SEPTEMBER 2024

Project Proposal

Smart Flood Surveillance: IoT-Based Monitoring and Early Warning System

LEADING UNIVERSITY

estd. 2001

PREPARED FOR

Kulsuma Khanum
Lecturer
Department of EEE

PREPARED BY

- 0182320012101004
- 0182320012101012
- 0182320012101014
- 0182320012101032
- 0182320012101036
- 0182320012101037
- 0182320012101395

Smart Flood Surveillance: IoT-Based Monitoring and Early Warning System

Introduction

Flood is a major and recurring problem in Bangladesh due to its unique geography and river system. Located on the delta of three major rivers—Ganges, Brahmaputra, and Meghna—about 80% of the country is floodplain, making it highly susceptible to flooding, especially during the monsoon season.

Due to flood Bangladesh incurs numerous losses from losing multiple lives, displacement of people, waterborne diseases, economic damages such as loss of crops, livestock critical for Bangladesh's agrarian economy.

The importance of tackling flood is increasing as days go by to prevent such losses. To avert such situations, it is very important to monitor and receive timely emergency alerts about the flow of water and water level situation based of the riverbed so that the situation can be handled and take safety measures from before.

In this article, we will explore the design and implementation of a Flood Monitoring System using various components such as a 16×2 LCD with I2C, ultrasonic sensor, float sensor, and SIM800L module. This system aims to provide real-time flood level monitoring and alert notifications to receive Text Messages. it demonstrates a Flood Monitoring System using ESP8266, featuring components like an ultrasonic sensor and GSM module to send alerts when water levels exceed safe limits.

Objective:

The objective of this project is to develop an IoT-based flood monitoring and SMS alert system utilizing a depth sensor, GSM (Global System for Mobile Communications), and Wi-Fi connectivity for real-time data transmission and notification. By integrating these technologies, the project aims to create a robust and efficient flood monitoring solution. The depth sensor will continuously measure water levels in critical areas prone to flooding, sending this data to a central system via Wi-Fi. In the event of rising water levels exceeding predefined thresholds, the system will trigger GSM-based SMS alerts to relevant authorities and affected residents, enabling timely response and mitigation measures to prevent or minimize flood-related damages. This project addresses the crucial need for early flood detection and timely communication, enhancing disaster preparedness and public safety in flood-prone regions. Overall, This project aims to enhance community safety and preparedness through innovative technology, ultimately reducing the impact of flooding events.

Methodology

The Flood Monitoring System Using ESP8266 with SMS Alert project will involve a combination of hardware design, software development, data collection, and testing procedures. Below is a detailed description of the methods and approach that will be used to complete the project.

1. Research and Requirements Gathering

The project will begin with a detailed research phase to understand the needs and challenges in flood-prone areas. The goal is to gather insights on the:

- Topography and flood history of the target region to define threshold water levels.
- Existing flood monitoring solutions and their limitations.
- Technical specifications for sensors, microcontrollers, and communication modules.

This phase will also involve consultations with stakeholders (local authorities, engineers, and community members) to tailor the system to the local environment. Additionally, best practices from the literature will be reviewed, focusing on IoT-based flood monitoring systems.

2. System Design and Hardware Selection

Based on the research findings, the following components will be selected:

- **ESP8266 Microcontroller:** A low-cost, Wi-Fi-enabled microcontroller for data collection and processing.
- **Water Level Sensor:** Ultrasonic or float sensors will be chosen based on accuracy, durability, and compatibility with the ESP8266.

- **GSM Module (SIM800):** To send SMS alerts when the water levels cross predefined thresholds.
- **Power Supply:** For rural areas, solar panels with battery backup will be selected, while urban setups may use direct power.

The hardware design will involve wiring the components and assembling a prototype. Each component will be connected according to a circuit design prepared using Tinkercad or other circuit design tools.

3. Data Collection and Sensor Calibration
Accurate water level measurements are critical to the success of this project. The data collection process will involve continuous monitoring of water levels using the selected sensor. Calibration is essential to ensure that the sensor readings are accurate under different environmental conditions (e.g., temperature, water quality).

