Water Quality Monitoring System Using TDS

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INTRODUCTION

- Water quality is essential for health and the environment, but traditional testing methods for dissolved solids are often expensive and time-consuming.

- Total Dissolved Solids (TDS) indicate the concentration of dissolved salts and minerals in water, which affects its taste, safety, and suitability for use.

- High TDS levels can indicate contamination or excessive minerals and must be monitored to ensure water is safe for consumption.

- This project introduces a simple TDS detection system using an ESP32 and a TDS sensor, which measures TDS values and provides real-time data on a laptop for monitoring and analysis.

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LITERATURE REVIEW

SL	Paper Title	Key Outcome	Author and Year
1	Water Quality Monitoring Using Embedded Controller ESP32	Built a system that monitors TDS in real time with IoT support; but wirelessly transmitting data increases power consumption and dependency on network infrastructure.	K. Lakshmi et al., 2025
2	Utilization of TDS Sensors for Aquaculture Pools using IoT	Achieved high accuracy (98 percent for TDS) in measuring dissolved solids in aquatic systems; but complexity increases when filtering or calibration drift occurs over time.	Sulistiyanto et al., 2025
3	Sustainable IoT Architecture for Real-Time Water Quality Assessment Using ESP-NOW	Demonstrated low-power, rural-area monitoring using p2p protocol, reducing reliance on WiFi; but still includes other sensors and requires periodic calibration for TDS sensors.	Ananya, Shirol et al., 2025

LITERATURE REVIEW

SL	Paper Title	Key Outcome	Author and Year
4	IoT-Based Water Quality Monitoring System using ESP32	Provides 24/7 TDS, pH, and temperature monitoring via ESP32 and mobile app, **but** many readings vary in accuracy under changing environmental conditions and calibration drift over time.	R. R. Bhambare,, et al., 2024
5	Measurement of Total Dissolved Solids and Total Suspended Solids: A Review	Studies highlight remote sensing and field methods; but field methods are laborious with limited coverage, while remote sensing cannot directly measure TDS due to optical inactivity.	Adjovu G. E. et al., 2023
6	TDS Sensor Based Automatic Nutrient Feeding System for Hydroponics	Prototype optimizes nutrient control with TDS sensors and automated relay, but added hardware and sensor dependencies make it more complex and costly.	Ade Hendri Hendrawan et al., 2023

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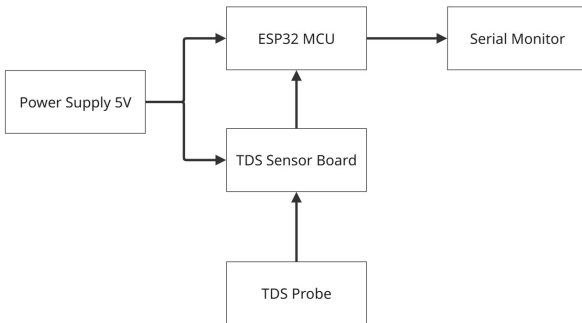(An ISO 9001: 2008 Certified Institution)
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PROPOSED SYSTEM: Block diagram

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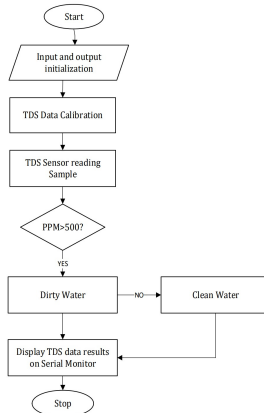Fax: 2307077, E-mail: mail@iesce.info, www.iesce.info

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PROPOSED SYSTEM: Flowchart

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PROPOSED SYSTEM

Input Module:

- **TDS Sensor:** Measures Total Dissolved Solids (ppm).
- Water sample applied to the sensor probe.
- Provides analog signal to ESP32.

Processing Unit:

- **ESP32 Microcontroller:**
  - Reads TDS sensor values.
  - Converts analog data to TDS (ppm).
  - Sends processed data to output module.

