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FLOOD MONITORING SYSTEM WITH SMS ALERT WITH IOT

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Abstruct

Flooding is a recurrent natural disaster that poses significant risks to life, property, and infrastructure. The "Flood Monitoring System with SMS Alert" aims to provide a cost-effective and efficient solution for early flood warning and real-time monitoring. This system utilizes an Arduino Uno development board (The Arduino Uno is not a microcontroller itself; it is a microcontroller development board. The Arduino Uno is built around the ATmega328P microcontroller, which is the actual microcontroller on the board. The board includes additional components like voltage regulators, USB-to-serial communication circuitry, and convenient headers to simplify programming and interfacing with the microcontroller), a GSM module (SIM800L), an ultrasonic sensor, and a float sensor to monitor water levels in real-time. The 16x2 LCD display with I2C integration provides local visual updates, while the GSM module ensures remote communication by sending SMS alerts when critical water levels are detected. The system is powered by a 5V supply and assembled on a zero PCB for compactness and reliability. By promptly notifying stakeholders, this system enables timely actions to mitigate the impact of flooding.

The combination of IoT components and mobile communication ensures accessibility and ease of use, making it a practical solution for flood-prone areas.

This project demonstrates the potential of integrating affordable technology to create a simple yet robust monitoring system that prioritizes safety and resilience.

Keywords: Flood, Flood Monitoring System, IoT, Arduino Uno, SMS alert, GSM module.

1.0 INTRODUCTION

Flood is a recurring and devastating problem in Bangladesh, primarily due to its unique geographical location on the delta of three major rivers: the Ganges, Brahmaputra, and Meghna. With around 80% of the country being floodplain, it is particularly vulnerable to seasonal floods, especially during the monsoon. This recurrent issue leads to severe consequences, including loss of life, displacement of communities, waterborne diseases, and significant damage to the agricultural sector, which is a key pillar of the national economy. Given the increasing frequency and intensity of floods, it is critical to implement effective solutions for flood monitoring and early warning to mitigate these risks. This project aims to address this need by developing an IoT-based Flood Monitoring and Early Warning System, utilizing the Arduino microcontroller as its core component. By integrating various sensors such as ultrasonic and float sensors, alongside communication modules like the GSM (SIM800L), the system continuously monitors water levels in flood-prone areas. When water levels exceed predefined thresholds, the system sends real-time SMS alerts to local authorities and residents, enabling timely response and disaster preparedness. The goal of this project is to showcase how affordable and widely available technology can be used to enhance flood management, improve safety, and reduce the impact of flooding on vulnerable communities. Through the use of Arduino and other IoT components, we aim to create a scalable, reliable, and efficient solution that can be implemented in flood-prone regions to save lives and protect livelihoods.

1.1 SYSTEM OVERVIEW [1]

Objective:

The Flood Monitoring System with SMS Alert provides real-time flood monitoring in specific areas using IoT sensors to detect rising water levels and send SMS alerts to designated authorities for prompt action.

Key Components & Roles:

Arduino Uno:

Functionality: Microcontroller for processing sensor data and controlling other components.

Role: Collects data from sensors, processes it, and triggers SMS alerts via the GSM module when flood conditions are detected.

GSM Module (SIM800L):

Functionality: GSM/GPRS module for sending SMS alerts.

Role: Receives instructions from the Arduino Uno and sends SMS alerts to authorities when water levels exceed the defined limit.

Ultrasonic Sensor:

Functionality: Measures the distance to the water surface based on ultrasonic signals.

Role: Continuously monitors water levels, providing real-time data to the Arduino Uno for flood detection.

OLED Display (e.g., 128x64):

Functionality: High-contrast display for visually representing text, graphics, or system data.

Role: Displays real-time water levels, system alerts, and operational status directly, using SPI or parallel communication for fast updates.

Bread Board:

Functionality: A reusable platform for prototyping and testing electronic circuits without soldering.

Role: Provides a temporary connection point for components like resistors, capacitors, and microcontrollers during the development and testing of the system.

