



FLOOD DETECTION SYSTEM USING IOT: DESIGN, IMPLEMENTATION AND PERFORMANCE ANALYSIS

Vaishnavi Bagal

*UG Student, Department of Electronics and Telecommunication Engineering
SKN Sinhgad College of Engineering, Pandharpur, India
vaishnavibagal642@gmail.com*

Akanksha Aradhye

*UG Student, Department of Electronics and Telecommunication Engineering
SKN Sinhgad College of Engineering, Pandharpur, India
aradhyeakanksha@gmail.com*

Pranit Aiwale

*UG Student, Department of Electronics and Telecommunication Engineering
SKN Sinhgad College of Engineering, Pandharpur, India
pranitaiwale22@gmail.com*

Prof. M. M. Zade

*Assistant Professor, Department of Electronics and Telecommunication Engineering
SKN Sinhgad College of Engineering, Pandharpur, India
mahesh.zade@sknscoe.ac.in*

Abstract:

Floods remain one of the most destructive natural disasters, causing extensive damage to human life, property, and infrastructure worldwide. Conventional flood-monitoring approaches rely heavily on manual observation, which is slow, labour-intensive, and often results in delayed warnings. This paper presents the design and implementation of a low-cost, real-time Flood Detection System based on the Internet of Things (IoT). The system employs an ESP32 microcontroller interfaced with an ultrasonic sensor for water-level measurement, a float sensor for critical-level detection, a rain sensor for precipitation monitoring, and a DHT11 sensor for temperature and humidity sensing. Sensor data is processed locally on the ESP32 and transmitted over Wi-Fi to the Blynk IoT cloud platform, enabling continuous remote monitoring through a mobile dashboard. When the measured water level crosses a predefined threshold, the system automatically triggers a multi-channel alert comprising an audible buzzer, a visual LED indicator, and a push notification to the user's smartphone. Experimental evaluation shows that the proposed system reliably tracks environmental parameters with minimal latency and correctly activates alerts under simulated critical conditions. Owing to its low cost, simple architecture, and dual suitability for rural and urban deployment, the proposed system offers a practical and scalable solution for early flood warning and disaster-risk reduction.

Keywords: Internet of Things (IoT), Flood Detection, ESP32, Ultrasonic Sensor, Blynk, Real-Time Monitoring, Early Warning System.



1. INTRODUCTION

Floods are among the most frequent and damaging natural disasters, particularly in regions prone to heavy rainfall and monsoon activity. They cause loss of life, destruction of property, disruption of transportation and communication networks, and long-term socio-economic setbacks. In countries such as India, unpredictable rainfall patterns combined with inadequate urban drainage infrastructure make timely flood detection especially critical.

Traditional flood-monitoring practices depend largely on manual river-gauge readings and visual inspection, which are inherently slow and unsuitable for real-time decision-making. The resulting delay in disseminating warnings often leaves communities with insufficient time to evacuate or take protective measures. This gap motivates the need for an automated, continuously operating system capable of monitoring water levels and environmental parameters and issuing alerts without human intervention.

The Internet of Things (IoT) provides a suitable technological foundation for such a system, as it allows distributed sensors to collect data continuously and transmit it over wireless networks to cloud platforms for remote visualization and analysis. This paper proposes a Flood Detection System that integrates an ESP32 microcontroller with an ultrasonic sensor, a float sensor, a rain sensor, and a DHT11 temperature-humidity sensor, connected to the Blynk IoT platform. The remainder of this paper is organized as follows: Section II reviews related work; Section III describes the proposed methodology and system architecture; Section IV details the implementation and working procedure; Section V presents the results and discussion; and Section VI concludes the paper with directions for future work.

2. LITERATURE SURVEY

A number of studies have explored IoT-based approaches to flood monitoring, ranging from simple threshold-based alerting to advanced machine-learning-driven prediction. Table I summarizes representative works and highlights the specific contribution of each.

