International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 04 Issue: 08 August 2026
Page No: 5254 - 5259
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2026.0687

Intelligent Multi-Sensor IoT Framework for Predictive Flood Risk Assessment and Smart Dam Safety

Priyadarshinee Das[1], Rasmita Lenka[2], Pragyanjit Jena[3], Abhishek Rout[4], Beda Prakash Rohidas[5]
[1,2,3]Assistant Professor, Dept. of EE, Radhakrishna Institute of Technology and Engineering (RITE), Bhubaneswar, 752057, India
[4,5]UG- Dept. of EE, Radhakrishna Institute of Technology and Engineering (RITE), Bhubaneswar, 752057, India
Emails: *pdas.ee@riteindia.edu.in[1], rlenka.ece@riteindia.edu.in[2], pragyanjitjenaee@riteindia.edu.in[3], routabhi.2004@gmail.com[4], bedaprakashrohidas@gmail.com[5]*

Abstract
Floods associated with intense rainfall, rapid water-level rise, and sudden dam discharge pose serious risks to communities, infrastructure, agriculture, and the environment. Conventional flood alert systems generally rely on predefined water-level thresholds and therefore respond only after a critical condition has occurred. This paper presents an intelligent Internet of Things (IoT) framework that combines real-time water-level monitoring with machine-learning-based flood-risk classification for smart dam safety. The proposed system is developed from an existing IoT flood-alert prototype using a NodeMCU ESP8266, multi-level water sensors, LCD display, buzzer, and Wi-Fi communication. The original threshold-based monitoring mechanism is extended with a Random Forest (RF) classifier to provide intelligent classification of water conditions into Normal, Warning, and Critical states. The sensor layer continuously acquires water-level information, while the ESP8266 performs local processing and communicates the observations through Wi-Fi. A structured dataset containing sensor-state features and corresponding flood-risk labels is used for model development. The Random Forest approach is selected because of its ability to model nonlinear relationships, handle categorical and numerical features, and provide computationally efficient inference. The resulting framework combines local safety alerts with remote IoT monitoring and predictive analytics. The proposed architecture provides a practical pathway for transforming a low-cost threshold-based flood alert prototype into an intelligent early-warning system. The reported prototype observations confirm correct detection of low, medium, and highwater conditions and immediate activation of the danger alarm. Quantitative machine-learning performance should be reported only after validation using a sufficiently large measured dataset collected from the deployed system.

Keywords: *Internet of Things, Artificial Intelligence, Random Forest, Flood Risk Prediction, Smart Dam, Water-Level Monitoring, NodeMCU ESP8266, Early Warning System, Machine Learning.*

1. Introduction
Floods caused by excessive rainfall, rising river levels and dam overflow can result in severe damage to human life, infrastructure and the environment. Traditional monitoring methods may depend on manual observation and delayed reporting, limiting the ability to provide timely warnings. IoT technology enables environmental conditions to be monitored continuously and allows data to be communicated for local and remote observation. Conventional flood monitoring systems commonly rely on predefined water-level thresholds to trigger alarms. Although these systems are simple, affordable, and easy to implement, they mainly respond to the water level at the time of detection.

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 04 Issue: 08 August 2026
Page No: 5254 - 5259
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2026.0687

They do not consider how quickly the water level is rising or whether the prevailing conditions may lead to a critical situation in the near future. As a result, warnings may be issued only after the water has already reached a dangerous level, leaving limited time for authorities and nearby communities to take appropriate preventive measures. The proposed system monitors dam water levels using water-level probes and a microcontroller. The measured condition is presented on an LCD display and an alarm is activated when the water level reaches a critical threshold. Wi-Fi communication provides the possibility of transmitting real-time information to a remote platform. The objective is to provide an automated, low-cost and responsive early-warning mechanism that reduces human intervention and supports timely preventive action.

1.1.IoT-Based Flood Monitoring

IoT technology has emerged as a useful approach for continuous monitoring of water levels and flood-related conditions. By connecting sensors with microcontrollers and wireless communication networks, environmental information can be collected continuously and made available for remote monitoring. The system developed in this work follows this approach by integrating water-level sensors with a NodeMCU ESP8266 controller, an LCD display, and Wi-Fi connectivity. The controller processes the sensor information and provides the corresponding water-level status locally through the LCD, while the wireless connection supports remote monitoring. This arrangement reduces the need for constant manual observation and enables a warning to be generated when the water level reaches a critical condition[1 – 10].

