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IoT-BASED REAL-TIME WATER QUALITY MONITORING AND PREDICTIVE ALERT SYSTEM USING ESP32

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ABSTRACT

Water quality monitoring is essential due to increasing contamination from industrialization and urbanization. This paper presents an IoT-based system using ESP32 to monitor parameters such as pH, TDS, turbidity, and temperature in real time. The system displays data locally on an LCD and transmits it to the cloud for remote monitoring. A prediction algorithm estimates the time to reach unsafe conditions, and alerts are generated when thresholds are exceeded. The system provides reliable real-time monitoring with predictive capability for smart water management.

Keywords: Internet of Things, ESP32, Water Quality Monitoring, Cloud Integration, Predictive Analysis, Smart Sensing System.

I. INTRODUCTION

Water is a vital resource, but its quality is affected by contamination and dissolved pollutants. Traditional laboratory methods are not suitable for continuous monitoring due to delay and manual effort. To overcome this, an IoT-based water quality monitoring system using ESP32 is proposed. The system enables real-time monitoring, cloud connectivity, and early prediction of unsafe conditions.

II. LITERATURE SURVEY

Several systems have been developed for water quality monitoring using Arduino and wireless technologies, mainly focusing on real-time data acquisition and alert generation. However, these systems lack cloud storage and predictive analysis capabilities. Recent IoT-based systems provide remote monitoring but still rely on basic threshold alerts. The proposed system overcomes these limitations by integrating cloud monitoring with moving average filtering and trend-based prediction. It also includes LCD display and buzzer alerts for local monitoring, improving system reliability and efficiency.

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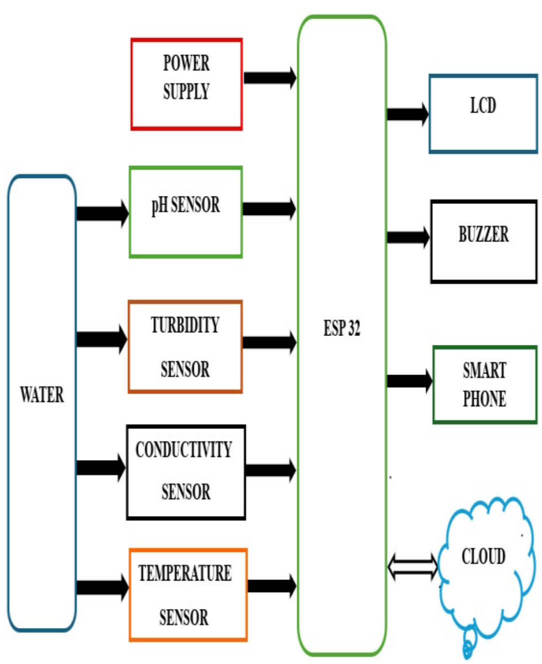
III. PROPOSED SYSTEM

The proposed system consists of multiple sensing units connected to an ESP32 microcontroller. The sensors measure water parameters and transmit analog/digital signals to the controller. The microcontroller processes the data and displays real-time values on an LCD module.

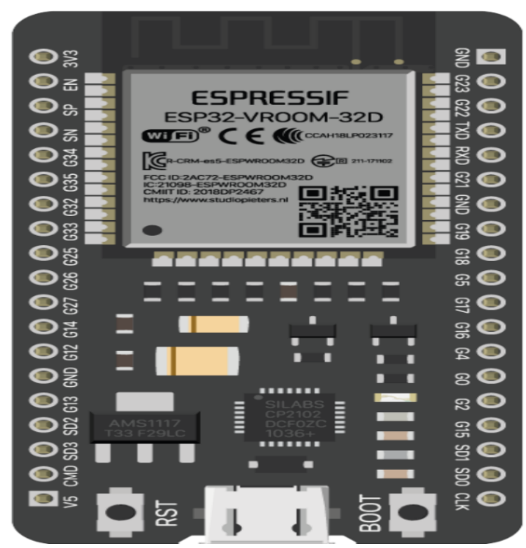
Using built-in Wi-Fi, the ESP32 uploads data to the Blynk cloud platform. The cloud dashboard allows remote visualization and monitoring through a smartphone or web interface. A prediction module continuously analyzes TDS variation. By calculating the rate of change of TDS values, the system estimates the remaining time before reaching the unsafe threshold.



The hardware architecture consists of sensing, processing, display, and alert units integrated into a compact embedded system.

