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WATER QUALITY MONITORING SYSTEM

Shantanu Kamthe[1], Kedar Khamkar[2], Rohit Lawand[3], Prof. Chetana Jain[4]

[1 2 3 4] Department of ENTC Trinity Academy of Engineering Pune, India

ABSTRACT–

The quality of water is crucial for sustaining a healthy lifestyle. This project involves the creation of an affordable and compact water quality monitoring system utilizing a TDS (Total Dissolved Solids) sensor along with a NodeMCU microcontroller ESP8266. The system continuously tracks the TDS levels in water to assess its purity and shows the results on a 0.96-inch OLED display. The TDS sensor generates an analog signal that is proportional to the concentration of dissolved solids in the water. This signal is processed by the NodeMCU, which computes the TDS value in parts per million (ppm). Depending on the calculated value, the system determines whether the water is classified as "Good" or "Not Healthy" and reflects this classification on the OLED screen. The implementation of the OLED display with I2C communication facilitates effective data visualization while utilizing minimal GPIO pins. The system is neatly assembled on a dot PCB to ensure stability and ease of transport. This solution is suitable for both home and small-scale industrial uses where real-time monitoring of water quality is vital. Furthermore, the system can be enhanced for IoT-based data logging with the integrated Wi-Fi capability of the NodeMCU, allowing for remote monitoring and notifications.

Keywords: Water quality monitoring, TDS sensor, NodeMCU ESP8266, OLED display, real-time monitoring, ppm, dissolved solids, IoT.

I. INTRODUCTION

Ensuring access to clean drinking water is crucial for health and wellness, particularly given the increasing worry about water pollution and contamination. Real-time monitoring of water quality is vital to guarantee that the water is safe for drinking. This project aims to create a compact and affordable system for monitoring water quality that utilizes a TDS (Total Dissolved Solids) sensor alongside a NodeMCU ESP8266 microcontroller. The TDS sensor gauges the level of dissolved impurities in water and sends an analog signal, which the NodeMCU processes to determine the TDS value in parts per million (ppm). The resulting value is shown on a 0.96-inch OLED screen, giving users a straightforward indication of water purity. If the TDS levels surpass a predetermined limit, the system signals that the water is not safe for usage. The complete circuit is affixed to a dot PCB board to enhance portability and stability. Utilizing the NodeMCU also opens up possibilities for IoT integration, enabling the system to upload data to cloud platforms for remote monitoring and long-term evaluation. This makes the project well-suited for domestic, educational, and minor industrial uses.

II. LITERATURE REVIEW

The paper by Kartik Maheshwari and Adrija Chakraborty, titled "Water Quality Monitoring System Implemented With IoT," presents an IoT-based system for monitoring various water quality parameters, including TDS and turbidity. The system utilizes an Arduino microcontroller interfaced with an Ethernet shield to process sensor data and upload it to the ThingSpeak IoT platform. Real-time monitoring is facilitated through a dashboard accessible from anywhere, and users receive alerts when water quality parameters exceed predefined thresholds. This approach offers an economical and convenient solution for continuous water quality monitoring.[1]

In the study "Water Quality Monitoring System Using TDS" by M. Likith Mahendra, H. Lithik Raj, and Maddela ManiSaketh, an Arduino Uno-based system is developed to measure TDS levels in water. The system provides real-time data via an LCD display or IoT-enabled devices for remote monitoring. It is designed as a low-cost, efficient, and user-friendly solution suitable for households, rural areas, and small-scale industries lacking advanced water testing facilities. The system ensures timely detection of contamination, promoting safe water usage.[2]

The research conducted by Prasant Chettri and colleagues, titled "IoT Based Water Quality Monitoring System Using Arduino Uno R3 & NodeMCU ESP8266," focuses on developing an intelligent IoT-based water quality monitoring system. The system employs a combination of sensors, including pH, TDS, turbidity, temperature, and moisture sensors, integrated with Arduino Uno and NodeMCU ESP8266 microcontrollers. Sensor data is processed and transmitted to cloud platforms for real-time monitoring and analysis. The study emphasizes the system's potential for providing timely alerts and maintaining water quality standards.[3]

III. METHODOLOGY

The water quality monitoring system is designed to measure the Total Dissolved Solids (TDS) in water and display the result on a 0.96-inch OLED screen. The system uses a NodeMCU ESP8266 microcontroller, which offers built-in Wi-Fi capability and sufficient processing power for real-time data acquisition and display. The core sensor used in this project is the TDS sensor, which detects the concentration of dissolved impurities in water and provides an analog voltage output proportional to the TDS level.

The analog signal from the TDS sensor is connected to the A0 pin of the NodeMCU. The microcontroller reads the analog values using the analogRead function. These values are then converted to voltage using the formula: voltage = analog value × VREF / ADC resolution, where VREF is the reference voltage (3.3V for NodeMCU) and ADC resolution is 1024. Based on this voltage, the system estimates the TDS value in parts per million (ppm) using a calibration factor, which can be adjusted according to sensor accuracy and water type.

The calculated TDS value is used to determine the quality of water. If the TDS value is below a defined threshold (e.g., 60 ppm), the water is considered "Good"; otherwise, it is marked as "Not Healthy". This result, along with the TDS value, is displayed on the OLED screen using the Adafruit_SSD1306 and Adafruit_GFX libraries. The display is refreshed every second to show updated readings.