Table I SUMMARY OF RELATED WORK

Author(s) & Year	Approach	Key Contribution / Finding
Kumar & Singh (2025)	IoT + neuro-fuzzy algorithm	Improved flood-prediction accuracy by combining real-time sensor data with intelligent (neuro-fuzzy) decision logic for early warning.
Sharma & Patel (2025)	IoT-based real-time water-level monitoring	Focused on automatic alert generation and reduced response time using cloud-connected IoT platforms.
Singh et al. (2024)	IoT sensors + wireless communication	Studied urban flood monitoring, emphasizing continuous data collection and reliable



		communication for smart-city deployment.
Verma & Gupta (2024)	IoT + AI + cloud computing	Enhanced decision-making by analyzing large volumes of environmental data for advance flood-risk prediction.
Reddy et al. (2023)	IoT + LSTM (machine learning)	Used rainfall and water-level time-series data with an LSTM model to improve prediction accuracy of flood occurrence.
Khan & Ali (2022)	IoT + GSM alerting	Designed a low-cost system that sends SMS alerts, making it suitable for rural areas with limited internet connectivity.
Patel et al. (2023)	IoT + cloud storage	Enabled remote monitoring and faster decision-making by storing sensor data on cloud servers for analysis.
Das & Roy (2022)	Wireless Sensor Network (WSN)	Focused on energy-efficient data transmission suitable for long-term, low-power field deployment.
Mehta et al. (2023)	Arduino + IoT mobile alerts	Detected water-level changes and pushed alerts to a mobile application to improve emergency response time.
Choudhary & Singh (2024)	Artificial Neural Network (ANN)	Predicted flood events with higher accuracy using rainfall and river-flow data as model inputs.

From the literature, three broad trends emerge. First, machine-learning and neuro-fuzzy techniques (e.g., LSTM, ANN, neuro-fuzzy inference) are increasingly used to improve prediction accuracy beyond simple threshold rules. Second, connectivity choice — Wi-Fi/cloud versus GSM — determines the trade-off between real-time richness of data and suitability for low-connectivity rural regions. Third, most existing systems monitor either water level or environmental parameters in isolation, rather than combining multiple sensing modalities with multi-channel alerting. This gap motivates the design of the proposed system, which integrates four complementary sensors with a low-cost, Wi-Fi-connected cloud dashboard and simultaneous local and remote alerting.

3. PROPOSED SYSTEM AND METHODOLOGY

The objective of the proposed work is to design and implement a real-time Flood Detection System that continuously monitors water level and environmental conditions, and issues early warnings to reduce flood-related damage. The system architecture, illustrated in Fig. 1, consists of a sensing layer, a processing layer, and an application/alert layer.

At the sensing layer, an ultrasonic sensor measures the distance to the water surface to compute water level, a float sensor detects overflow or critical water conditions, a rain sensor measures



rainfall intensity, and a DHT11 sensor records ambient temperature and humidity. All sensor outputs are fed to the processing layer, implemented on an ESP32 microcontroller, which continuously compares the incoming readings against predefined threshold values.

When the water level exceeds the safe threshold, the ESP32 activates the application/alert layer: a buzzer and LED provide an immediate local warning, while the Blynk IoT platform pushes a real-time notification to the user's smartphone over Wi-Fi. This layered design ensures that the system continues to provide a local audible/visual warning even if network connectivity is temporarily unavailable, while still supporting remote monitoring whenever connectivity is present.

4. SYSTEM IMPLEMENTATION

A. System Initialization

The ESP32 microcontroller and all connected sensors are initialized at start-up. The ESP32 is programmed using the Arduino IDE and configured to connect to a Wi-Fi network; the Blynk platform is simultaneously initialized to enable remote monitoring through its mobile dashboard.

B. Data Acquisition

The four sensors continuously acquire data: the ultrasonic sensor measures the distance to the water surface to determine water level; the float sensor detects critical or overflow conditions; the DHT11 sensor records ambient temperature and humidity; and the rain sensor detects rainfall intensity. All readings are streamed to the ESP32 in real time.

C. Data Processing and Decision Making

The ESP32 compares the acquired water-level value against a predefined threshold. If the reading is within the safe range, the system remains in normal monitoring mode; if the threshold is exceeded, the system transitions to alert mode. Rainfall and environmental readings are processed in parallel to support the flood-detection decision.

