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SMART WATER QUALITY MONITORING USING IOT

Rajesh M[1], Dr. K. Thenmozhi[2]

Student, Department of Information Technology, Dr. N.G.P Arts and Science College, Coimbatore[1]

Assistant Professor, Department of Information Technology, Dr. N.G.P Arts and Science College, Coimbatore[2]

Abstract: Water quality is critical for public health, agriculture, and industrial processes. Traditional monitoring relies on manual sampling and laboratory analysis, which is time-consuming, costly, and unable to provide real-time data. This project presents a Smart Water Quality Monitoring System using IoT technology, integrating a pH sensor and flow sensor with an ESP32 microcontroller. Sensor data is displayed on an LCD and transmitted via WiFi to a cloud platform for real-time remote monitoring. The system is cost-effective, automated, and scalable, enabling continuous monitoring, early contamination detection, and proactive water management for domestic, industrial, and municipal use.

Keywords: IoT, ESP32, pH Sensor, Flow Sensor, Water Quality, Real-Time Monitoring, Cloud Platform, Blynk.

I. INTRODUCTION

The Smart Water Quality Monitoring System using IoT provides an automated, real-time solution for ensuring safe water in domestic, agricultural, and industrial environments. Traditional water testing methods depend on periodic manual sampling and laboratory analysis, which are time-consuming, costly, and fail to detect sudden contamination. The proposed system addresses these limitations using an ESP32 microcontroller interfaced with a pH sensor and flow sensor, enabling continuous monitoring of water parameters.

Sensor data is processed by the ESP32, displayed on a local LCD screen, and transmitted via WiFi to a cloud platform accessible through web or mobile applications. Threshold-based alerts notify users of unsafe water conditions immediately, enabling quick corrective action. This system promotes public health, environmental protection, and efficient water resource management.

II. SYSTEM STUDY

a. EXISTING SYSTEM

Current water quality monitoring relies on periodic manual sampling and laboratory analysis. While accurate, this method is slow, labor-intensive, and unable to detect sudden quality changes between sampling intervals. The absence of real-time monitoring, remote access, and automated alerts makes traditional systems reactive rather than proactive, delaying contamination response and increasing health risks.

b. PROPOSED SYSTEM

The proposed Smart Water Quality Monitoring System uses an ESP32 microcontroller as its core, interfaced with a pH sensor, flow sensor, LCD display, and WiFi module. It continuously monitors water parameters in real time, comparing sensor readings against predefined safety thresholds. Data is displayed locally on the LCD and transmitted to a cloud platform via WiFi for remote access. Automatic alerts notify users of abnormal conditions, while data logging enables long-term trend analysis. The modular, scalable architecture supports deployment across homes, industries, agriculture, and municipal networks.

c. ADVANTAGES OF THE PROPOSED SYSTEM

The system provides continuous real-time monitoring, early contamination detection, and remote access via web or mobile applications. It eliminates manual sampling, reducing human effort and operational costs. Automated alerts improve response time, while data logging supports trend analysis and regulatory compliance. The affordable IoT components make it suitable for large-scale deployment, and the modular design allows easy expansion with additional sensors such as turbidity, temperature, or dissolved oxygen.

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III. SYSTEM REQUIREMENTS

a. HARDWARE REQUIREMENTS

Power Supply: 12V 2A regulated switching adapter (100–240V AC input, 5V/3.3V DC output, min. 2A). Provides stable power to the ESP32, sensors, and LCD with over-current and short-circuit protection.

ESP32 Microcontroller: Dual-core Xtensa 32-bit LX6 processor at up to 240 MHz, 520 KB SRAM, 4 MB flash, built-in Wi-Fi (802.11 b/g/n) and Bluetooth 4.2. Provides up to 34 GPIO pins, 18-channel 12-bit ADC, UART/SPI/I2C/PWM interfaces, and multiple low-power sleep modes for efficient IoT operation.

pH Sensor: Measures water acidity/alkalinity over a 0–14 pH range. Operating voltage 3.3– 5V DC, analog output proportional to pH, accuracy ±0.1–0.2 pH, response time under 10 seconds. Requires periodic two-point calibration using pH 4 and pH 7 buffer solutions.

