Automated Flood Detection and Rapid SMS Alert System

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Abstract: *This paper presents the design and implementation of an IoT-based, real-time flood monitoring and alert system that leverages the ESP8266 Wi-Fi module for wireless communication and cloud integration. A non-contact ultrasonic sensor is employed to continuously monitor water levels by measuring the distance from the sensor to the water surface with high accuracy. Upon detecting a water level exceeding a predefined safety threshold, the system triggers an audible alarm and displays persistent visual alerts on an LCD module to provide immediate on-site warnings. Concurrently, real-time data is transmitted to the ThingSpeak platform, enabling remote monitoring, cloud storage, and graphical visualization of water level trends over time. The system also integrates Twilio's SMS API to dispatch critical alerts directly to users' mobile devices, ensuring rapid response during potential flood events. Additionally, support for Serial Plotter visualization enhances real-time debugging and system validation during development. The proposed solution is designed to be low-cost, scalable, and easy to deploy, making it an ideal candidate for early flood detection in vulnerable regions, water resource management, and smart drainage infrastructure. By fusing edge sensing, wireless communication, and cloud analytics, this system exemplifies a forward-looking approach to environmental monitoring and disaster resilience in the era of smart cities.*

Keywords: **Flood, ESP8266 Wi-Fi Module, Ultrasonic Sensor, IOT, SMS**

1. INTRODUCTION

Floods are among the most destructive natural disasters, often resulting in extensive damage to property, infrastructure, and human life—particularly in low-lying, poorly drained, or densely populated urban areas. Various factors contribute to flooding, including heavy rainfall, river overflow, cyclones and storm surges, tsunamis, inadequate drainage systems, and dam failures or sudden water releases. The increasing frequency and intensity of such events, driven by climate change and rapid urbanization, underscore the urgent need for reliable and responsive flood detection systems. Traditional flood warning methods often fall short in delivering timely, localized alerts and lack the ability for remote monitoring. The main objective of a flood monitoring and alarming system is to detect rising water levels in real-time and provide early warnings to prevent damage, loss of property, and ensure the safety of people. This system aims to continuously monitor the water level in flood-prone areas using sensors and alert users when the water reaches a dangerous level. By doing so, it helps in taking timely action to evacuate or protect affected areas. The system also aims to provide accurate data through wireless communication or web servers, making remote monitoring possible. Overall, the goal is to support disaster preparedness, reduce the impact of floods, and enhance public safety through a reliable and efficient alerting system.

2. Literature Review

Sl. No	Author(s)	Year	Objective
1	A Khan, S K Gupta, E. I. Assiri	2020	Het-Sens model for flood warning using water level and rainfall data.
2	Garima S, N Bisht, P Bisht, P Singh	2020	IoT-based flood monitoring system with weather forecasting and Android app.
3	Sumangala G, Abishek M, Sampath M.P, et.all	2024	Flood alert system using Arduino and IoT for overflow detection near reservoirs.
4	S B Zahir, P Ehkan, T Sabapathy, M Jusoh, et.all	2019	Smart IoT flood monitoring system with alerts and online monitoring.
5	Iqbal Fariansyah Ridwan	2023	Review of IoT-based flood detection systems and their effectiveness.
6	M Esposito, L Palma, A Belli, L Sabbatini, Paola Pierleoni	2022	Review of advances in IoT-based early warning systems for disaster preparedness.

7	R S Miani, R Paquini	2025	Disaster detection using sliced network traffic monitoring and IoT.
8	J Porte, A Briones, J M Maso, C Pares, A Zaballos, J L Pijoan	2020	Heterogeneous wireless IoT system for disaster communication.
9	W T Sung, I V Devi, S J Hsiao	2022	AioT-based flash flood warning system using LoRa and cloud alerts.

3. HARDWARE DESIGN

The proposed flood monitoring system integrates several key hardware and software components to enable real-time detection, alerting, and remote monitoring. A regulated 5V power supply energizes all components, including the ESP8266 WiFi module, which serves as the system's central controller.