A. ESP32 Microcontroller

ESP32 acts as the central processing unit of the system. It features dual-core processing, built-in Wi-Fi, multiple ADC channels, and low power consumption. The controller reads analog signals from sensors, performs data conversion, and transmits processed values to the cloud.



B. pH Sensor Module

The pH sensor measures hydrogen ion concentration in water. It operates based on electrochemical principles and generates a voltage proportional to pH value. The signal conditioning circuit converts the analog signal into a readable range for the ESP32 ADC.

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C. TDS Sensor

The TDS sensor measures the concentration of dissolved substances such as salts and minerals in water, expressed in ppm. It works based on electrical conductivity, where dissolved ions increase the conductivity of water. Higher conductivity indicates higher TDS levels and more impurities.

D. Turbidity Sensor

The turbidity sensor measures the clarity of water by detecting suspended particles, expressed in NTU. It works on the light scattering principle, where particles scatter light emitted by an infrared source, and the scattered light is detected by a photodiode. Higher turbidity indicates more impurities in water.

E. Temperature Sensor (DS18B20)

The temperature sensor measures water temperature, which affects chemical reactions and sensor accuracy. The DS18B20 sensor provides accurate digital temperature readings using a one-wire communication protocol. It is reliable and easy to interface with microcontrollers like ESP32.

F. LCD Display

The LCD module displays real-time water quality parameters such as pH, TDS, turbidity, temperature, and system status. It

receives data from the microcontroller and shows it as text on the screen. LCDs are widely used due to low power consumption and easy interfacing.

G. Buzzer

The buzzer is used to provide an audible alert when water quality exceeds safe limits. The microcontroller activates the buzzer based on threshold conditions, enabling quick detection of unsafe water.

H. Trend-Based TDS Prediction

The system predicts future TDS values using moving average and rate of change.

1.Moving Average formula:

TDS_avg = (TDS1 + TDS2 + TDS3 + ... + TDSn) / n

2. Rate Of Change(ROC):

ROC = (TDS_current - TDS_previous) / Δt

3.Time To Unsafe Condition:

Time = (TDS_threshold - TDS_current) / ROC

The moving average reduces noise, and the rate of change determines TDS variation. Based on this, the system predicts the time required to reach unsafe levels and generates early alerts.

IV. SYSTEM SETUP AND OUTPUT

A. Hardware Installation

The experimental setup consists of pH, turbidity, TDS, and temperature sensors connected to the ESP32 for real-time water quality monitoring. Analog sensors are read through ADC pins, while the DS18B20 uses one-wire communication. A 16×2 LCD displays sensor values, and a buzzer provides alerts for unsafe conditions. The system is programmed using Arduino IDE and continuously processes sensor data.

B. Sensor Data Acquisition

The system continuously collects water quality data using pH, turbidity, TDS, and temperature sensors. Each sensor measures a specific parameter and sends data to the ESP32. The microcontroller processes these readings into pH, turbidity, TDS (ppm), and temperature (°C) values.

C. Cloud Data Transmission

The ESP32 microcontroller is equipped with built-in Wi-Fi connectivity which allows the system to transmit the measured sensor values to the Blynk IoT

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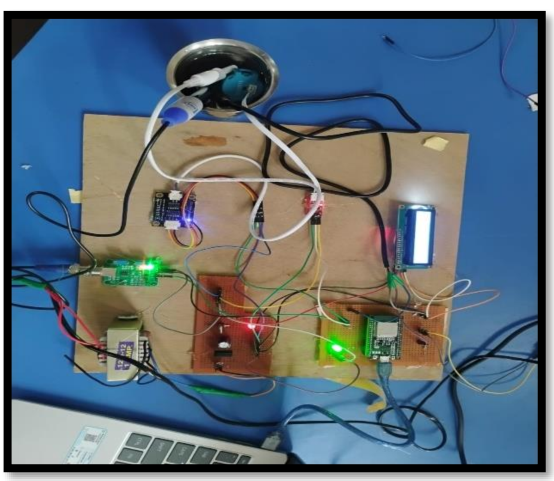
cloud platform. The Blynk dashboard displays the sensor readings in real time using graphical widgets and gauges. Users can monitor water quality parameters remotely through the Blynk mobile application.

In addition to displaying sensor values, the system also sends alert notifications to the user when the water quality exceeds predefined safety limits.