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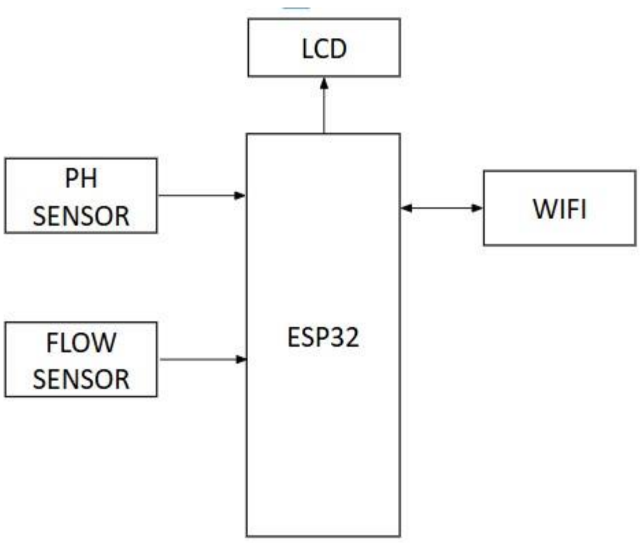
Flow Sensor (YF-S201): Hall-effect sensor measuring water flow rate from 1–30 L/min. Operating voltage 5V DC, digital pulse output proportional to flow, accuracy ±5%. Detects leaks, blockages, and abnormal flow in pipelines. Compact, corrosion-resistant design. LCD Display (16×2): Character display showing real-time pH and flow readings. Operates at 5V, I2C or parallel interface, wide viewing angle with LED backlight. Displays system status and alert messages for on-site monitoring.

Supporting Components: Jumper wires, breadboard, 10kΩ pull-up resistors, 220Ω current limiting resistors, capacitors (100µF, 0.1µF), mounting hardware, and weatherproof enclosures for stable field deployment.

IV. SYSTEM DESIGN

a. BLOCK DIAGRAM



b. WORKING PRINCIPLE

On power-up, the ESP32 initializes all sensors, establishes a Wi-Fi connection, and activates the LCD. The pH sensor continuously measures water acidity while the flow sensor monitors flow rate and detects irregularities. The ESP32 processes sensor data against predefined thresholds. When values exceed safe limits, the system triggers alerts, updates the LCD with warning messages, and transmits real-time data to the cloud via Wi-Fi. This enables early contamination detection, remote monitoring, and proactive water management.

c. APPLICATION MODEL

The system supports both local and remote monitoring. The LCD provides on-site real-time readings and alert messages. The web-based dashboard offers graphical visualization of pH and flow data, historical trend analysis, threshold-based alerts, and secure access for authorized users. Mobile application integration enables push notifications, remote sensor data access, and location-based monitoring across multiple sites.

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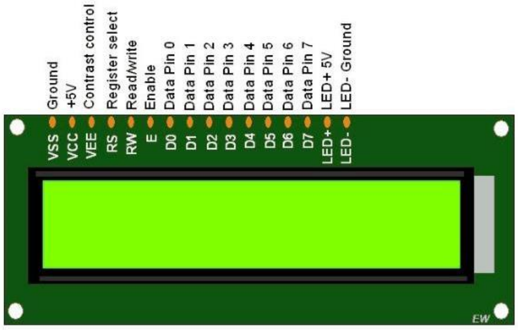

V. TESTING AND IMPLEMENTATION

Unit testing validated each component independently: the pH sensor was tested using standard buffer solutions, the flow sensor was verified at different flow rates, and the ESP32 was tested for correct GPIO interfacing and serial communication. Integration testing confirmed seamless interaction between all components, including real-time LCD display updates and reliable Wi-Fi data transmission to the cloud. Performance testing measured sensor response time, accuracy, and stability under continuous operation. Sensor readings were compared against reference instruments to validate reliability.

Implementation followed six phases: (1) System planning and threshold definition based on water safety standards; (2) Hardware assembly with sensor installation and ESP32 interfacing; (3) Firmware development for sensor reading, threshold comparison, LCD display, and cloud transmission; (4) Full system integration and end-to-end validation; (5) Sensor calibration and threshold fine-tuning; (6) Deployment and continuous monitoring with scheduled maintenance and recalibration.

VI. CONCLUSION

The Smart Water Quality Monitoring System successfully demonstrates a cost-effective, automated IoT solution for real-time monitoring of pH and flow rate. Integration of sensors with the ESP32 and cloud connectivity enables continuous data collection, instant anomaly detection, and both local and remote monitoring. The system reduces dependence on manual testing, improves response time to contamination events, and supports sustainable water management. Its modular, scalable design makes it suitable for smart cities, industries, agriculture, and rural deployments, with scope for expansion to additional parameters such as turbidity, temperature, and dissolved oxygen.

VII. SCOPE FOR FUTURE ENHANCEMENTS

Future enhancements include integrating additional sensors (turbidity, TDS, dissolved oxygen, temperature) for comprehensive water quality analysis. Incorporating AI and Machine Learning can enable predictive contamination detection, automated anomaly classification, and optimized water distribution. Advanced mobile and web dashboards with real-time visualization and multi-site centralized monitoring will improve user interaction. Security enhancements such as data encryption, user authentication, and fault-tolerant communication, combined with solar power and battery backup, will ensure robust and scalable deployment across smart city and rural water management networks.

BIBLIOGRAPHY

[1] A. Kumar, A. K. Sharma, and R. Singh, "IoT-Based Smart Water Quality Monitoring System," Procedia Computer Science, vol. 171, pp. 210–217, 2020.

[2] S. Geetha and S. Gouthami, "Internet of Things Enabled Real-Time Water Quality Monitoring System," Smart Water, vol. 5, no. 1, pp. 1–11, 2020.