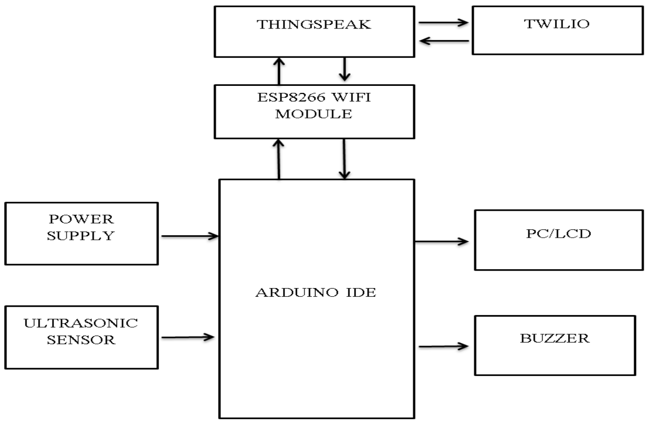

Fig: Block diagram of the proposed system

The ESP8266 reads water level data from an HC-SR04 ultrasonic sensor, which calculates the distance between the sensor and the water surface. Based on this input, the microcontroller evaluates whether the water level exceeds the predefined threshold of 5 cm. If so, it activates a buzzer and updates a 16×2 LCD display—adjusted via a potentiometer—to show status messages such as "Normal" or "Danger." Concurrently, the system transmits the collected data to the ThingSpeak cloud platform, where users can view real-time and historical water level trends. In high-risk scenarios, the ESP8266 uses the Twilio API to send SMS alerts to predefined mobile numbers, ensuring timely notification. Together, these components create a cohesive, cost-effective, and scalable solution for flood risk management.

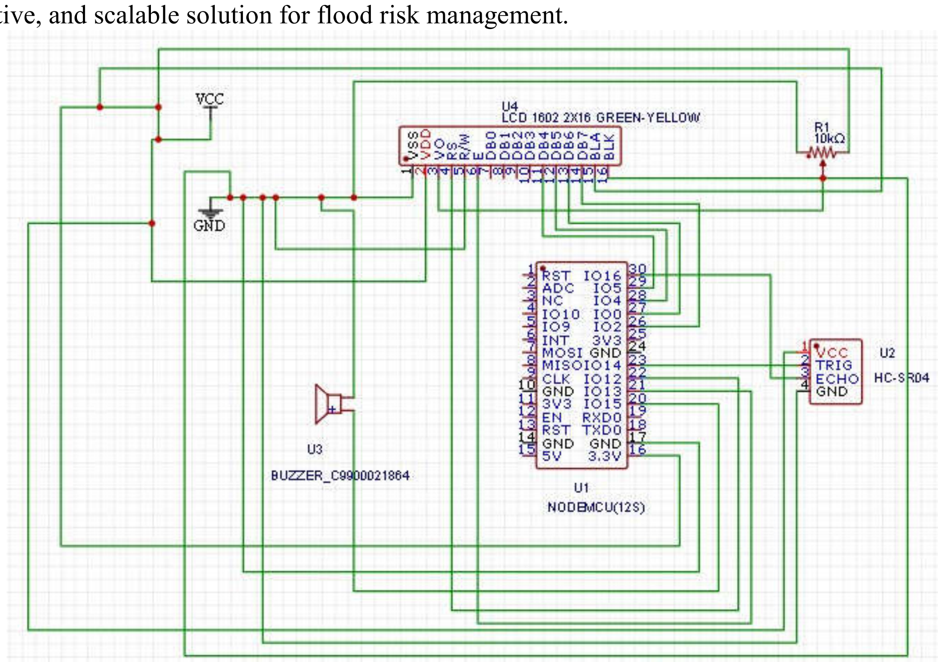

Fig: Circuit Diagram using ESP8266 Wi-Fi module

The flow chart of the proposed flood monitoring system outlines a continuous cycle that begins when the ESP8266 module is powered on. Upon startup, all components—including the ultrasonic sensor, buzzer, LCD display, and Wi-Fi connectivity—are initialized, and connections to ThingSpeak and Twilio are prepared. The system then measures the water level using the ultrasonic sensor, which calculates the distance to the water surface by sending and receiving sound pulses. This measured distance is used to determine the current water level. The ESP8266 then compares the calculated water level with a predefined danger threshold, typically set at 5 cm. If the water level exceeds this threshold, the system displays a "Danger" alert on the LCD, activates the buzzer, sends an SMS notification via Twilio, and uploads the data to ThingSpeak for remote monitoring. If the water level remains within a safe range, it displays "Normal" on the LCD, keeps the buzzer off, but still transmits the data to ThingSpeak for ongoing analysis. After each cycle, the system pauses briefly—usually for around 15 seconds—to reduce network load before starting the next reading. This loop continues indefinitely, providing real-time flood monitoring until the system is manually turned off.