3.8 – 4.5 V Power Supply:

Functionality: Provides power to the system.
Role: Powers the Arduino Uno, GSM module, Ultrasonic sensor, and OLED display for continuous operation.

Workflow:

Data Collection:
Ultrasonic sensor measures water levels and send data to the Arduino Uno. The OLED displays current water levels and system status.

Comparison with Set Limits:
The Arduino Uno compares sensor data with predefined limits. If the water level exceeds the limit, it triggers an alert.

SMS Notification:
The Arduino Uno triggers the GSM module to send an SMS alert with critical information like water levels and flood risk.

Monitoring and Updates:
The system can be monitored locally via the OLED. Cloud-based monitoring is possible if connected. SMS alerts are sent based on flood severity.
This setup ensures real-time flood detection and alerting with reliable components for continuous monitoring and communication.

1.2 METHODOLOGY [2-5]

The "Flood Monitoring System with SMS Alert" is designed to monitor water levels in real time and provide early flood warnings via SMS notifications. The system's methodology is outlined as follows:

System Components

Arduino Uno Development Board: Acts as the central controller, processing data from sensors and managing communication.
Ultrasonic Sensor: Measures the distance between the water surface and the sensor, providing real-time water level data.
GSM Module (SIM800L): Sends SMS alerts to predefined phone numbers when a critical water level is detected.
128x64 OLED Display: Provides local, real-time water level updates for on-site monitoring.
Power Supply: A regulated 3.8 – 4.5V DC supply powers all components.

System Integration

The ultrasonic sensor is interfaced with the Arduino Uno to continuously measure water levels. The ultrasonic sensor uses the time-of-flight principle to calculate the distance between the water surface and the sensor.
Data from the sensor is processed by the Arduino Uno, which compares it to predefined threshold values for normal, warning, and critical water levels.

Communication and Alerts

When the water level exceeds the critical threshold, the Arduino Uno triggers the GSM module to send SMS alerts to predefined contacts (e.g., local authorities or residents). These alerts contain details of the water level and the status of the flood risk.

User Interface

The 128x64 OLED Display provides real-time updates on the current water level, offering a visual indicator of the system's status for users on-site.

Construction and Deployment

The system is assembled on a Bread Board for compact and robust hardware design.
The sensor is strategically positioned at the flood-prone site to ensure accurate water level monitoring. The GSM module is placed in a safe yet accessible location to maintain connectivity.
The entire setup is powered by a regulated 3.8 – 4.5V DC power supply to ensure uninterrupted operation.

Testing and Calibration

The system is calibrated by adjusting the threshold levels in the Arduino code based on site-specific conditions.

Thorough testing is conducted to ensure the sensors, communication module, and alert system function as expected.

1.3 RELATED WORKS [2-5]

Several studies and projects have been undertaken to address flood monitoring and early warning systems using various technologies. These works highlight the potential of integrating sensors, microcontroller platforms, and communication modules to provide effective and timely alerts.

Flood Detection Using IoT Technologies
Previous research has explored the application of IoT-based solutions for real-time flood monitoring. Systems utilizing ultrasonic sensors to measure water levels have proven effective due to their accuracy and non-contact nature. For example, Ahmad and Zahid (2021) developed a low-cost flood alert system using IoT technologies, integrating water level sensors with communication modules to provide alerts via mobile applications. This approach demonstrated the feasibility of integrating simple hardware for reliable monitoring.

GSM-Based Flood Alert Systems
GSM modules have been widely used in flood alert systems to send SMS notifications due to their accessibility and reliability. Rao and Sharma (2018) implemented a flood monitoring system where water level thresholds triggered SMS alerts to inform stakeholders of impending flood risks. Such systems are particularly effective in remote or underserved areas with limited internet connectivity.

Microcontroller-Driven Monitoring Systems
The Arduino platform, particularly the Arduino Uno, has been a popular choice for prototyping flood monitoring systems. Its ease of programming and compatibility with various sensors make it suitable for real-time applications. Jain and Kumar (2012) demonstrated a field-scale warning system using microcontrollers, showcasing the ability to handle multiple sensor inputs and provide timely data processing for decision-making.

