1. Project Title:

IoT Flood Monitoring & Alerting System

---

2. Project Description:

Flooding is one of the most devastating natural disasters, particularly in regions like Bangladesh, where millions of people are vulnerable to flash floods and monsoon rains. The IoT Flood Monitoring & Alerting System is designed to mitigate the effects of flooding by providing early warnings to residents, thereby reducing the loss of life, property, and livelihoods. Recent events, like the Feni Flood of August 2024, which displaced over 500,000 people, underscore the critical need for real-time flood monitoring systems capable of alerting communities before a crisis escalates.

This project leverages IoT technology, using an ESP8266 microcontroller, to continuously monitor water levels in flood-prone areas. Two types of sensors—an ultrasonic sensor and a float sensor—are employed to detect rising water levels. When these levels surpass safe thresholds, the system triggers alerts through a GSM module (SIM800l), which sends SMS notifications to authorities and residents in nearby communities. A 16x2 LCD display provides a clear visual of real-time water levels and the system's operational status, enabling quick decision-making.

In addition to real-time alerts, the system captures and stores historical water-level data, which is processed using big data analytics. By aggregating this data over time, the system can identify trends and patterns, allowing for predictive modeling of flood risks. This integration of big data enables early detection of potential flood scenarios, helping local governments and humanitarian organizations take proactive measures, such as organizing evacuations or deploying emergency resources, well before the floodwaters rise.

The use of big data for flood prediction transforms this IoT-based solution from a reactive system into a predictive tool, enhancing its ability to safeguard lives and property. The GSM-based alert system ensures that even in remote areas without reliable internet connectivity, warnings reach communities in time. This scalable solution can be deployed across flood-prone regions, from urban infrastructure to rural agricultural areas, reducing the risk of severe damage caused by flooding.

3. Equipment List:

ESP8266 Microcontroller:
The ESP8266 is the central component responsible for managing sensor data and controlling communication via the GSM module. Its Wi-Fi capabilities and low power consumption make it ideal for IoT applications, such as flood monitoring, where real-time data transmission is critical.

GSM Module (SIM800l):
This module provides cellular communication, enabling the system to send SMS alerts when flood levels exceed safety thresholds. The GSM module ensures that alerts are sent even in areas without internet access, making it essential for real-time flood warnings in remote locations.

Ultrasonic Sensor:
The ultrasonic sensor measures the distance between the sensor and the water surface. This sensor provides continuous, real-time data on water levels and is key to detecting the early stages of flooding by measuring the rise in water height.

Float Sensor:
The float sensor offers a second layer of water-level detection by responding to the physical rise of water. This redundancy ensures that even if the ultrasonic sensor fails, the system can still detect rising floodwaters and issue alerts.

16x2 LCD Display with I2C:
The LCD display is used to show real-time water levels, system status, and alerts. The I2C interface makes it easier to connect and minimizes the number of pins required, allowing for a more compact design while still providing a clear display for local monitoring.

Zero PCB:
The Zero PCB is used to securely connect all the components, including the sensors, GSM module, and power supply, for testing and prototyping. It allows for easy adjustments during the development phase and helps to keep the circuit organized.

5V Power Supply:
This power supply ensures the ESP8266, sensors, GSM module, and LCD display have a consistent and reliable source of energy. It is crucial for ensuring that the system operates smoothly, especially in regions where power disruptions may occur.

4. Unique Feature:

A key distinguishing feature of this project is the integration of both ultrasonic and float sensors to monitor water levels. The ultrasonic sensor measures the distance between the sensor and the water surface, while the float sensor provides an additional level of accuracy by detecting the water level more directly. The system also includes a GSM module (SIM800l) for real-time alerting via SMS, ensuring that users are promptly notified of rising water levels. The use of an I2C-enabled LCD display allows for a compact and user-friendly interface that shows real-time data without requiring a computer. This combination of sensors and communication technology makes the system reliable and effective for flood prevention.

5. Methodology:

Step 1: Setting Up the ESP8266
The ESP8266 microcontroller is programmed to control the sensors and handle communication with the GSM module. The ESP8266 will constantly monitor the input from the ultrasonic and float sensors, comparing the data with predefined flood risk thresholds.

Step 2: Integrating Sensors
The ultrasonic sensor is mounted at a height above the water surface to measure the water level by calculating the time it takes for sound waves to bounce back from the water. The float sensor provides an additional check for water levels. Both sensors are connected to the ESP8266, providing accurate, real-time data on the current water level.

Step 3: LCD Display Setup
A 16x2 LCD display is used to show real-time water levels and system status. It is connected to the ESP8266 via the I2C interface, allowing the user to view critical information directly from the system without needing to connect to a computer or mobile device.

Step 4: Adding Communication Functionality
The GSM module (SIM800l) is connected to the ESP8266 to send SMS alerts when the water level exceeds the defined threshold. The GSM module communicates with mobile networks, ensuring that alerts reach users in real-time, even in areas without Wi-Fi connectivity.

Step 5: Power Supply and PCB Assembly
The system is powered using a 5V power supply, and all components are assembled on a Zero PCB for stability and ease of connection. The portable design allows the system to be deployed in different locations based on specific monitoring requirements.

Step 6: Testing and Calibration
The system is tested in various flood-prone areas to ensure that it responds appropriately to rising water levels. The sensitivity of the sensors is calibrated, and the alert system is verified to send timely notifications.

6. Expected Outcome:

Accurate Flood Monitoring:
Upon completion, the IoT Flood Monitoring & Alerting System will continuously monitor water levels and provide real-time alerts when the water exceeds safe levels.

SMS-Based Alert System:
The system will send real-time SMS alerts using the GSM module (SIM800l) to notify users of potential flooding, enabling quick action to prevent damage.

Educational Value:
This project offers valuable insights into IoT systems, sensor integration, and communication protocols, making it a strong educational tool for learning about environmental monitoring and early warning systems.

Portable and Efficient Design:
The system's compact and portable design makes it ideal for deployment in various environments, including rural areas with limited infrastructure for flood detection.

7. Reference:

ReliefWeb. (2022, July 10). Climate change exacerbated flash floods in Bangladesh. https://reliefweb.int/report/bangladesh/climate-change-exacerbated-flash-floods-bangladesh

Just Do Electronics. (2023, October 16). Flood monitoring system using GSM and ESP8266. https://justdoelectronics.com/flood-monitoring-system-using-gsm-and-esp8266

Electrical Technology. (2021, March 10). Early flood detection system using IoT and GSM. https://www.electricaltechnology.org/2021/03/early-flood-detection-system.html

IEEE Xplore. (2022, November 25). An IoT-based early flood detection and monitoring system. https://ieeexplore.ieee.org/document/9962925

Cuadra, R. (2021, May 20). IoT-based flood detection system. GitHub. https://github.com/roycuadra/IoT-based-flood-detection-system

Ahmed, S., & Rahman, M. (2023, August 3). Analysis of IoT-based system for flood monitoring application. ResearchGate. https://www.researchgate.net/publication/376017878_Analysis_of_IoT_Based_System_for_Flood_Monitoring_Application

Alam, M., & Hossain, R. (2022, July 28). IoT-based early flood detection using machine learning. ResearchGate. https://www.researchgate.net/publication/362367624_IOT_BASED_EARLY_FLOOD_DETECTION_USING_MACHINE_LEARNING

Li, J., & Zhao, Y. (2017, December 1). A real-time flood monitoring system based on Internet of Things. ScienceDirect. https://www.sciencedirect.com/science/article/abs/pii/S2210537917302469