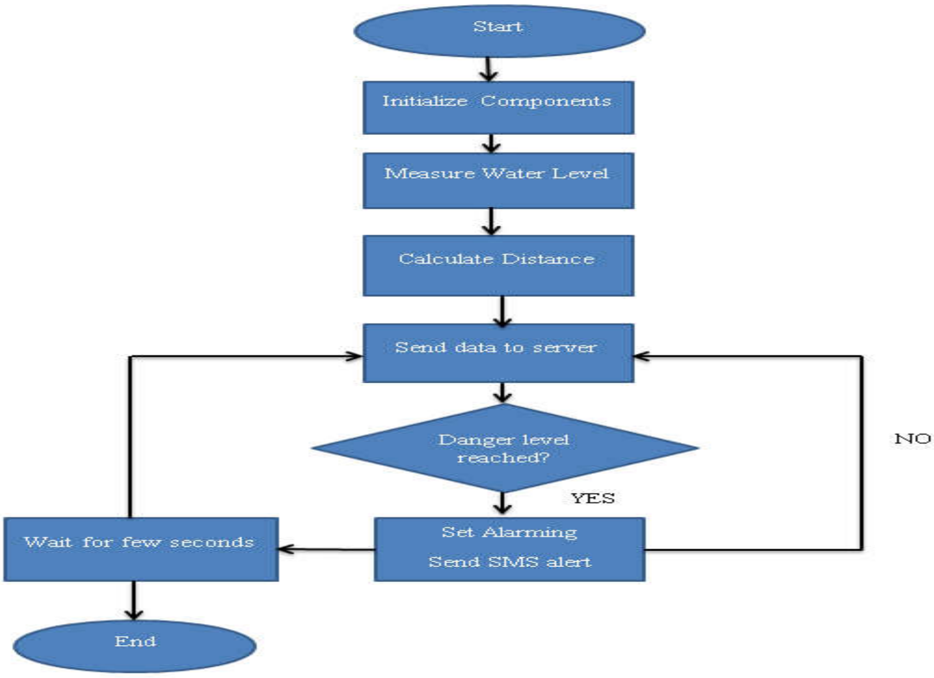

Fig: Flow Chart of the system

4. RESULTS AND DISCUSSION

In this project, an intelligent flood monitoring system was successfully developed and validated, integrating an ultrasonic sensor, ESP8266, buzzer, 16x2 LCD, and 10K potentiometer. Real-time alerts are sent via Twilio API, while data is logged to ThingSpeak cloud. Operating at 115200 baud, the system enables efficient serial communication for accurate, cloud-connected water level monitoring.

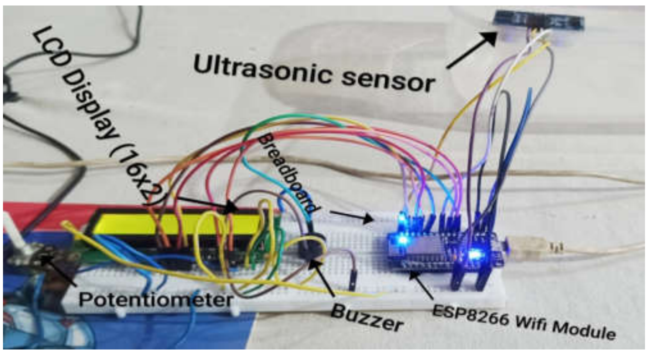

Fig: The designed hardware model

a) Experiment for detecting flood level using ESP8266 Wi-Fi module in Thingspeak software (In Normal Condition)