PROPOSED SYSTEM

Output Module:

- **Laptop Serial Monitor:**
  - Displays real-time TDS values (in ppm) through the Arduino IDE serial monitor.
  - Allows easy observation and logging of water quality data.

- **Alternative Options:**
  - Data can also be displayed on an LCD display, OLED screen, or sent to cloud platforms/dashboards for remote monitoring.

SURVEY

Aspect	Traditional Methods	Proposed ESP32-Based System
Technology Used	Lab-based TDS meters and spectrophotometers	ESP32, TDS sensor kit, laptop (serial monitor)
Detection Method	Manual water sampling and laboratory testing	Real-time TDS detection using sensor probes and analog-to-digital conversion
Features Extracted	TDS values (ppm) from precise lab instruments	TDS values (ppm) displayed on laptop, with options for LCD/OLED or cloud monitoring
Cost and Accessibility	Expensive, time-consuming, requires lab setup	Low-cost, portable, easy to use for field or rural applications

WORKING

- The system uses a **TDS sensor** to measure the concentration of dissolved solids in water, expressed in **ppm**.
- The TDS sensor probe detects the **electrical conductivity** of the water, which is directly related to the dissolved salt and mineral content.
- Sensor readings are sent as **analog signals** to the **ESP32**, which converts them into digital TDS values.
- The ESP32 processes the data and calculates the TDS level in **ppm**.
- The results are displayed in real time on the **laptop serial monitor**, with options for output to LCD/OLED or cloud platforms for extended monitoring.

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APPLICATIONS

- **Drinking Water Testing:** Ensures water has safe TDS levels for households, schools, and rural communities.

- **Agriculture:** Monitors irrigation water quality to protect crops and soil health.

- **Aquaculture and Fish Farming:** Maintains optimal water quality for aquatic life by monitoring dissolved solids.

- **Industrial and Wastewater Monitoring:** Checks TDS levels in small-scale industries or treatment plants before discharge.

- **Educational Projects:** Useful for learning IoT, sensors, and environmental monitoring with ESP32.

CHALLENGES

- **Sensor Accuracy:** TDS readings can vary due to temperature changes, electrical noise, or unstable water samples.

- **Calibration Requirement:** The TDS sensor requires proper calibration for reliable and consistent results.

- **Water Type Variation:** A single TDS threshold may not be suitable for all water sources (drinking, irrigation, aquaculture).

- **Limited Parameter Detection:** The system only measures TDS and does not account for other factors like pH, turbidity, or dissolved oxygen.

ADVANTAGES

- **Low Cost:** Built with inexpensive and readily available components.
- **Real-Time Results:** Displays TDS values instantly on the laptop serial monitor.
- **Easy to Implement:** Simple design using ESP32 and TDS sensor kit.
- **Flexible Output Options:** Data can be shown on a laptop, LCD/OLED, or sent to the cloud.
- **Portable:** Compact and suitable for use in rural or remote locations.

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FUTURE SCOPE

- **Multiple Parameters:** Integrate additional sensors (pH, temperature, turbidity, dissolved oxygen) for comprehensive water quality analysis.
- **Wireless Monitoring:** Use ESP32's built-in Wi-Fi/Bluetooth to send data to a mobile app or cloud dashboard.
- **Smart Automation:** Connect with water treatment or filtration systems to automatically respond to poor water quality.
- **Renewable Power:** Deploy as a solar-powered portable unit for rural and outdoor applications.

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CONCLUSION

- A simple and low-cost water quality monitoring system was developed using ESP32 and a TDS sensor.
- The system provides real-time TDS readings (in ppm) through the laptop serial monitor, with options for extended outputs (LCD/OLED or cloud).
- It is suitable for drinking water testing, agriculture, aquaculture, industrial monitoring, and educational purposes.
- The system is effective, portable, and practical for deployment in rural and remote areas.

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