D. LCD Display Output

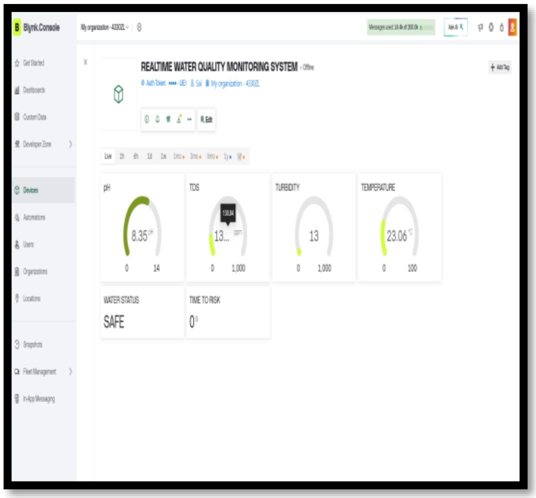
The system also provides local monitoring using a 16×2 LCD display. The LCD screen displays the measured sensor values including pH, turbidity, TDS, and temperature. The LCD display also indicates the overall water quality status as SAFE or UNSAFE based on predefined threshold values.

V. RESULTS



The experimental setup consists of an ESP32 microcontroller connected with pH, turbidity, TDS, and temperature sensors. These sensors measure water parameters and send data to the ESP32. The processed values are displayed on an LCD and transmitted to the cloud for remote monitoring.

The LCD display module is used to show real-time water quality parameters measured by the sensors. The ESP32 sends processed sensor data to the LCD through the I2C interface. The display shows parameters such as pH value, TDS level in ppm, turbidity level in NTU, and water temperature in degrees Celsius. The LCD also displays the water quality status as SAFE or UNSAFE based on predefined threshold values. This allows users to easily understand the condition of water locally without accessing the cloud dashboard.



The ESP32 sends sensor data to the Blynk cloud platform via Wi-Fi. Users can monitor water parameters remotely through a mobile app. Alerts are generated when values exceed safe limits, and prediction helps estimate future unsafe conditions.

Experimental Result Table

Sample	pH	TDS	Turbidity
Sample 1	6.8	83	57
Sample 2	7.1	95	40
Sample 3	6.3	520	65

The experimental results indicate that the proposed system successfully measures and monitors water quality parameters in real time. The system is capable of identifying unsafe water conditions and generating alerts through both local and cloud-based interfaces.

VI. CONCLUSION

The proposed IoT-based water quality monitoring system using the ESP32 microcontroller was successfully designed and implemented. The system integrates multiple sensors including pH sensor, turbidity sensor, TDS sensor, and temperature sensor to measure important water quality parameters.

The ESP32 collects sensor data and processes it to determine the quality of water. The measured values are displayed on a 16×2 LCD display for local monitoring and are simultaneously transmitted to the Blynk cloud platform for remote monitoring through a smartphone application.

An alert mechanism using a buzzer and cloud notification is implemented to notify users when water parameters exceed safe limits. This helps in quickly identifying unsafe water conditions and prevents potential health risks.

In addition, a trend-based prediction algorithm is incorporated in the system to estimate the time required for water to become unsafe based on the rate of change of TDS values. This predictive feature improves the reliability of the monitoring system by providing early warning alerts.

The experimental results demonstrate that the proposed system is efficient, low-cost, and capable of providing reliable real-time monitoring of water quality. The system can be applied in various applications such as drinking water monitoring, environmental monitoring, and smart water management systems.

VII. REFERENCES

[1] World Health Organization, Guidelines for Drinking Water Quality, WHO Press, Geneva, Switzerland.

[2] S. Sharma and R. Kumar, "IoT Based Water Quality Monitoring System Using ESP32," International Journal of Smart Environmental Systems, 2021.

[3] Arduino Documentation, "Arduino Integrated Development Environment," Available: https://www.arduino.cc

[4] Blynk Inc., "Blynk IoT Platform Documentation," Available: https://blynk.io

[5] D. Brown, Smart Sensor Technologies for Environmental Monitoring, Springer Publications, 2020.

[6] A. Kumar et al., "Wireless Sensor Network Based Water Monitoring System," IEEE Conference on Smart Technology, 2019.

[7] P. Singh and R. Gupta, "Real-Time Water Quality Monitoring Using IoT Sensors," International Journal of Environmental Engineering, 2022.