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IoT Based Drinking Water Quality Monitoring with ESP32

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Abstract: The increasing urbanization and industrialization have led to significant pollution of water resources, posing a serious threat to public health. Ensuring the quality of drinking water is paramount for maintaining human well-being. This paper presents an IoT-based system utilizing the ESP32 microcontroller for real-time monitoring of drinking water quality parameters. The proposed system employs a combination of sensors to measure key water quality indicators such as pH, temperature, turbidity, and conductivity. These sensors are interfaced with the ESP32, which processes the sensor data and transmits it to a cloud platform for remote monitoring and analysis. The ESP32's low- power consumption and Wi-Fi capabilities make it an ideal choice for this application. Experimental results demonstrate the effectiveness of the proposed system in accurately measuring water quality parameters. The data collected from the sensors is visualized on a web-based dashboard, providing users with real- time insights into the drinking water quality. The system's ability to detect anomalies and trigger alertsenables timely intervention to address potential contamination issues. .

I. INTRODUCTION

The IoT-based drinking water quality monitoring system presented in this paper offers a reliable and efficient solution forensuring the safety and purity of drinking water. By leveraging the capabilities of the ESP32 and cloud-based technologies, thissystem can contribute to improving public health and environmental sustainability.The primary problem addressed in this project is the lack of real-time monitoring and efficient management of drinking water quality, particularly in areas affected by urbanization and industrialization. Specific challenges include contamination from industrial effluents, agricultural runoff, and other pollutants, delayed detection due to traditional testing methods, and limited accessibility in remote or underserved areas. This project aims to address these challenges by developing an IoT-based system that can provide real-time monitoring, early detection of contaminants, and improved access to water quality data.

II. LITERATURE SURVEY

The integration of Internet of Things (IoT) technology with water quality monitoring systems has garnered significant attention in recent years. Numerous studies have explored thepotential of IoT to address the limitations of traditional methods, such as delayed detection and limited accessibility.

A. *Key Findings from Existing Research*

1) *Sensor Selection:* Researchers have investigated various sensors to measure water quality parameters, including pH, temperature, turbidity, conductivity, and dissolved oxygen. Common choices include potentiometric, optical, and electrochemical sensors.
2) *IoT Platforms:* The ESP32 microcontroller has emerged as a popular choice for IoT applications due to its low-power consumption, Wi-Fi capabilities, and integration with various sensors.
3) *Data Transmission:* Different communication protocols, suchas Wi-Fi, Bluetooth, and cellular networks, have been employedto transmit sensor data to cloud platforms or local servers. **Cloud-based platforms:** Cloud services like ThingSpeak, AWS IoT, and Google Cloud Platform have been utilized for data storage, processing, and visualization.
4) *Machine Learning:* Machine learning algorithms have been applied to analyze historical water quality data and predict future trends.
5) *Mobile Applications:* Mobile apps have been developed to provide real-time access to water quality data and alerts.

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B. Representative Studies

Zhang et al. (2018): Developed an IoT-based water quality monitoring system using wireless sensor networks. The system successfully monitored temperature, pH, and conductivity.

Li et al. (2020): Proposed an IoT and cloud-based waterquality monitoring system. The system integrated sensors,ESP32, and a cloud platform for data analysis and visualization. 4

Vaishnavi V. Daigavane and Dr. M. A. Gaikwad: Presented an IoT-based water quality monitoring system that measured turbidity, pH, and temperature. The system used ESP32 and cloud-based services for data transmission and analysis.

Overall, the literature suggests that IoT-based drinking water quality monitoring systems using ESP32 offer a promising solution for addressing the challenges of traditional methods. The integration of sensors, IoT platforms, cloud computing, and machine learning enables real- time monitoring,

This survey highlights the convergence of NLP and QNLP, pointing toward improved semantic analysis in auto-generated sentences.

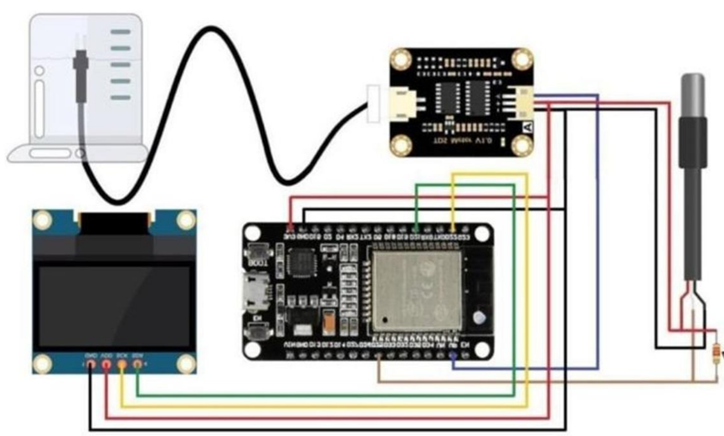
III. ANALYSIS

A. Project Planning and Research

Experimental results demonstrate the effectiveness of the proposed system in accurately measuring water quality parameters. The data collected from the sensors is visualized on a web- based dashboard, providing users with realtime insights into the drinking water quality. The system's ability to detect anomalies and trigger alerts enables timely intervention to address potential contamination issues. The IoT-based drinking water quality monitoring system presented in this paper offers areliable and efficient solution for ensuring the safety and purity of drinking water. By leveraging the capabilities of the ESP32 and cloud-based technologies, this system can contribute toimproving public health and environmental sustainability.