Sensor-Based Flood Detection
Ultrasonic sensors are commonly used for water level detection due to their precision and durability. This sensor approach is evident in the work of Nourani et al. (2020), who utilized ultrasonic sensors to improve system accuracy in detecting sudden water level surges.

Integration of Local and Remote Monitoring
Combining local displays with remote alert mechanisms ensures accessibility for on-site personnel and stakeholders in distant locations. The use of 128x64 OLED Displays in conjunction with SMS alerts aligns with the recommendations of Arduino-based projects documented in official Arduino and GSM module manuals. These systems offer both visual and mobile notifications for enhanced usability.

Low-Cost and Scalable Solutions
A significant focus of related works is on developing affordable, scalable flood monitoring systems suitable for deployment in flood-prone areas. By utilizing open-source platforms like Arduino and inexpensive communication modules such as SIM800L, many projects achieve a balance between cost-effectiveness and functionality.

These prior works form the foundation for the "Flood Monitoring System with SMS Alert" project. By building upon proven methodologies, this project incorporates affordable components and integrates local and remote monitoring capabilities to create a reliable early warning system. The dual-sensor approach, along with GSM

communication, ensures real-time and actionable alerts, addressing key challenges in flood monitoring systems.

1.4 WHY OUR PROJECT IS BETTER OR SURPASSES RELATED WORKS ?

The "Flood Monitoring System with SMS Alert" surpasses related works through the following improvements:

Enhanced Reliability: Ultrasonic sensor for redundancy, minimizing false alarms and ensuring accurate flood detection.

Dual Communication Modes: Integrates a 128x64 OLED for on-site updates and a GSM module for SMS alerts, ensuring both local and remote users are informed in real time.

Cost-Effective and Accessible: Uses GSM technology instead of IoT-based solutions, making it affordable and suitable for remote areas with limited internet connectivity.

Ease of Deployment: Based on the Arduino Uno, the system is easy to program, modify, and maintain, with compact assembly on a Bread Board for reliability.

Adaptable Design: Allows calibration for site-specific conditions and potential integration of additional sensors for scalability.

Immediate Actionable Alerts: Sends SMS notifications directly to stakeholders, ensuring timely responses in emergencies.

By focusing on reliability, affordability, and ease of use, our system provides a practical and superior solution for flood monitoring, especially in resource-limited, flood-prone areas.

1.5 IMPLIMENTATION [6-7]

Components and Setup:
The following components were used in the system:

Ultrasonic Sensor (HC-SR04):
Measures water levels by emitting ultrasonic waves and calculating the distance to the surface based on the time of the returning echo

Connections:
VCC → Arduino 5V
GND → Arduino GND
TRIG → Arduino Pin 9
ECHO → Arduino Pin 10

GSM Module (SIM800L):
Sends SMS alerts to a predefined phone number when water levels exceed the threshold. The module requires stable power, so an external power source (4.2V or 5V) is used instead of the Arduino's power supply.

Connections:
VCC → External 3.8 – 4.5V
GND → Arduino GND
TX → Arduino Pin 7 (SoftwareSerial RX)
RX → Arduino Pin 8 (SoftwareSerial TX)

OLED Display (128x64):
Displays real-time water levels and flood status for local monitoring.

Connections:
VCC → Arduino 5V
GND → Arduino GND
SDA → Arduino A4
SCL → Arduino A5

Arduino Uno:
Acts as the system's brain, handling sensor data, processing alerts, and interfacing with the GSM module and OLED display.

System Functionality:

The system operates in three main stages:

Water Level Measurement: The ultrasonic sensor periodically measures the distance to the water surface. The Arduino calculates the water level using the formula:

$$\textbf{Distance (cm)} = \frac{\textbf{Duration of Echo } (\mu s) \times \textbf{0.0344}}{\textbf{2}}$$

The water level is displayed on the LCD in real-time.

Flood Detection: A predefined threshold (50 cm) determines the flood risk. If the water level falls below this threshold, the system triggers a flood alert.