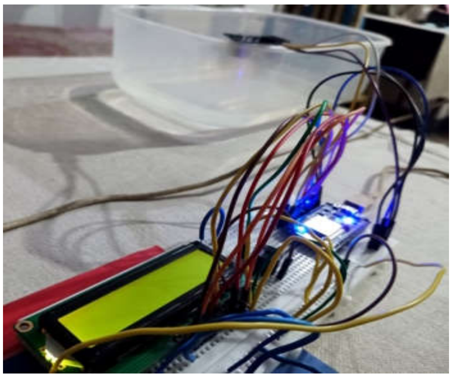

Fig: Readings shown in the model

Table 1 : Normal Water Level Readings from ThingSpeak

Time (HH:MM)	Water Level (cm)	Flood Status	Green Lamp	Red Lamp	Remarks
23:38	9.2	Normal	ON	OFF	Water level safe
23:38	9.2	Normal	ON	OFF	Stable condition
23:39	8.1	Normal	ON	OFF	Slight decrease
23:40	8.7	Normal	ON	OFF	Water still safe
23:40	7.5	Normal	ON	OFF	Slight dip observed
23:41	7.9	Normal	ON	OFF	Stable range
23:41	7.1	Normal	ON	OFF	Approaching threshold
23:41	6.8	Normal	ON	OFF	Still safe
23:41	6.1	Normal	ON	OFF	Close to threshold
23:42	9.0	Normal	ON	OFF	Sharp increase
23:42	8.1	Normal	ON	OFF	Stable again
23:42	7.6	Normal	ON	OFF	No alert required

In this setup, a water level reading below 5cm indicates a potential flood risk; however, all recorded values remain above this threshold. This implies that the distance between the sensor and the water surface is sufficiently large, indicating a safe water level. Correspondingly, the system activates the Green Lamp to signal normal conditions, while the Red Lamp remains OFF, as no immediate threat or danger has been detected.

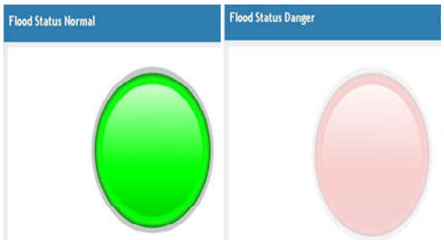

Fig: Green light indicates normal water level

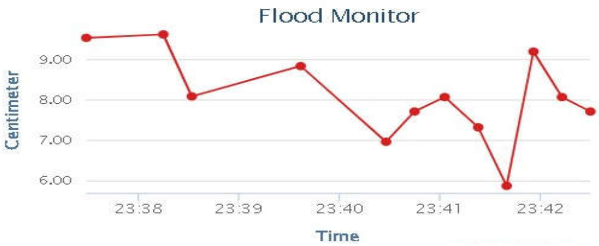

Fig: Graphical representation of water level readings

The graph provides a real-time visualization of water level data captured by the ultrasonic sensor and transmitted via the ESP8266 Wi-Fi module to the ThingSpeak cloud platform. The Y-axis indicates the distance between the sensor and the water surface in centimeters, while the X-axis represents the time of each recorded measurement. Observations show that the distance consistently ranged from approximately 6.0cm to 9.5cm across various testing conditions. Notably, no readings dropped below 5.0cm, suggesting that the water level remained safely below the predefined flood threshold throughout the monitoring period. This consistency confirms the system's reliability in detecting and reporting real-time water levels.

Experiment 2: Experiment for detecting flood level using ESP8266 Wi-Fi module in ThingSpeak software (Danger Level)

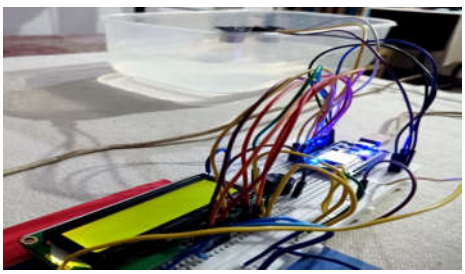

Fig: Water level is at danger condition (i.e, more than 7 cm)

Table1: Normal Water Level Readings from ThingSpeak

Sl No.	Time	Water Level (cm)	Condition	Red Lamp	Green Lamp
1	23:56:00	6.2	Warning	ON	OFF
2	23:56:20	4.0	**Danger**	ON	OFF
3	23:56:40	4.6	**Danger**	ON	OFF
4	23:57:00	3.9	**Danger**	ON	OFF
5	23:57:20	3.7	**Danger**	ON	OFF
6	23:57:40	3.4	**Danger**	ON	OFF
7	23:58:00	3.3	**Danger**	ON	OFF
8	23:58:20	3.2	**Danger**	ON	OFF
9	23:58:40	3.4	**Danger**	ON	OFF
10	23:59:00	2.9	**High Danger**	ON	OFF
11	23:59:20	3.3	**Danger**	ON	OFF
12	23:59:40	4.0	**Danger**	ON	OFF