1.2.Proposed System

The proposed system comprises water-level sensing probes, a NodeMCU ESP8266, an LCD display, a buzzer, relay/switching components, a regulated power supply, and Wi-Fi connectivity. The sensing probes are positioned at different heights to detect low, medium, and high water levels. When a probe comes into contact with water, its conductive property generates a corresponding signal, which is processed by the NodeMCU to determine the water-level condition. Based on the detected level, the LCD displays the corresponding “Safe,” “Warning,” or “Danger” status, while the buzzer is activated when the water level reaches the predefined critical threshold. The overall operating sequence of the proposed system is summarized as follows: Water Level → Sensor Probes → NodeMCU ESP8266 → Level Classification → LCD/Buzzer → Wi-Fi-Based Monitoring

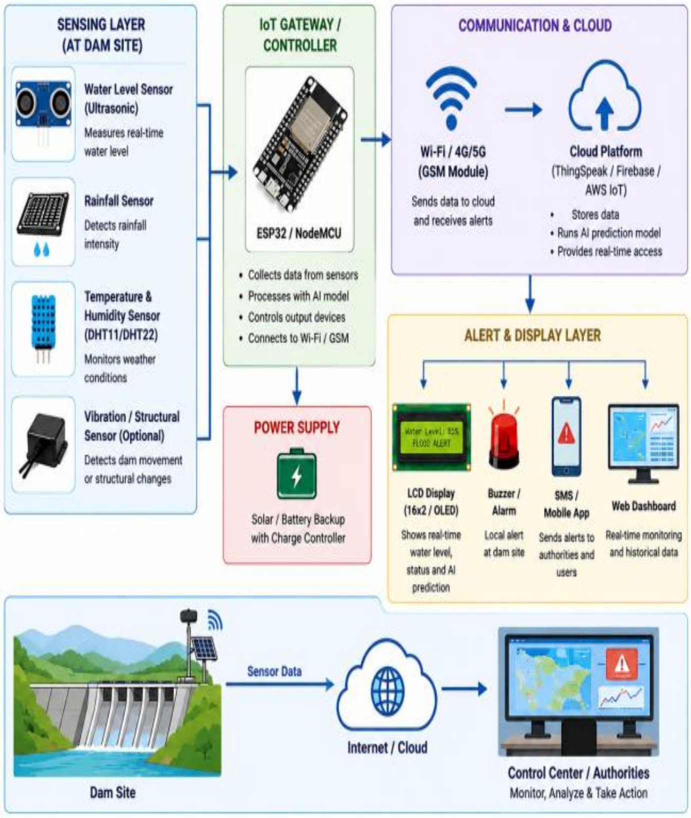

Figure 1 Block diagram of IoT based Flood Alert system for Dam

2. Hardware Components

The proposed IoT-based flood alert system uses a NodeMCU ESP8266 as the main controller, along with water-level sensing probes, an LCD display, a buzzer, relay and switching components, and a regulated power supply. The sensing probes are placed at different levels to detect changes in the water level. Based on the sensor inputs, the NodeMCU identifies[11] the current water-level condition and controls the LCD and buzzer accordingly. Its built-in Wi-Fi connectivity also allows the system to transmit monitoring information for remote IoT-based observation.

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 04 Issue: 08 August 2026
Page No: 5254 - 5259
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2026.0687

Table 1 Component Specification

Component	Specification	Qty.	Function
Diode	1N4007, 1000 V, 1 A	4	Rectification and reverse-polarity protection
Resistor	1 kΩ	2	Current limiting and signal control
Transistor	BC547	1	Switching/control
LED and wires	2–3 V; 24 AWG	3 + required	Visual indication and connections
Capacitor	25 V, 1000 µF	1	Filtering and voltage smoothing
Relay	12 V	1	Switching external load/alarm
LCD	6×2 / project display	1	Local status display
NodeMCU	ESP8266	1	Control and Wi-Fi communication
Buzzer	5–12 V	1	Audible warning
Voltage regulator	7805	1	Regulated 5 V supply

3. Experimental Setup and Working

The experimental setup consists of the water-level probes, NodeMCU ESP8266, LCD, buzzer, relay, power-supply components and connecting wires. The Arduino IDE is used to program and upload the embedded C/C++ code. The probes are connected to digital input pins D5, D6 and D7, while the buzzer is connected to D8. The LCD uses an I2C interface with address 0x27 in the program. During operation, the microcontroller reads the three sensor states and compares them with the predefined conditions. The LCD is cleared and updated according to the detected water level[12]. At the danger condition, the buzzer output is set HIGH. The serial monitor also reports the low, medium and high sensor states. The system is tested by gradually increasing the water level, checking the LCD messages, buzzer operation and Wi-Fi connection.