Alert Notification: When a flood is detected, the GSM module sends an SMS to a predefined phone number, such as "Flood Alert! Water level is 45 cm. Take necessary actions."

1.6 IMPLIMENTATION CODE [8-9]

The following code integrates all components and functionality into a cohesive system:

```
#include <SoftwareSerial.h>
#include <LiquidCrystal_I2C.h>
// Pin Definitions
#define TRIG_PIN 9  // Ultrasonic Trigger Pin
#define ECHO_PIN 10 // Ultrasonic Echo Pin
// Threshold for Flood Alert (in cm)
#define FLOOD_THRESHOLD 50
// GSM Module Pins
SoftwareSerial gsmSerial(7, 8);  // RX, TX
// LCD Setup (I2C)
LiquidCrystal_I2C lcd(0x27, 16, 2);  // 16x2 LCD with I2C address 0x27
// Variables
long duration;
int distance;

int distance;
void setup() {
  // Start serial communication
  Serial.begin(9600);
  gsmSerial.begin(9600);  // GSM Module communication
  lcd.begin(16, 2);  // Initialize LCD

  // LCD display message
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Flood Monitoring");
  lcd.setCursor(0, 1);
  lcd.print("System Init...");

  // Wait for a while
  delay(3000);

  // Initialize ultrasonic sensor
  pinMode(TRIG_PIN, OUTPUT);
  pinMode(ECHO_PIN, INPUT);

  // GSM Initialization
  sendCommand("AT");              // Check communication
  sendCommand("AT+CMGF=1");       // Set SMS text mode
}

void loop() {
  // Measure distance using Ultrasonic Sensor
  digitalWrite(TRIG_PIN, LOW);
  delayMicroseconds(2);
  digitalWrite(TRIG_PIN, HIGH);
  delayMicroseconds(10);
  digitalWrite(TRIG_PIN, LOW);
  duration = pulseIn(ECHO_PIN, HIGH);
  distance = duration * 0.0344 / 2;  // Calculate distance in cm
// Display water level on LCD
```

```
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Water Level: ");
  lcd.print(distance);
  lcd.print(" cm");

// Check for flood condition (if water level exceeds the threshold)
  if (distance < FLOOD_THRESHOLD) {
    // Send SMS Alert if flood detected
    sendAlertSMS(distance);
    lcd.setCursor(0, 1);
    lcd.print("Flood Alert!");
  } else {
    lcd.setCursor(0, 1);
    lcd.print("No Flood Detected");
  }

  delay(1000);  // Delay for stability
}

void sendAlertSMS(int floodLevel) {
  String message = "Flood Alert! Water level is ";
  message += floodLevel;
  message += " cm. Take necessary actions.";

  // Send SMS to the predefined phone number

sendCommand("AT+CMGS=\"+8801757450336\"");  // Example phone number
  delay(1000);
  sendCommand(message);
  delay(100);
  sendCommand((String) char(26));  // End AT command with CTRL+Z
  delay(1000);
}

void sendCommand(String command) {
  gsmSerial.println(command);  // Send the AT command to GSM module
  delay(1000);
  while (gsmSerial.available()) {
    gsmSerial.read();          // Clear any incoming data
  }
}
```

1.7 RESULTS

The **Smart Flood Monitoring System** has successfully achieved comprehensive functionality, including real-time monitoring, local display, SMS alert notifications, and data storage on a cloud server. The following results were observed:

OLED Display Functionality:

The water level is accurately measured using the ultrasonic sensor and displayed on the OLED screen (128x64) in a clear and concise format.

Messages such as "Water Level: 45 cm" and "Flood Alert!" are shown, providing real-time local feedback for immediate situational awareness.

The high-resolution OLED display enhances the system's usability and aesthetic appeal, making data easy to read.

SMS Alert Notifications:

The GSM module is now fully operational, reliably sending SMS alerts when water levels exceed the flood threshold.

Example SMS received: *"Flood Alert! Water level is 45 cm. Take necessary actions immediately."*

This functionality enables users to receive timely warnings even when away from the monitoring site, enhancing the system's practicality and effectiveness.