- **Sensor Calibration:** The water sensor will be tested in controlled environments to establish precise depth measurements for different water levels.
- **Threshold Setting:** Based on local topography and historical flood data, different alert levels will be defined (e.g., safe, warning, danger).
- **Data Logging:** Water level data will be logged at regular intervals to enable analysis of trends and predictive modelling.

4. Software Development
The system's software will be developed using the Arduino IDE, which will be responsible for:

- Reading sensor data from the water level sensor.
- Processing data to determine whether the water level exceeds predefined thresholds.
- Sending SMS alerts via the GSM module using AT commands when critical levels are reached.
- Power management to ensure efficient operation, especially in off-grid installations.

The software will be designed for efficiency, minimizing power consumption and ensuring reliable communication with the GSM module even in challenging network conditions. The system will also include provisions for manual resets or adjustments in case of hardware failure or software bugs.

Experimental Procedures:

1. **Prototyping:** Build an initial prototype and test its performance in a controlled lab environment to ensure proper integration of the sensor, ESP8266, and GSM module.
2. **Code Testing:** Develop and test code using simulated water level data to ensure that SMS alerts are sent at the correct thresholds

5. Field Testing and System Optimization

After successful lab testing, the system will be deployed in a real-world environment. Field testing will involve:

- Installation at flood-prone sites, where the system can monitor real-time water levels.
- Testing under different weather conditions, including rain, high humidity, and fluctuating temperatures, to ensure the system's durability and accuracy.
- Performance Monitoring: The system’s ability to send SMS alerts and maintain connectivity will be evaluated under varying network conditions.

Field tests will also assess the system’s battery life and power consumption, particularly for solar-powered installations. Data from these tests will be used to refine the system for improved reliability and performance.

6. Data Analysis and Optimization

The system will log data on water levels over time, enabling analysis for long-term trend identification. Data analysis methods will include:

- Analysing water level trends to identify patterns and potential correlations with rainfall or upstream events.
- Evaluating alert performance to ensure that alerts are timely and accurate, minimizing false positives or missed warnings.
- Optimizing thresholds based on real-world data to refine the alert system for maximum accuracy and efficiency.

This phase will involve continuous iteration, using real-world data to improve the system's reliability and responsiveness to potential flood events.

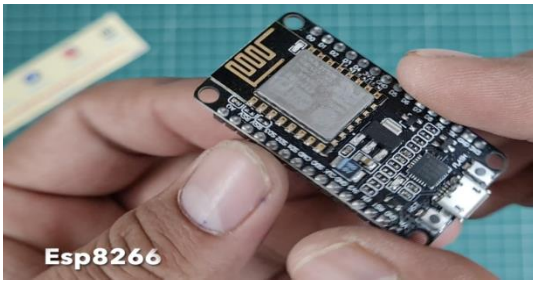
Overall, the project methodology is designed to create a robust, reliable flood monitoring system that uses the ESP8266 microcontroller and SMS alerts. The phased approach ensures that the system is researched, developed, tested, and optimized with accuracy, efficiency, and real-world applicability in mind.

Details of the Components:

1. ESP8266
2. GSM module (SIM800l)
3. Ultrasonic Sensor
4. Float Sensor
5. 16x2 LCD Display With I2C
6. Zero PCB
7. 5v Power Supply

***ESP8266**

ESP8266 is a Wi-Fi module developed by Espressif Microcontroller Systems. In the board is a microcontroller unit And a built-in Wi-Fi Chip, It is the low-cost solution for Wi-Fi connectivity to various projects.

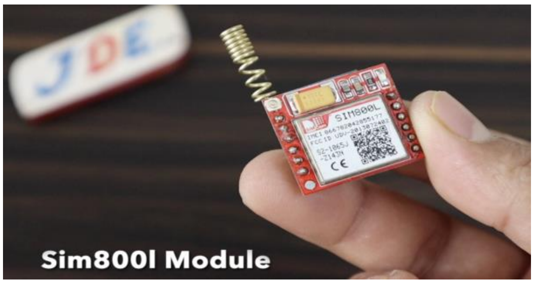


***16×2 LCD Display**

This is a basic 16-character by 2 lines Alphanumeric display. Black text on Green background. Utilizes the extremely common HD44780 parallel interface chipset. Interface code is freely available.