[3] N. Vijayakumar, R. Karthikeyan, and S. Suresh, "Design of IoT Based Water Quality Monitoring System Using Sensors," Int. J. Eng. Adv. Technol., vol. 9, no. 4, pp. 1832–1836, 2020.

[4] A. Alahi, A. Mukhopadhyay, and S. Ghosh, "An IoT Based Smart Water Quality Monitoring System," IEEE Sensors Journal, vol. 21, no. 12, pp. 13475–13484, 2021.

[5] P. P. Ray, "Internet of Things for Smart Water Management: A Review," IEEE Internet of Things Journal, vol. 8, no. 14, pp. 11320–11336, 2021.

DOI: 10.17148/IARJSET.2026.13376

[6] R. Priyadarshini, S. Kumar, and M. Ramesh, "Real-Time Water Quality Monitoring Using IoT and Cloud Platform," Int. J. Scientific & Technology Research, vol. 10, no. 1, pp. 105–109, 2021.

[7] S. K. Sood and I. Mahajan, "Smart Water Monitoring System Using IoT Technologies," Journal of Cleaner Production, vol. 276, pp. 124–132, 2021.

[8] M. K. Gupta and R. Verma, "IoT-Based Water Pollution Monitoring and Control System," Environmental Technology & Innovation, vol. 23, pp. 101–109, 2021.

[9] A. K. Jaiswal, P. Mishra, and R. Tiwari, "Development of ESP32 Based Smart Water Quality Monitoring System," Int. Conf. on Emerging Smart Computing & Informatics, pp. 421–426, 2021.

[10] S. Chatterjee and A. K. Kar, "Smart Water Quality Monitoring Using IoT and Cloud Computing," IEEE Access, vol. 9, pp. 45025–45035, 2021.

[11] M. S. Sanya, M. A. Alawi, and I. Eugenio, "Design and Implementation of Smart Water Quality Monitoring System Using IoT," Int. J. Advanced Science, Research and Engineering, vol. 8, no. 3, pp. 1–10, 2022.

[12] R. S. Kumar and P. Balaji, "IoT Enabled Water Quality Assessment System Using pH and Flow Sensors," Materials Today: Proceedings, vol. 62, pp. 3715–3721, 2022.

[13] Z. Zulkifli et al., "IoT-Based Water Monitoring Systems: A Systematic Review," Water, vol. 14, no. 22, pp. 1–19, 2022.

[14] A. Karthik, M. Gokul, and S. Praveen, "Cloud-Connected IoT Framework for Water Quality Monitoring," Int. J. Distributed Sensor Networks, vol. 18, no. 5, pp. 1–12, 2022.

[15] S. R. Patil and D. P. Kadam, "Design of Low-Cost IoT-Based Water Quality Monitoring System," Int. J. Computer Applications, vol. 184, no. 44, pp. 20–25, 2022.

[16] D. N. Suriya and S. V. Kumar, "IoT Based Water Quality Monitoring System," Journal of Sustainable Wireless Systems, vol. 5, no. 1, pp. 30–39, 2023.

[17] A. R. Prakash, S. S. Rao, and V. R. Kumar, "Smart Water Quality Monitoring Using ESP32 and IoT," Int. Conf. on Smart Systems and Inventive Technology, pp. 512–517, 2023.

[18] R. Nandhini and K. S. Kumar, "Water Quality Monitoring Using IoT and Machine Learning," Journal of Ambient Intelligence and Humanized Computing, vol. 14, pp. 1043– 1054, 2023.

[19] M. A. Murti et al., "Smart System for Water Quality Monitoring Utilizing Long-Range IoT," Applied Water Science, vol. 14, no. 69, pp. 1–12, 2024.

[20] Y. Singh and T. Walingo, "Smart Water Quality Monitoring with IoT Wireless Sensor Networks," Sensors, vol. 24, no. 9, pp. 2871–2882, 2024.

[21] E. H. Irawan, N. Nurchim, and Wijiyanto, "Prototype of Household Water Quality Monitoring System Using IoT," J. Inotera, vol. 9, no. 2, pp. 45–52, 2024.

[22] S. M. Rahman and M. H. Rahman, "IoT-Enabled Smart Water Quality Monitoring for Smart Cities," Sustainable Cities and Society, vol. 99, pp. 104–112, 2024.

[23] A. A. Bakar et al., "IoT-Based Real-Time Water Quality Monitoring and Sensor Calibration," Int. J. Interactive Mobile Technologies, vol. 19, no. 1, pp. 155–170, 2025.

[24] P. R. Nair and K. J. Mathew, "Secure IoT Framework for Water Quality Monitoring Systems," IEEE Internet of Things Journal, vol. 12, no. 2, pp. 2451–2462, 2025.

[25] S. Patel, N. Shah, and R. Mehta, "AI-Assisted IoT Framework for Smart Water Quality Monitoring," IEEE Access, vol. 13, pp. 102345–102357, 2025.

