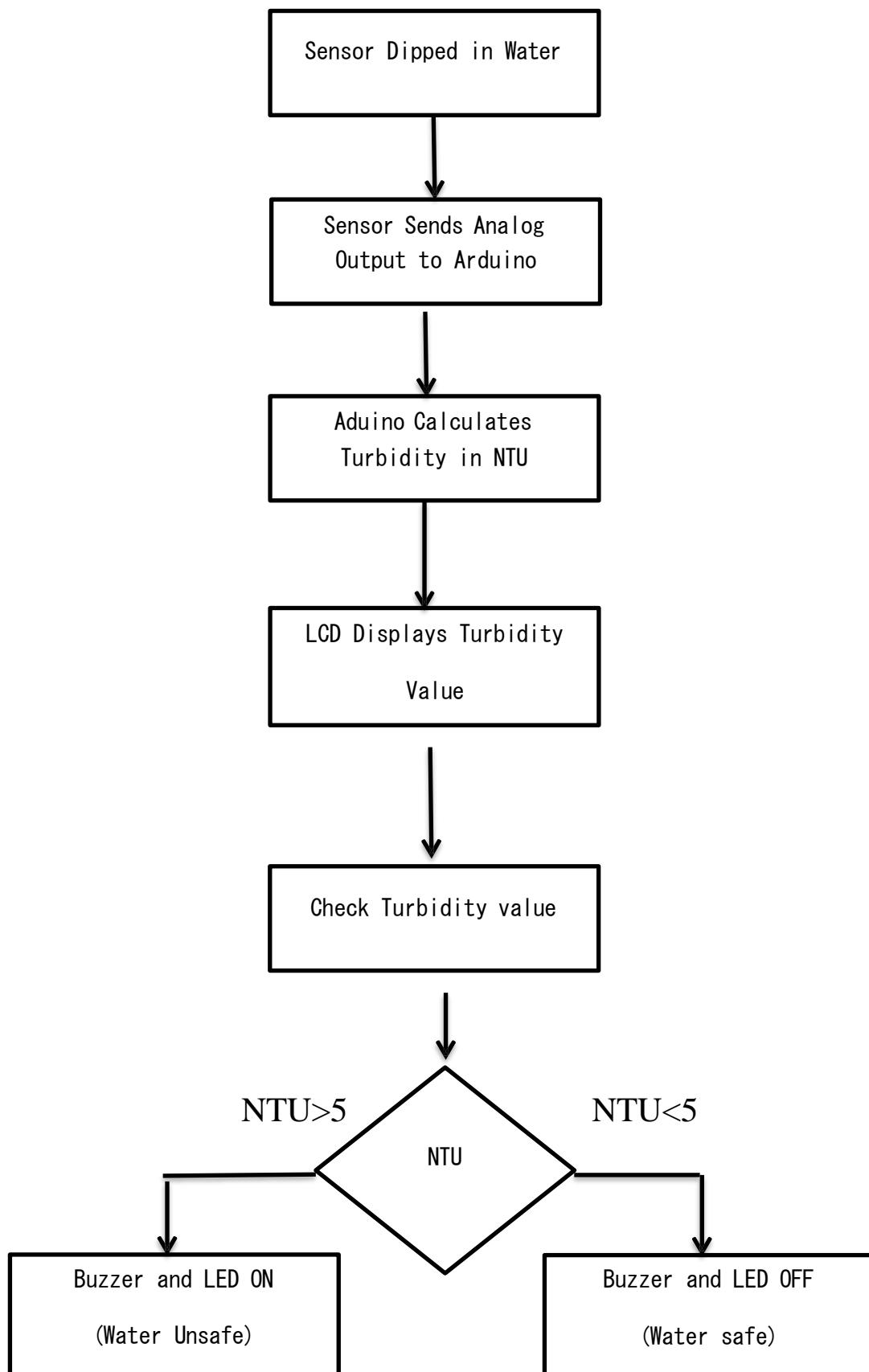
voltage = sensorValue * (5.0 / 1023.0);

turbidity = -1120.4 * voltage * voltage + 5742.3 * voltage - 4352.9;
```

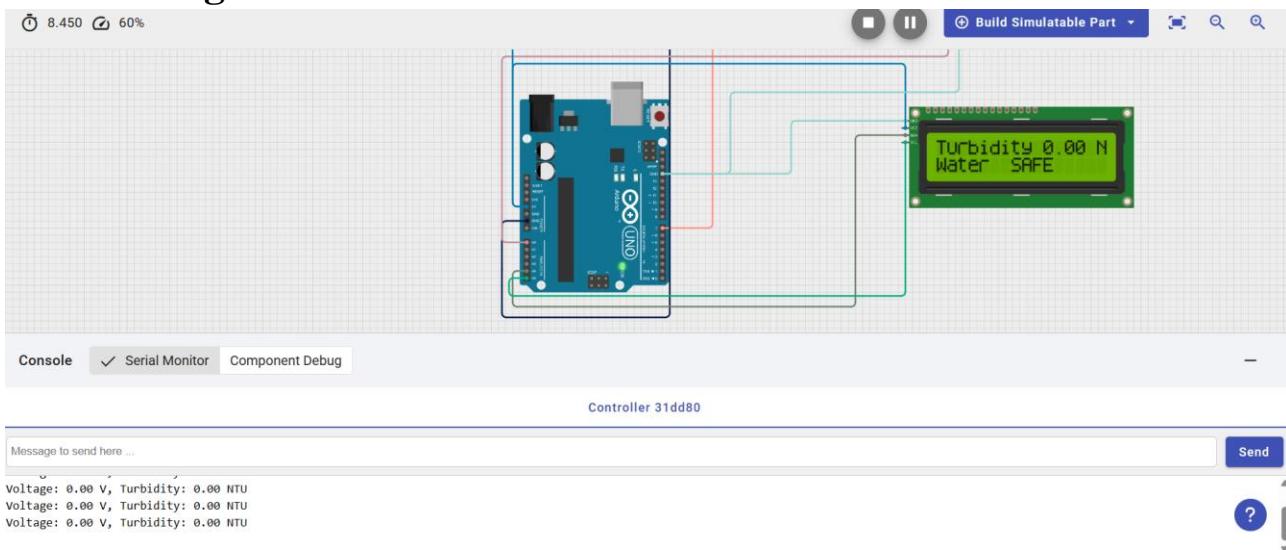
```
// Prevent negative values  
  