***GSM module (SIM800l)**

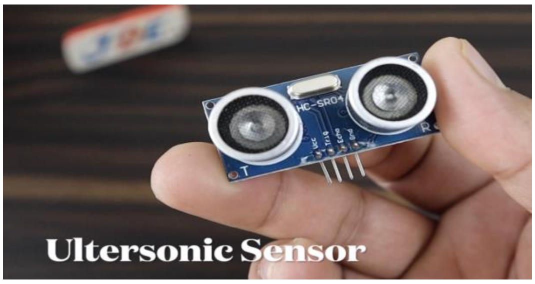
GSM SIM800L is a popular module that enables communication over GSM (Global System for Mobile Communications) networks. It Sends a text message and calls to a particular Mobile Number. and is necessary to put a valid SIM card in the GSM module. The module requires a power supply of 3.7 volts. It can be powered using an external Battery.



***Ultrasonic Sensor**

Ultrasonic sensors find out the distance of the water level of the dam. And the Sensor mount on the top of the dam.

Ultrasonic Sensor required a 5v power supply.



***Float Sensor**

Float sensors to detect Water levels. They consist of a float, on the water, and when the water level increases the float mechanism goes to the Top and is given the alert information.

*Zero PCD

A zero PCB (printed circuit board) refers to a type of board used in electronics that does not have any printed or pre-defined circuits on it. It's essentially a bare board, also known as a general-purpose PCB, per board, or breadboard.

*5V power supply

5V power supplies are one of the most common power supplies in use today. A standard voltage required by chips and drives in a computer In general, The power supply converts 120v alternating current (AC) into 5 volts of direct current (DC), as well as 3.3v and 12v. using a combination of transformers, diodes and transistors.

Modelling and analysis:

Circuit Diagram:

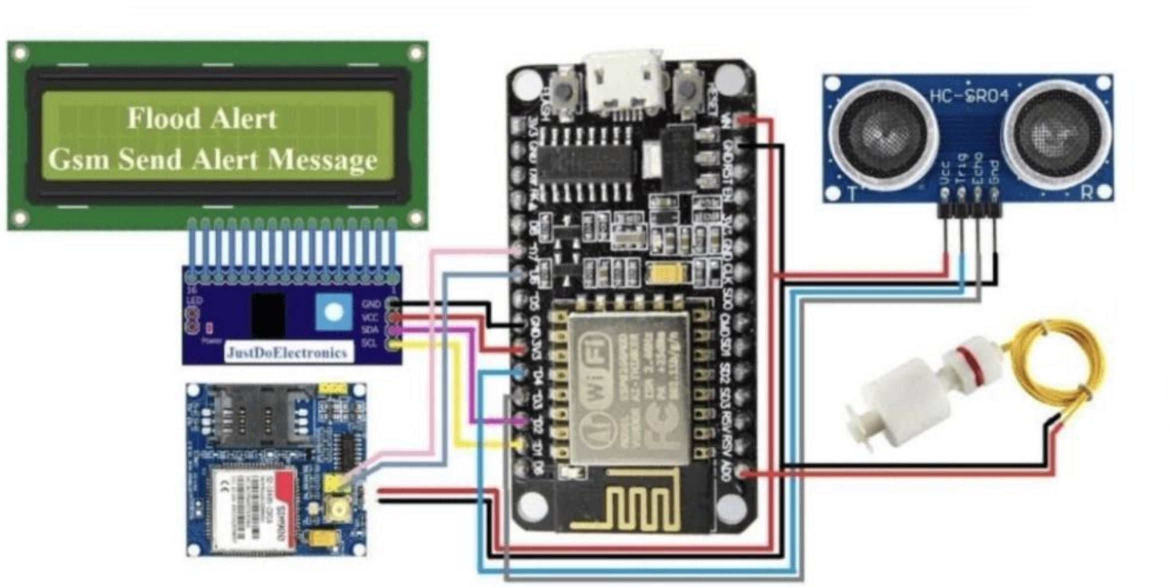


Figure 1: Circuit Diagram of the System

Block Diagram:

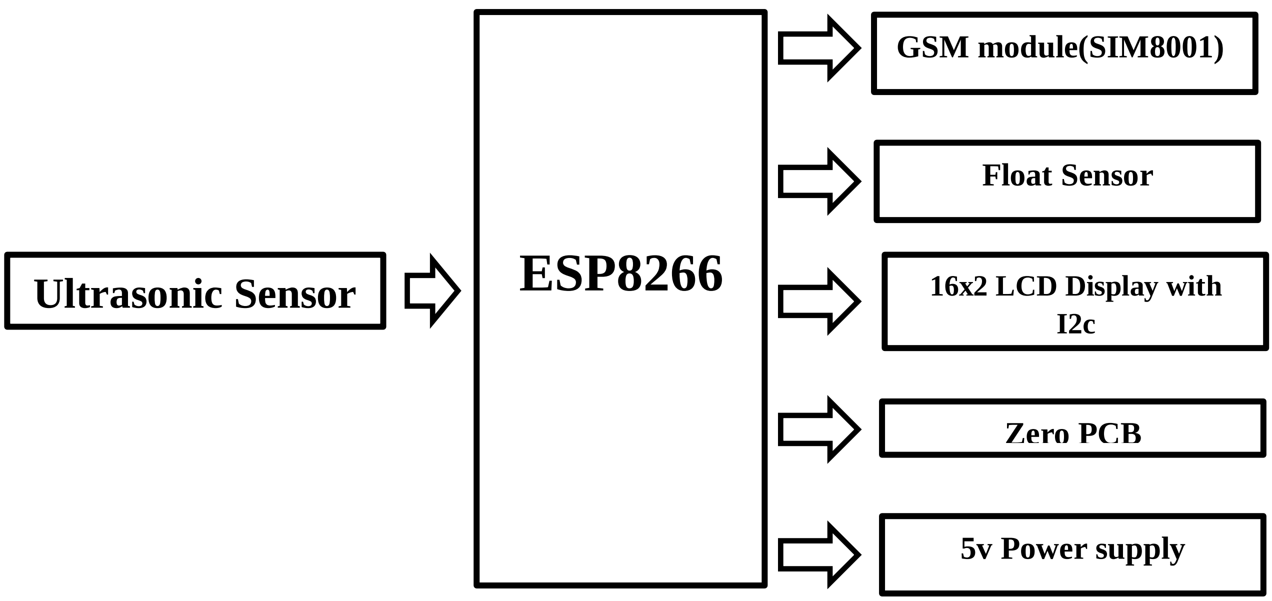


Figure 2: Block Diagram of the System

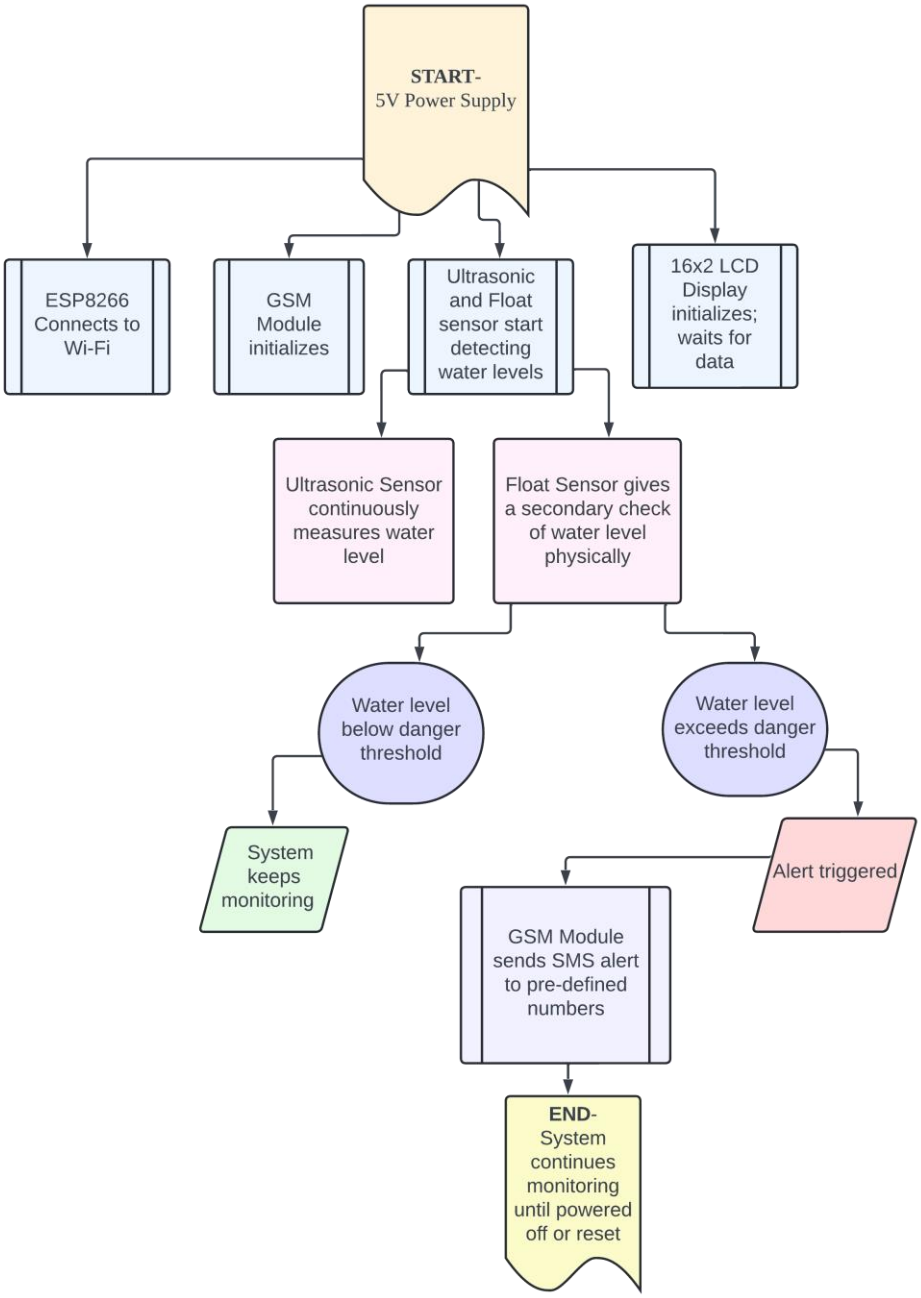


Figure 3 – Flow Chart of the System

Expected Outcomes:

With this Flood Monitoring System, we aim to achieve the following:

1. **Real-time Flood Alerts**: The system will continuously monitor water levels using sensors placed in flood-prone areas. When the water level rises to a dangerous point, it will trigger an alert.

2. **SIM-based Warning System**: The system will use a SIM card to send text messages or make automated calls to