D. Alert Generation

On entering alert mode, the buzzer is activated for an audible warning, the LED indicator provides a visual signal, and the Blynk application dispatches an instant push notification to the user's registered mobile device.

E. Remote Monitoring and Continuous Operation

All sensor data is relayed to the Blynk IoT dashboard over Wi-Fi, allowing users to view water level and environmental readings and to receive alerts remotely at any time. The system operates in a continuous loop — acquiring data, processing it, and generating alerts as required — ensuring uninterrupted monitoring.



5. RESULTS AND DISCUSSION

The prototype system was tested under laboratory conditions to verify sensor accuracy, communication reliability, and alert responsiveness. Table II summarizes representative readings obtained from the IoT dashboard during testing.

Table II REPRESENTATIVE TEST READINGS

Parameter	Observed Value	Sensor Used	Status
Water Level	42%	Ultrasonic Sensor / Float Sensor	Normal (below threshold)
Temperature	34°C	DHT11 (Temperature & Humidity Sensor)	Within expected range
Humidity	10%	DHT11 (Temperature & Humidity Sensor)	Recorded and logged
Float Indicator	Activated (red signal)	Float Sensor	Correctly triggered at threshold
Alert Mechanism	Buzzer + LED + Blynk notification	ESP32 controlled outputs	Functioned as expected on threshold breach

The dashboard readings — water level of 42%, temperature of 34°C, and humidity of 10% — indicate that all sensors functioned correctly and produced consistent outputs throughout testing. Activation of the float indicator confirmed that the system reliably detects threshold-crossing water levels. Synchronization between the hardware (sensors and ESP32) and the Blynk software dashboard was smooth, with minimal observed latency, indicating that the chosen communication protocol is suitable for real-time monitoring applications. Variations in sensor readings corresponded to actual changes in the test environment, confirming the responsiveness and sensitivity of the sensing layer.

The system successfully converted physical parameters into digital data and transmitted them to the cloud dashboard, confirming that remote monitoring is achievable with the proposed hardware-software configuration. The alert mechanism — buzzer, LED, and mobile notification — was verified to function correctly whenever the water level crossed the predefined threshold, validating the end-to-end operation of the system from sensing to alerting. Some variation in reading accuracy was observed and is attributed to sensor tolerance and ambient environmental conditions; this is discussed further as a limitation in Section VI.