if (turbidity < 0) turbidity = 0;  
  
// Print on Serial Monitor  
  
Serial.print("Voltage: ");  
  
Serial.print(voltage);  
  
Serial.print(" V, Turbidity: ");  
  
Serial.print(turbidity, 2);  
  
Serial.println(" NTU");  
  
// Display on LCD  
  
lcd.clear();  
  
lcd.setCursor(0, 0);  
  
lcd.print("Turbidity: ");  
  
lcd.print(turbidity, 2);  
  
lcd.print("NTU");  
  
// WHO safe drinking water threshold  
  
const float turbidityThreshold = 5.0;  
  
lcd.setCursor(0, 1);  
  
if (turbidity > turbidityThreshold) {  
  
    lcd.print("Water: NOT SAFE");  
  
    digitalWrite(buzzerPin, HIGH);  
  
    digitalWrite(ledPin, HIGH);
```

```
    } else {  
        lcd.print("Water: SAFE    ");  
        digitalWrite(buzzerPin, LOW);  
        digitalWrite(ledPin, LOW);  
    }  
    delay(1000); // Update every second  
}
```

Flow Explanation



Block Diagram



Connection

Turbidity Sensor

- VCC = 5V
- GND = GND
- A0 = A0

16x2 I2C LCD Display

- SDA = A4
- SCL = A5
- VCC = 5V
- GND = GND

Buzzer

- Anode (+) = D8
- Cathode (-) = GND

LED

- Anode (+) = D7
- Cathode (-) = GND

Components Working Principles / Functionality

1. Arduino UNO

- Arduino UNO is an open-source microcontroller board based on the ATmega328P IC.
- It has 14 digital pins (6 can be used as PWM outputs) and 6 analog inputs.
- In this project, Arduino acts as the brain of the system:
 - Reads analog voltage from the turbidity sensor.
 - Converts it into NTU values using the calibration formula.
 - Sends data to the LCD for display.
 - Controls the buzzer and LED according to water purity level.
- It operates at 5V and can be powered via USB or external adapter.

2. Turbidity Sensor

- A turbidity sensor measures water clarity based on the principle of light scattering.
- It consists of:
 - Infrared LED → emits light through the water sample.
 - Photodiode/Phototransistor → detects how much light passes through or scatters.
- **Working principle:**
 - If water is clear → more light passes through → lower sensor voltage → lower NTU.
 - If water is dirty → light is scattered/blocked → higher sensor voltage → higher NTU.
- The sensor outputs an analog signal (0–4.5V approx.), which is read by Arduino.

3. LCD Display (16x2 I2C)

- A 16x2 LCD can display 16 characters per row and has 2 rows.
- With the I2C adapter, it requires only 2 Arduino pins (SDA, SCL) instead of 8–10.
- In this project:
 - First row displays “Turbidity:”.
 - Second row shows the turbidity value in NTU and water condition (Safe/Unsafe).
- I2C communication makes it easy, reduces wiring, and saves Arduino pins for other sensors.

4. Buzzer

- A Piezo buzzer converts electrical signals into sound.
- When Arduino sends a HIGH signal:
 - The buzzer vibrates and produces a tone.
- In this project:
 - If water turbidity > threshold (unsafe), buzzer turns ON to alert the user.
 - If water is safe, buzzer remains OFF.

5. LED (Light Emitting Diode)

- A small semiconductor device that emits visible light when current flows through it.
- In this project:
 - LED ON → Water is impure/unsafe.
 - LED OFF → Water is clear/safe.
- Acts as a visual indicator along with buzzer for quick status checking.

Bill of Materials

S.NO	Component	Make/Model	Qty	Unit Price (INR)	Total (INR)
1	Arduino UNO	Original / Clone (ATmega328P)	1	350	350
2	Turbidity Sensor Module	SEN0189 (DFRobot) / Generic	1	555	555
3	LCD Display 16x2 with I2C	HD44780 + I2C Backpack	1	250	250
4	Buzzer	5V Piezo Buzzer	1	83	83
5	LED	5 mm LED	1	5	5
6	Resistors	220om	1	10	10
7	Breadboard	400 Tie-points	1	150	150

Project output

- The system successfully measures water turbidity in real-time.
- Clear water (<5 NTU) → No alarm, LCD shows “Safe Water”.
- Turbid water (>5 NTU) → Buzzer and LED ON, LCD shows “Unsafe Water”.
- Provides a low-cost, portable, and real-time solution for water quality checking.

Output image



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