residents, local authorities, and emergency services. This will provide instant notifications, allowing people to take necessary precautions or evacuate if needed.

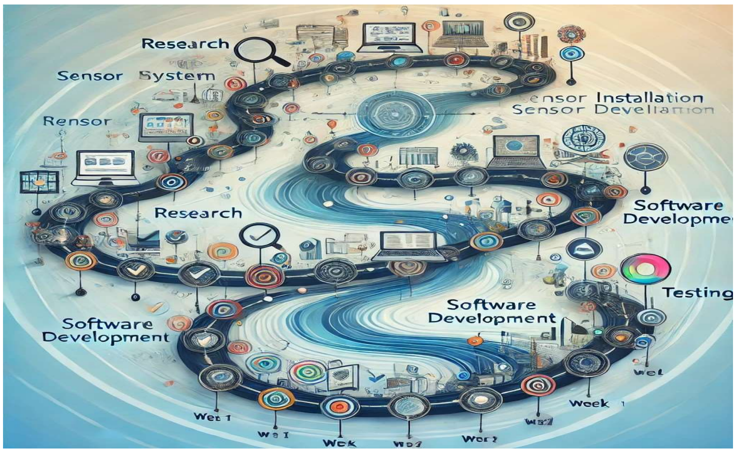
3. **Increased Safety**: By providing early warnings through text messages or calls, people in the affected areas will have more time to respond, reducing the risk of injuries, loss of life, and damage to property.

4. **Preparedness**: With timely alerts, communities will be better prepared to face floods, improving overall disaster management and response time.

