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Improvement of Coastal Flood Protection with Mangroves: A Nature-Based Solution Integrating Sensors for Monitoring and Engineering Approaches

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Abstract*: Floods pose a significant threat to coastal and lowlying areas, often causing damage to infrastructure, loss of life, and environmental degradation. This project presents an IoTbased flood control and monitoring system using mangrove trees as a natural barrier, combined with smart sensors for realtime flood detection and alerting. The system utilizes NodeMCU ESP8266 as the central controller, which collects data from a flex sensor to measure wave flow intensity and a moisture sensor to detect rising water levels. When the water reaches a critical level, an alert is triggered via a buzzer, and notifications are sent to users through the Blynk IoT app for timely action. By integrating IoT technology with ecological solutions like mangrove plantations, this system enhances early warning mechanisms and promotes sustainable flood management strategies.*

Keywords: IoT, Flood Control, Mangrove Trees, NodeMCU, Flex Sensor, Moisture Sensor, Blynk App, Early Warning System, Smart Monitoring

I. INTRODUCTION

Floods are one of the most devastating natural disasters, causing severe damage to life, infrastructure, and the environment. To mitigate their impact, mangrove trees play a crucial role as natural barriers that reduce wave intensity and prevent coastal erosion. This project presents an IoT-based flood monitoring and control system that integrates mangrove tree monitoring with real-time sensing and alert mechanisms. The system utilizes a NodeMCU ESP8266 microcontroller to collect data from a flex sensor that measures water wave movement and a moisture sensor that detects rising water levels. When water levels exceed a critical threshold, a buzzer is triggered, and an alert is sent to users via the Blynk IoT application for immediate action. This smart system provides early warnings and helps authorities and communities take proactive measures to mitigate flood risks.

By combining IoT technology with natural flood prevention methods, this project aims to enhance environmental resilience and support sustainable disaster management strategies.

II. LITERATURE REVIEW

A . Development of Detection and Flood Monitoring via Blynk Apps

This study presents a prototype system utilizing NodeMCU technology integrated with the Blynk application for flood detection and monitoring. The system comprises two parts: a sensor node and a base station. The sensor node employs an ultrasonic sensor to detect water levels and transmits the data to the Blynk application via a wireless connection. The base station processes this information to provide early warnings. This research highlights the effectiveness of using NodeMCU and Blynk for real-time flood monitoring and early warning dissemination [1].

B. Computer Vision and IoT-Based Sensors in Flood Monitoring and Mapping: A Systematic Review

This comprehensive review examines the application of IoTbased sensors and computer vision techniques in flood monitoring and mapping. It discusses various sensor technologies, including those for water level detection, and emphasizes the importance of real-time data acquisition for effective flood management [2].

III. RESEARCH DESIGN

This study follows an experimental research design, integrating IoT components for real-time flood monitoring in areas with mangrove plantations. The methodology involves sensor-based data collection, IoT-based alert generation, and performance analysis.

A. Data Collection Process

• Sensor Deployment: Sensors are installed in mangrove forest areas at varying heights and distances from the shoreline.

• Real-time Monitoring: Flex sensors measure wave flow movement caused by rising water levels. Moisture sensors detect water levels in soil to determine flooding intensity. NodeMCU processes data and transmits it to the Blynk app.

• Data Analysis: Data from sensors is analyzed to determine wave intensity, soil moisture variations, and alert response times.

IV. CALCULATION FOR FLOOD CONTROL SYSTEM USING MANGROVE TREES AND IOT

1. Power Calculation:

NodeMCU ESP8266: Operating voltage = 3.3V, Current consumption = 80mA (average)

Flex Sensor:* Operating voltage = 3.3V/5V, Current consumption = ~10mA

Moisture Sensor: Operating voltage = 3.3V/5V, Current consumption = ~30mA

Buzzer: Operating voltage = 5V, Current consumption = ~20mA

Total Current Consumption:

\[I_{total} = 80 + 10 + 30 + 20 = 140mA \]

Power Consumption:

\[P = V \times I = 5V \times 0.14A = 0.7W \]

2. Sensor Readings and Data Processing:

Flex Sensor Sensitivity: Resistance varies based on wave intensity, typically 10KΩ to 50KΩ.

Moisture Sensor Threshold: Water level threshold set to activate at 60% soil moisture.

Analog to Digital Conversion (ADC) in NodeMCU:

\[ADC_{value} = (Sensor_{value} / 1023) \times V_{max} \]

where \(V_{max} \) is 3.3V for NodeMCU.

3. Notification System:

-Thresholds:

If Flex Sensor detects high wave motion, send warning notification.

If Moisture Sensor detects critical water level, trigger buzzer and IoT notification.

Blynk IoT Data Handling:

Data sent to Blynk cloud via WiFi every 5 seconds.