When the system detects that the water level has dropped below 5cm, it initiates a series of automated safety responses to address the potentially hazardous condition. The Red LED, acting as a danger indicator, is immediately turned ON to provide a clear visual warning, while the Green LED, which signals a safe state, is turned OFF. Simultaneously, a buzzer is activated to audibly alert individuals in the vicinity of the low water level. In addition to local alerts, the system sends an SMS notification via Twilio to inform the user or relevant authorities, ensuring timely intervention. Furthermore, the detected data is uploaded to the ThingSpeak platform, where it is visualized in real-time for continuous remote monitoring and analysis.

Fig: Red Lamp 'ON' indicating water level at Danger condition at Danger condition

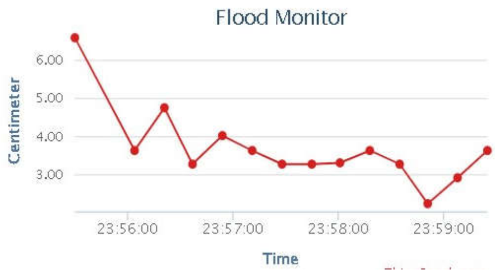

Fig: Graphical representation of water level readings

The graph generated from the ThingSpeak cloud platform provides a clear visualization of real-time water level measurements obtained from the ultrasonic sensor integrated into the flood monitoring and alarming system. The Y-axis denotes the measured water level in centimeters, while the X-axis tracks the corresponding time of each recorded data point. A consistent pattern of data points below the critical 5 cm threshold is evident, with some readings dropping as low as 2.9 cm, strongly indicating flood-like conditions. The trend reveals fluctuations between 3.0 cm and 4.8 cm, all of which remain within the danger zone. This sustained low-level pattern signifies a high risk of flooding and validates the system's trigger of emergency alerts and data transmission for remote monitoring.

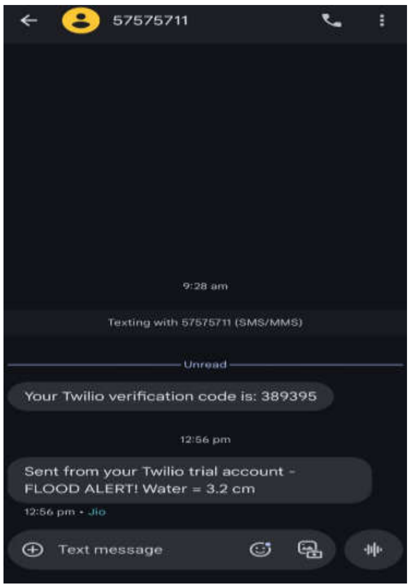

Fig: SMS alert notification from TWILIO

A real-time flood alert notification in the form of an SMS is generated by the ESP8266-based flood monitoring system using the Twilio API service. When the ultrasonic sensor detects that the water level has fallen below the safe threshold—signaling a possible flood threat—the system immediately sends an SMS alert to the registered mobile number. For example, a message such as "Sent from your Twilio trial account - FLOOD ALERT! Water = 3.2 cm" indicates that the water level has risen significantly, with the distance from the sensor to the water surface reduced to just 3.2 cm—well below the critical danger mark. This alert enables the user to take prompt precautionary measures. The integration with Twilio ensures that users receive crucial notifications in real-time, even if they are not physically present at the monitored location, thereby enhancing safety and preparedness.

CONCLUSION

In conclusion, the ESP8266-based flood monitoring and alarming system presents a practical and efficient IoT solution for early flood detection and response. By combining real-time water level measurement with cloud-based data visualization and automated SMS alerts, the system ensures users are informed promptly during critical conditions. Its key advantages—including remote data access, customizable thresholds, and visual indicators—make it suitable for various applications, from residential areas to agricultural fields. Although the system has a few limitations, such as internet dependency, limited sensor range, and lack of weatherproofing, these can be mitigated with thoughtful design enhancements. Overall, this project successfully demonstrates how affordable, scalable, and accessible IoT technologies can be leveraged to build proactive safety systems that help mitigate the impacts of flooding.

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