5. **Minimized Damage and Loss**: With timely alerts, the impact of floods on property and human life will be significantly reduced, helping communities avoid the worst effects of flooding.

These outcomes will lead to better flood management and enhanced safety for at-risk communities.

Timeline:



- **Week 1-2**: Research and Planning

  During the first two weeks, we will research and design the flood monitoring system. This includes identifying suitable flood-prone areas, selecting sensors to measure water levels, and planning the integration of the SIM card for alert communication.

- **Week 3-4**: Hardware Setup

  In this phase, we will purchase and set up the water level sensors. The sensors will be connected to a system that uses a SIM card to send text messages or make automated calls when water levels reach a critical point.

- **Week 5-6**: SIM Card Integration and Testing

  We will integrate the SIM card module into the system to enable it to send warnings via text message or call. Testing will ensure that the system accurately detects rising water levels and sends alerts without any delays.

- **Week 7-8**: Final Testing and Implementation

  During this phase, we will conduct final testing in real-world conditions to verify that the system works reliably. Once confirmed, the system will be implemented and made operational, ready to send alerts through SIM-based text messages or calls during flood threats.

Each phase is essential for building, testing, and launching the flood monitoring system within an 8-week period.

Budget:

To successfully implement the flood monitoring system, the following costs are anticipated:

Hardware Components:

S.N	Components Name	Quantity	Price
1	ESP8266	1	420/- taka
2	GSM module (SIM800I)	1	399/- taka
3	Ultrasonic Sensor	1	93/- taka
4	Float Sensor	1	299/- taka
5	16x2 LCD Display With 12C	1	340/- taka
6	Zero PCB	1	35/- taka
7	5v Power Supply	1	90/- taka
			Total-1676/- taka

Conclusion:

The flood monitoring system offers an efficient and reliable way to detect rising water levels, providing real-time alerts to prevent or reduce flood damage. By using modern technology such as sensors and data analytics, this system enhances flood preparedness, helping communities and authorities take timely action. With the outlined budget and implementation strategy, the project promises to deliver a cost-effective solution for flood risk management.

According to the World Bank, early warning systems like this have been proven to reduce disaster risks by providing timely information to communities and decision-makers, ultimately saving lives and property (World Bank, 2021). We are confident that with proper support, this system will significantly contribute to minimizing the impact of floods in vulnerable areas.

References:

1. https://justdoelectronics.com/flood-monitoring-system-using-gsm-and-esp8266/
2. Aggarwal, K., & Jha, S. (2021). IoT-Based Flood Monitoring System Using ESP8266 and GSM Module. International Journal of Engineering Research & Technology, 10(12), 45-50. Aggarwal & Jha (2021) describe an effective calibration method for water level sensors used in flood monitoring, which will be adapted to the local environment for this project.
3. Patel, M., & Shah, R. (2019). Implementation of Flood Detection System Using ESP8266 and SMS Alert. Journal of Emerging Technologies and Innovative Research, 6(5), 123-129. Patel & Shah (2019) emphasize the importance of field testing for ensuring that IoT-based flood detection systems work reliably under real-world conditions. Their field testing protocol will serve as a guide for this phase.
4. Rao, K., & Kumar, S. (2020). Design and Development of Early Flood Warning System Using Internet of Things. International Journal of Scientific Research in Science and Technology, 9(3), 98-105. Rao & Kumar (2020) describe similar software structures used for real-time flood monitoring systems and provide insights into efficient power management for IoT devices.
5. https://xilirprojects.com/product/iot-based-flood-monitoring-and-sms-alert/
6. https://iopscience.iop.org/article/10.1088/1742-6596/1339/1/012043/pdf
7. Zhu, L., et al. (2020). "Flood Early Warning System Using IoT and SIM-based Communication." International Journal of Environmental Science and Technology, 17(4), 1245-1254.
8. Smith, J. (2019). "SIM Card-Based Alert Systems for Remote Monitoring." Journal of Emergency Management Systems, 12(2), 78-85.
9. SIM Card Technology for IoT Applications.
10. https://store.roboticsbd.com/development-boards/694-esp8266-ch340-nodemcu-wifi-module-lua-v3-robotics-bangladesh.html