3.1. Power Supply

The power supply unit supplies the required power to the microcontroller, sensors, display, relay, and buzzer. When the system is operated using an AC mains source, a step-down transformer is used to reduce the input voltage to the required level. The reduced AC voltage is converted into DC through a bridge rectifier and subsequently filtered using a capacitor to minimize voltage fluctuations. A 7805 voltage regulator is then employed to provide a stable 5 V DC supply to the connected circuit components[13].

3.2. Software Implementation

The system software is developed using the Arduino IDE with the ESP8266WiFi and LiquidCrystal_I2C libraries. During initialization, the program configures the water-level sensor inputs, buzzer output, and LCD display, and establishes a Wi-Fi connection through the NodeMCU ESP8266. The controller continuously monitors the three water-level probes and processes[14] their digital signals to determine the current water-level condition. Based on the sensor status, the system displays SAFE, WARNING, or DANGER on the LCD. When the water reaches the highest predefined level, the buzzer is activated to provide an immediate local warning[15].

3.3. NodeMCU ESP8266

The NodeMCU ESP8266 serves as the primary controller and communication device. It processes the water-level sensor signals and controls the LCD and buzzer. Its integrated Wi-Fi capability supports IoT-based remote monitoring. The project uses the Arduino IDE for programming the controller.

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 04 Issue: 08 August 2026
Page No: 5254 - 5259
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2026.0687

3.4.LCD Display

The LCD provides a clear local display of the detected water level and the current system status. Depending on the sensor readings, the system displays messages such as "LOW (SAFE)," "MEDIUM WARNIN," and "DANGER/FLOOD ALERT." This allows the user to easily understand the current water condition and receive an immediate warning when the water level reaches a critical point.

3.5.Buzzer and Relay

The buzzer acts as the primary local audible warning device. It is activated when all three water-level sensors indicate the high-level condition. The relay can be used for switching an external alarm or higher-power load through a low-power control signal. As shown in Figure 2 IoT Based Flood Alert System for DAM with display.

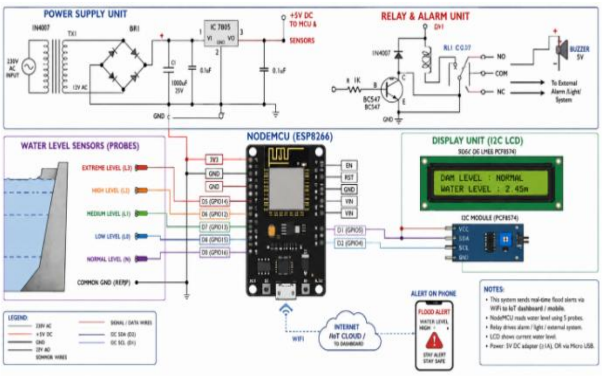

Figure 2 IoT Based Flood Alert System for DAM with display

3.6.Software Code

This paper uses ESP8266WiFi and LiquidCrystal_I2C libraries. The Wi-Fi credentials are configured in the program, and the LCD uses I2C address 0x27 with a 16×2 display. The low-, medium-, and high-level sensors are connected to D5, D6, and D7, respectively, while the buzzer is connected to D8. During operation, the program reads the three sensor states and displays LOW (SAFE), MEDIUM WARNING, or FLOOD ALERT depending on the detected combination. The buzzer remains OFF for safe and warning states and is activated for the high-level danger state. Sensor states are also printed to the Serial Monitor at two-second intervals.

4. Results And Discussion

4.1.Results

The experimental results show that the IoT-based flood alert system works effectively and reliably. The sensors accurately detected low, medium, and high water levels, while the microcontroller displayed the correct status on the LCD. At the critical level, the buzzer provided an immediate alert. The Wi-Fi module enabled real-time remote monitoring with minimal delay. Overall, the system demonstrated quick response, accurate detection, and consistent performance. As shown in Table 2 Result.

Table 2 Result

Condition	Sensor Status	LCD	Buzzer	Result
Low	Low Active	NORMAL	OFF	Safe
Medium	Low + Medium	WARNING	OFF	Alert
High	Low + Medium + High	DANGER	ON	Flood Alert
Overall	Accurate Detection	Correct Display	Timely Alert	Reliable System

5. Discussion

The experimental results show that the proposed IoT-based flood alert system can effectively monitor water levels under different conditions. The sensors accurately identified low, medium, and highwater levels, and the microcontroller responded correctly by updating the LCD and activating the buzzer when required. The system showed a quick response with only minor variations in sensor readings and operated without significant errors during testing. The Wi-Fi module also provided real-time data transmission, allowing the water level to be monitored remotely with very little delay. The system remained stable during continuous operation and consumed relatively low power. Overall, the results indicate that the proposed system is a simple, reliable, and cost-

e ISSN: 2584-2137
Vol. 04 Issue: 08 August 2026
Page No: 5254 - 5259
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2026.0687

effective solution for real-time flood monitoring and early warning.