IV. DESIGN

A. Circuit Diagram



B. Methods & Algorithms

Methods and Algorithms for IoT-Based Drinking Water QualityMonitoring Data Acquisition and Processing

1) Sensor selection: Choose appropriate sensors based onaccuracy, precision, and compatibility with the ESP32.
2) Sensor calibration: Regularly calibrate sensors to ensureaccurate measurements.
3) Data sampling: Determine the optimal sampling rate for each sensor based on the desired level of detail and system resources.
4) Data preprocessing: Clean and preprocess sensor data to remove noise, outliers, or missing values. Communication and Data Transmission
5) Protocol selection: Choose a suitable communication protocol (e.g., Wi-Fi, Bluetooth) based on range, data rate, and power consumption requirements

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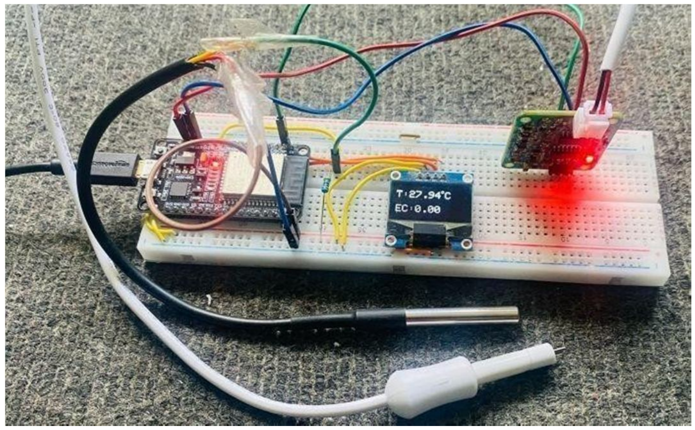
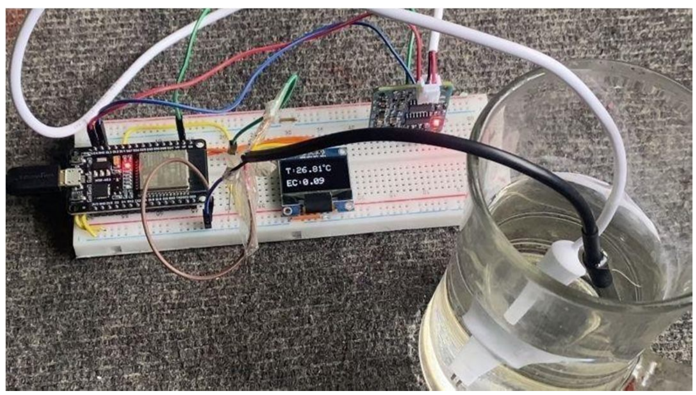
V. DEPLOYMENT AND RESULT

A. Testing and Validation

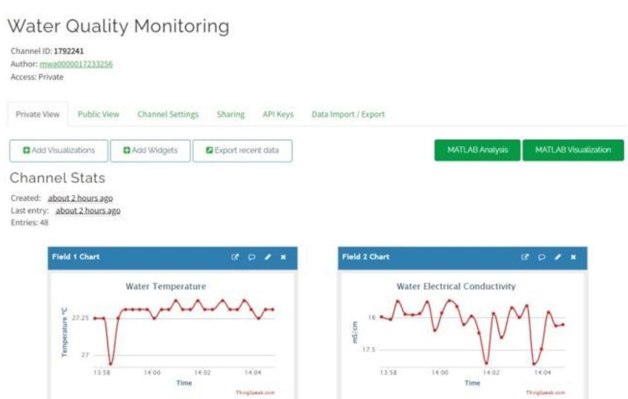


TEST CASE 1- The temperature sensor will show the room temperature. When the TDS Sensor is dry andnot exposed to air,it will show an EC value as zero. You can view these data on OLED Screen.



TEST CASE 2-When the temperature Sensor & TDS Sensor is dipped in water, the OLED will display theEC & Temperature value of the water.

B. Output Screens



You can also monitor the same data on the Thingspeak dashboard. To view the data, go to the Thingspeak private view & you will see the EC & Temperature data getting uploaded after the interval of every 15 seco

VI. CONCLUSION

A. Project Conclusion

The IoT-based drinking water quality monitoring project utilizing the ESP32 microcontroller has successfully demonstrated an effective solution for real-time monitoring of water quality parameters. This system incorporates various sensors to measure critical indicators such as pH, turbidity, temperature, and dissolved oxygen levels.Key Achievements:Real-Time Monitoring: The ESP32's Wi-Fi capabilitiesallowed for continuous data transmission to a cloud server, enabling users to monitor water quality remotely via a web or mobile application.Data Accuracy and Reliability: By integrating high-quality sensors, the system provided accurate readings, allowing for timely detection of water quality issues.User- Friendly Interface: The developed application offered an intuitive interface for users to visualize data trends and receive alerts for any anomalies.Cost- Effectiveness: The use of ESP32 and readily available sensors made the project economically viable, ensuring that water quality monitoring canbe accessible to various communities.Scalability: The modular design of the system allows for easy scalability, making it adaptable for larger networks or different geographical locations.

B. Future Scope

1) Additional Sensor Integration: Incorporating sensors for other parameters (like chlorine or heavy metals) to increase accuracy.
2) Machine Learning: Predictive models to anticipate qualitydegradation trends, enabling proactive maintenance.
3) Improved Connectivity: Leveraging 5G or LPWAN forfaster, large-scale data transmission.
4) Smart City Integration: Combining with urban infrastructureto support widespread public health monitoring.

VII. ACKNOWLEDGEMENT

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