AquaSense: Smart Water Quality IoT System

Water Quality Control System (IoT)

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1. Title

Water Quality Control System with IoT Integration

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2. Abstract

This project presents the design and development of a cost-effective **Water Quality Monitoring and Control System** using embedded and IoT technologies. The system continuously measures water quality through a **TDS (Total Dissolved Solids) sensor**, displays real-time data on an **LCD**, and uploads measurements to an IoT dashboard for remote visualization and analysis. It provides reliable insight into water conditions and enables real-time monitoring, making it useful for residential, agricultural, and environmental applications.

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3. Introduction

Water quality is essential for health, agriculture, and ecosystem sustainability. Traditional water testing methods require manual sampling and laboratory analysis, which are laborious and time-consuming. The objective of this project is to automate water quality assessment by using sensors and network connectivity. The system provides immediate feedback locally and remotely, contributing to smarter environmental monitoring.

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4. Problem Statement

Manual water quality monitoring is slow, expensive, and lacks remote accessibility. There is a need for a real-time, reliable, automated solution that:

- Monitors water continuously
- Provides instant alerts
- Allows remote monitoring through internet connectivity

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5. Objectives

- Implement a real-time water quality monitoring system.
- Display measurements on a local LCD display.
- Facilitate IoT-based remote data visualization.
- Provide a scalable, modular design for easy enhancements.

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6. Scope of Project

The project can be expanded to include:

- Additional sensors (pH, turbidity)
- Cloud analytics and machine learning
- Alert notifications based on thresholds
- Mobile or web dashboards

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7. Components and Hardware

Component	Quantity	Description
Arduino Uno	1	Microcontroller
TDS Sensor	1	Measures dissolved solids in water
16×2 LCD Display	1	Displays real-time data
Potentiometers	2	LCD contrast & calibration
Breadboard	1	Prototyping platform
Jumper Wires	Several	Electrical connections
Resistors	Several	Signal conditioning
USB Cable	1	Power & programming
Wi-Fi Module*	1 (optional)	IoT connectivity

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8. System Design

8.1 Hardware Architecture

The system consists of the following modules:

1. **Sensor Module**
   - The TDS sensor measures dissolved solids in water.
   - Analog signals are sent to Arduino's ADC.
2. **Processing Module**
   - Arduino reads sensor data.
   - Converts analog values to calibrated TDS values.
   - Controls display and IoT transmission.
3. **Display Module**
   - A 16×2 LCD presents real-time values and status.
4. **IoT Module (Optional)**
   - Wi-Fi module (e.g., ESP8266/ESP32) provides connectivity.
   - Sends data to cloud platforms.

9. Circuit Diagram

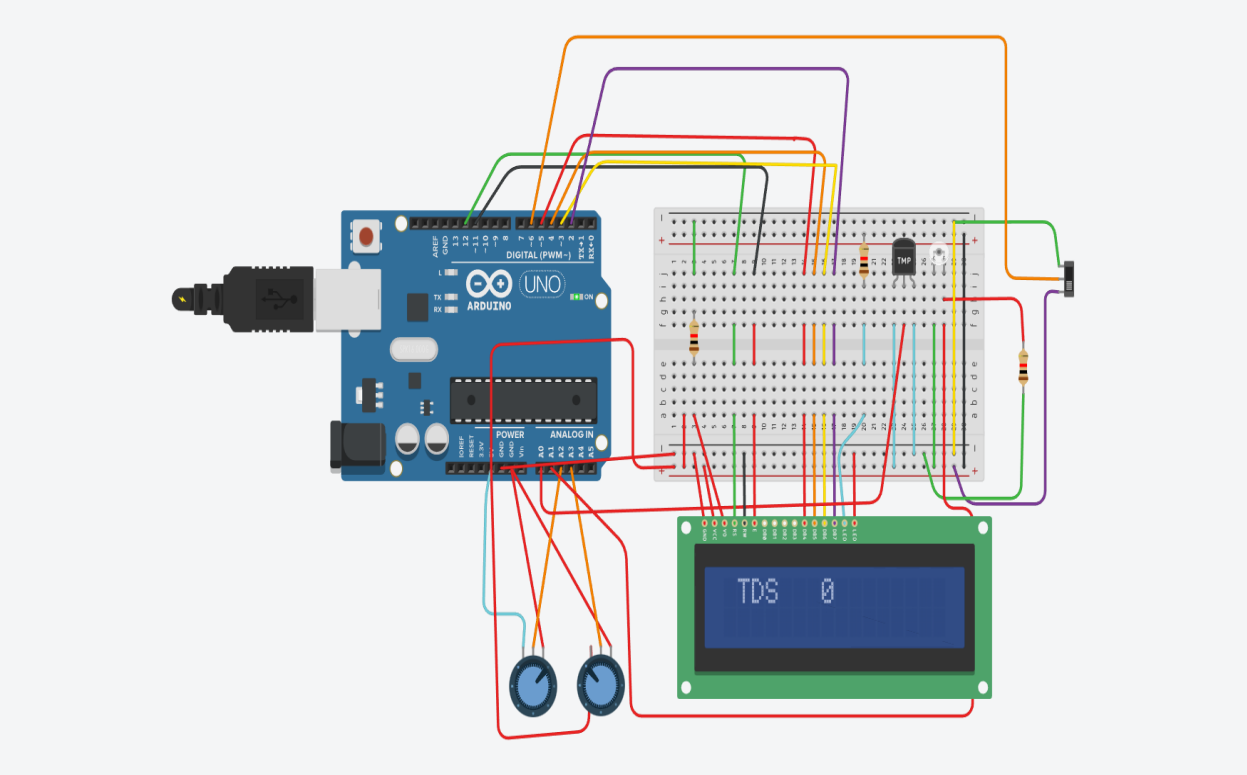

Figure: Water Quality Control System — Hardware Block Diagram

10. Software Design

10.1 Programming Tools

- **Arduino IDE**

11. Calibration and Testing

11.1 Sensor Calibration

Calibration is performed using standard solutions to ensure:

- Accurate measurement
- Correct conversion from raw voltage to TDS values

Values were adjusted in code based on multiple trials.

11.2 Testing Procedure

1. Place TDS sensor in different water samples.
2. Verify readings against known standards.
3. Adjust calibration constants.
4. Test IoT uploading and dashboard reception.

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12. Results

The system:

- Displays real-time TDS values on LCD.
- Sends readings to an IoT dashboard with timestamps.
- Maintains accurate data after calibration.

13. Discussion

The system achieved real-time monitoring with feedback both locally and online. The modular structure allows adding sensors or analytics features easily. Calibration was critical to ensure precision. IoT connectivity expanded the usability by allowing remote monitoring anywhere, anytime.

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14. Conclusion

The **Water Quality Control System (IoT)** successfully met its objectives. It provides automated, real-time monitoring of water quality and enables remote data access through the internet. This system can serve educational, environmental, and practical monitoring needs, and can be further enhanced with additional features.

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15. Future Work

Future improvements may include:

- **Multi-parameter sensing**: pH, turbidity, temperature
- **Alert notifications** (SMS/email) based on unsafe levels
- **Mobile dashboard app**
- **Power optimization and waterproof housing for outdoor use**

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16. References

- Arduino Documentation
- Sensor datasheets and calibration manuals
- IoT platform API documentation