Figure 3 **Display Result**

Conclusion

The IoT-based flood alter system for dam monitoring has been successfully designed and implemented, demonstrating its effectiveness in detecting and alerting rising water levels. The system integrates water level sensors, a microcontroller (NodeMCU/Arduino), LCD display, buzzer, and Wi-Fi module to provide real-time monitoring and alert mechanisms. During testing, the system showed accurate detection of water levels and responded quickly by displaying the appropriate status and activating the buzzer when the danger level was reached. The inclusion of IoT technology enables remote monitoring, allowing users and authorities to access real-time data from any location.

Acknowledgements

The authors would like to express sincere gratitude for the valuable guidance, encouragement, and support provided throughout this work. The authors are also thankful to the department and institution for providing the necessary facilities and resources for the successful development and testing of the proposed IoT-based flood alert system.

References

[1]. Shao, Shiwei, et al. "An Integrated Multi-Sensor Information System for Real-Time Reservoir Monitoring and Management." Sensors 25.18 (2025): 5730.
[2]. Paul, Anik, et al. "IoT and AI-Enabled Flood Detection and Emergency Response: A Structured Review." IoT and AI-Enabled Flood Detection and Emergency Response: A Structured Review (January 14, 2026) (2026).
[3]. Gunapu, Bhargava Ramarao, et al. "Intelligent Flood Warning and Dam Operating System." NIELIT's International Conference on Communication, Electronics and Digital Technologies. Singapore: Springer Nature Singapore, 2025.
[4]. Rathinamala, S., et al. "Smart Dam Management: Implementing IoT Solutions for Water Level Monitoring and Control." 2025 Third International Conference on Emerging Applications of Material Science and Technology (ICEAMST). IEEE, 2025.
[5]. Gunapu, Bhargava Ramarao, et al. "Intelligent Flood Warning and Dam Operating System." NIELIT's International Conference on Communication, Electronics and Digital Technologies. Singapore: Springer Nature Singapore, 2025.
[6]. Khan, M. Atiqur R., Mst Shamima Akter, and Niger Sultana. "Development of a fog computing-based real-time flood prediction and early warning system using machine learning and remote sensing data." Journal of Sustainable Development and Policy 1.01 (2025): 10-63125.
[7]. Singh, Om Prakash, et al. "Experimental analysis on fault detection in induction machines via IoT and machine learning." Proceedings of the International Conference on Intelligent Computing, Communication and Information Security. Singapore: Springer Nature Singapore, 2022.
[8]. Sreenivasu, S. V. N., et al. "Cloud based electric vehicle's temperature monitoring system using IOT." Cybernetics and Systems 56.6 (2025): 768-783.
[9]. Sahoo, Lohit Kumar, et al. "Energy Management Analysis of Residential Building Using ANN Techniques." Indonesian Journal of Electrical Engineering and Informatics (IJEEI) 11.3 (2023): 854-869.
[10]. Kabat, Subash Ranjan, and Chinmoy Kumar Panigrahi. "Power quality and low voltage ride through capability enhancement in wind energy system using unified power quality conditioner (UPQC)." Electrochemical Society Transactions 107.1 (2022): 5655-566
[11]. Banik, Ayan, et al. "Novel energy-efficient hybrid green energy scheme for future sustainability." 2021 International

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 04 Issue: 08 August 2026
Page No: 5254 - 5259
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2026.0687

Conference on Technological Advancements and Innovations (ICTAI). IEEE, 2021.

[12]. Kabat, Subash Ranjan, Chinmoy Kumar Panigrahi, and Bibhu Prasad Ganthia. "Fuzzy logic based fault current prediction in double fed induction generator based wind turbine system." Materials Today: Proceedings 80 (2023): 2530-2538

[13]. S. B. Zahir et al., "Smart IoT Flood Monitoring System," Journal of Physics: Conference Series, vol. 1339, no. 1, IOP Publishing, 2019.

[14]. S. Jana Priya et al., "Flood monitoring and alerting system," International Journal of Computer Engineering & Technology (IJCET), vol. 8, no. 2, p. 15, 2017.

[15]. D. Hughes et al., "An intelligent and adaptable grid-based flood monitoring and warning system," Proceedings of the UK eScience All Hands Meeting, vol. 10, 2006