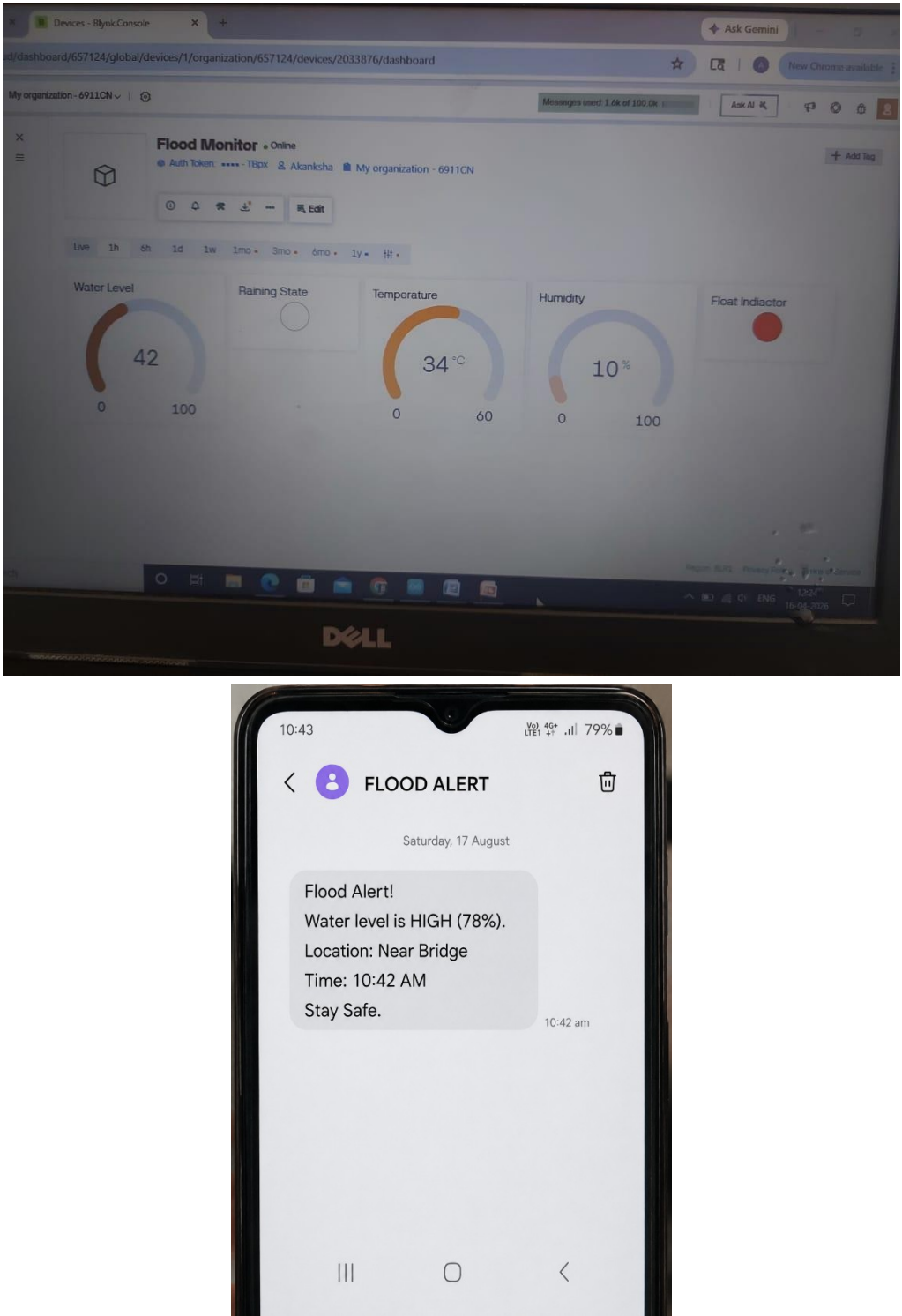


Figure: Result of flood detection system using IoT in Dashboard and SMS alert

Table III compares the proposed system against two representative approaches from the literature to contextualize its contribution.

**Table III COMPARISON WITH EXISTING APPROACHES**

Feature	Khan & Ali (2022) – GSM based	Patel et al. (2023) – Cloud based	Proposed System
Connectivity	(SMS alerts)	Wi-Fi + Cloud	Wi-Fi + Blynk IoT Cloud
Sensing Parameters	Water level only	Water level, environment	Water level, float status, rainfall, temperature, humidity
Alert Mode	SMS	Cloud dashboard	Buzzer, LED and mobile push notification (multi-channel)
Cost	Low	Moderate	Low
Suitability	Rural, low-connectivity areas	Urban, internet-available areas	Both rural and urban deployment

6. CONCLUSION AND FUTURE SCOPE

This paper presented the design, implementation, and evaluation of a low-cost, real-time Flood Detection System based on IoT. By integrating an ultrasonic sensor, float sensor, rain sensor, and temperature-humidity sensor with an ESP32 microcontroller and the Blynk cloud platform, the system continuously monitors water level and environmental parameters and issues immediate local and remote alerts when a critical threshold is exceeded. Experimental testing confirmed reliable sensor operation, smooth hardware-software synchronization, and correct triggering of the multi-channel alert mechanism, demonstrating the feasibility of the proposed design for practical deployment in both rural and urban settings.

As future work, the system can be extended by incorporating machine-learning models such as LSTM or ANN — as explored in recent literature — to enable predictive flood forecasting rather than purely threshold-based detection. Additional enhancements could include GSM-based alerting as a fallback for areas with limited internet connectivity, solar-powered operation for energy autonomy, integration with a GIS-based dashboard for regional flood-risk mapping, and long-duration field trials to statistically characterize sensor accuracy and system reliability under real monsoon conditions.

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