The hardware components are assembled on a dot PCB board for permanent mounting, and jumper wires are used for flexible connections. The system is powered via a USB cable connected to a power bank or computer. The modular design allows for future expansion, such as integrating IoT features for cloud-based monitoring using the NodeMCU's Wi-Fi capabilities.[4]

IV. WORKING

Block Diagram –

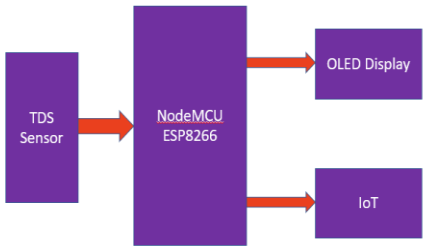

Fig. 1: Block Diagram of Water Quality Monitoring System

The block diagram of the water quality monitoring system consists of the following main components: TDS Sensor, NodeMCU ESP8266, OLED Display, Power Supply (via USB), and the user interface. The TDS Sensor is submerged in water and continuously measures the Total Dissolved Solids. It generates an analog voltage proportional to the concentration of impurities present in the water. This analog signal is fed into the NodeMCU's analog pin (A0). The NodeMCU ESP8266 acts as the central processing unit of the system. It reads the analog data, processes it by converting it into voltage, and then calculates the TDS value in ppm using calibration. Based on the TDS value, the NodeMCU determines whether the water quality is "Good" or "Not Healthy". This result is then sent to a 0.96" OLED Display through I2C communication using SDA and SCL pins. The power supply is provided via a USB cable, making the system portable. This setup offers a simple and real-time monitoring solution for basic water quality analysis.

Schematic Diagram –

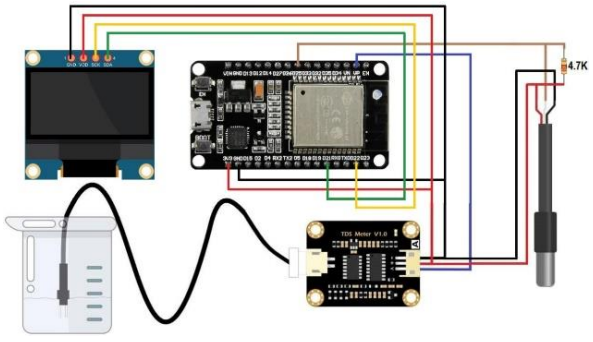

Fig. 2: Schematic Diagram of Water Quality Monitoring System

The circuit diagram consists of the NodeMCU ESP8266 microcontroller connected to a TDS Sensor and an OLED Display. The TDS Sensor has three wires: VCC, GND, and Analog Out. The VCC is connected to the 3.3V pin of the NodeMCU, GND to GND, and the Analog Out is connected to the A0 analog input pin. The OLED Display module uses I2C communication and is connected using only two wires. The SDA (Data) pin of the OLED is connected to D2 (GPIO4) on the NodeMCU, and the SCL (Clock) pin is connected to D1 (GPIO5). The VCC and GND of the OLED are connected to the 3.3V and GND of the NodeMCU respectively. All components are mounted on a dot PCB for reliable connections. Power is supplied through the NodeMCU's micro USB port, which can be connected to a computer or a power bank. This minimal and efficient circuit ensures low power consumption and compactness, ideal for real-time water quality monitoring.[5]

Algorithm –

1. Start the system and initialize serial communication and OLED display.
2. Read analog value from the TDS sensor connected to A0 pin.
3. Convert analog value to voltage using formula: `voltage = analogRead × (3.3 / 1024)`.
4. Calculate TDS value using the calibrated conversion formula.
5. Check if TDS value < threshold (e.g., 60 ppm).
6. If true, set water quality status as "Good".
7. Else, set water quality status as "Not Healthy".
8. Display TDS value and water status on OLED screen.
9. Print data to Serial Monitor for debugging or logging.
10. Wait for 1 second and repeat from step 2.

V. COMPONENTS USED

Following components are used for designing Water Quality Monitoring System:

1. NodeMCU ESP8266:

It is a low-cost Wi-Fi-enabled microcontroller used for reading sensor data and processing it. In this project, it reads analog values from the TDS sensor and controls the OLED display output.

2. TDS Sensor:

This sensor measures the Total Dissolved Solids (TDS) in water and gives analog output based on the concentration of impurities. It helps determine the purity level or quality of the water.

3. 0.96" OLED Display:

A compact display module that communicates with the microcontroller via I2C. It is used to display the real-time TDS value and water quality status.

4. Dot PCB Board:

It is a general-purpose board used for soldering and permanently mounting components for neat and reliable hardware assembly.

5. USB Cable:

Used to power the NodeMCU and upload code from the computer. It also supplies 5V which the board regulates internally.

6. Connecting Wires:

Jumper wires are used to make electrical connections between the components. They allow for flexible and non-permanent wiring of the circuit.

7. Cloud Platform:

A cloud-based service allows the content to be managed and updated remotely.

VI. CONCLUSION

The water quality monitoring system successfully demonstrates a low-cost and efficient method for measuring Total Dissolved Solids (TDS) in water using a TDS sensor and NodeMCU ESP8266. The system provides real-time monitoring and displays the TDS value and water quality status on a compact OLED screen. This portable and easy-to-use setup helps users quickly assess whether water is safe for consumption. The project can be further expanded by integrating IoT capabilities to enable remote monitoring and data logging. Overall, this system offers a practical solution for household or small-scale water quality testing in an accessible and effective manner.

VII. REFERENCES :

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