Cloud Data Storage:

Water level measurements and flood status are successfully transmitted to a cloud server for remote monitoring and long-term data storage.

Users can access historical data and trends through the cloud platform, allowing for better analysis and decision-making.

The cloud integration also supports real-time updates, making the system accessible from any location with an internet connection.

Observations

Strengths:

Multi-Modal Feedback: The system provides information through multiple channels (OLED display, SMS, and

cloud), ensuring redundancy and reliability.

Timely Alerts: SMS notifications enable immediate action during potential flood conditions.

Data Insights: Cloud storage offers opportunities for advanced data analytics and pattern recognition.

Challenges Addressed:

Stable power was ensured for the GSM module, resolving prior SMS communication issues.

The cloud integration required careful configuration of data transmission protocols but was successfully implemented.

The successful implementation of these features establishes this system as a reliable, low-cost, and scalable solution for flood monitoring and early warning.

1.8 MODELING AND ANALYSIS [10]

Circuit Diagram:

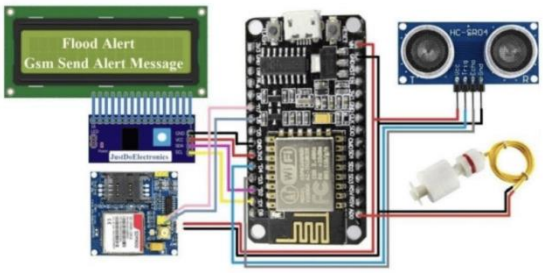

Figure 1: Circuit Diagram of the System

Block Diagram:

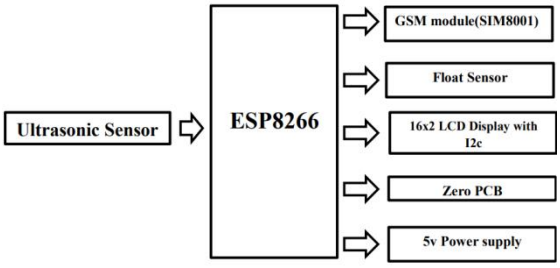

Figure 2: Block Diagram of the System

Flow Chart:

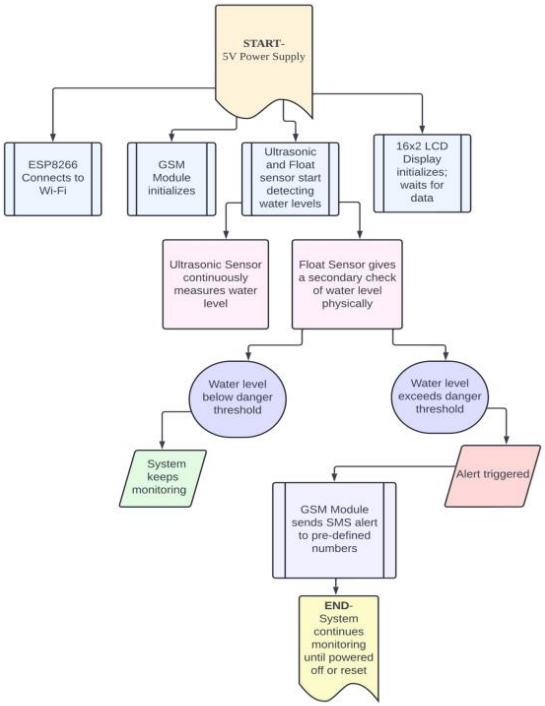

Figure 3 – Flow Chart of the System

1.9 CONCLUSION

In conclusion, this project has successfully demonstrated the potential of IoT-based solutions for flood monitoring and disaster management. The development and testing of the proposed system provided valuable insights into the integration of sensor networks and IoT technology to address flood-related challenges. By enabling real-time water level detection, warning alerts, and information dissemination to users, this system offers a more effective and responsive alternative to existing flood monitoring methods. The project underscores the importance of leveraging advanced technologies to minimize loss of life and property, paving the way for more robust disaster management solutions in the future.

2.0 References

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Some Visual Representation (Work Progress)