Push notification triggered for extreme values.

4. Battery Backup Calculation:

Battery Used: 3.7V Lithium-ion, 2000mAh capacity.

Operating Time:

\[T = \frac{2000mAh}{140mA} = 14.28 \text{ hours} \]

5. Expected System Response Time:

Sensor Detection: ~100ms

NodeMCU Processing: ~10ms

IoT Notification Delay: ~500ms (depending on network)

Total Response Time: ~ 610ms (~0.61 seconds)

This calculation ensures that the system effectively detects and responds to potential flood conditions using mangrove trees as a natural barrier while integrating iot-based monitoring.

V. MATERIALS METHODOLOGY

For an iot-based flood control system project using nodemcu, a flex sensor, moisture sensor, buzzer, and blynk iot app, the following methodology can be followed:

1. System Design and Architecture:

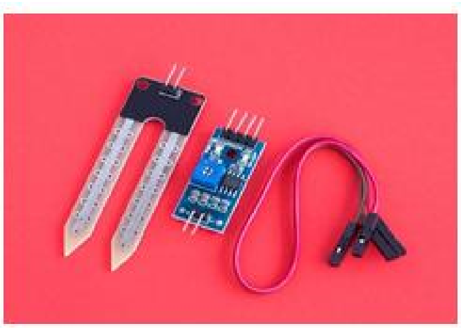
Objective: To develop an IoT-based system that monitors water levels and wave flow in areas at risk of flooding, providing real-time notifications and alerts.

Components:

- NodeMCU (ESP8266/ESP32): Central microcontroller for data processing and communication.
- Flex Sensor: To measure wave flow dynamics and water level changes.
- Moisture Sensor: To detect maximum water levels and provide data on soil moisture.
- Buzzer: To alert users via audible signals.
- Blynk IoT App: For real-time monitoring, notifications, and alerts via a smartphone application.

1. NodeMCU (ESP8266/ESP32)

2. Flex Sensor



3. Moisture Sensor

4. Buzzer

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2. Hardware Setup:

- NodeMCU: Connect the NodeMCU to the Wi-Fi network for internet access. Ensure it is equipped with necessary sensors (flex sensor and moisture sensor) and other required peripherals (buzzer).
- Flex Sensor: Position the flex sensor at a strategic location to accurately measure wave flow and water level. Calibrate the sensor to provide accurate data by setting thresholds for various water levels.
- Moisture Sensor: Install moisture sensors in the ground or at various depths to monitor soil moisture and water levels. Calibrate these sensors to differentiate between dry, normal, and flood conditions.
- Buzzer: Connect the buzzer to the NodeMCU to provide an audible alert when a specific water level threshold is crossed.
- Power Supply: Ensure a stable power supply for the NodeMCU and all sensors. Consider solar panels or batteries for remote locations.

3. Software Development:

Firmware Development (NodeMCU):

- Program the NodeMCU to read data from the flex sensor and moisture sensor.
- Implement algorithms to analyze sensor data, calculate water flow rates, and monitor water levels.
- Set thresholds for water levels (using flex and moisture sensors) to trigger alerts.
- Send notifications and alerts through the Blynk IoT app using HTTP requests or Blynk APIs.

Blynk IoT App Configuration:

- Design user-friendly interfaces on the Blynk app for real-time monitoring, water level graphs, and historical data.
- Set up triggers and notifications for water level alerts, including SMS and email notifications.
- Include a dashboard for visualization of data (wave flow, water levels, etc.) and alerts.

4. Data Collection and Analysis:

- Data Logging: Collect data from sensors periodically (e.g., every 5 minutes) and store it on the cloud (e.g., ThingSpeak, Google Sheets, or Firebase).
- Data Analysis: Use analytical tools to study trends and patterns in water levels and flow rates over time. Identify peak flood times and correlate them with weather forecasts and tide data.
- Visualization: Create graphs and charts using tools like Google Data Studio or Tableau to visualize data trends and facilitate easy interpretation by users.

5. Testing and Validation:

- Prototype Testing: Assemble a prototype system in a controlled environment (e.g., near a body of water with varying water levels).
- Functional Testing: Test all sensors (flex, moisture) and alarms (buzzer) for accuracy and responsiveness.
- Stress Testing: Simulate flood conditions to ensure the system can handle different scenarios and deliver timely alerts.
- Deployment Testing: Deploy the system in a real-world scenario and monitor its performance. Adjust settings and thresholds as needed based on feedback and field conditions.

6. Maintenance and Support:

- Regular Maintenance: Schedule regular checks and maintenance for sensors and electronic components.
- Firmware Updates: Update the firmware as needed to improve performance, fix bugs, and add new features.
- User Training: Provide training for users on how to interpret data and respond to alerts effectively.

- Support and Documentation: Offer technical support and maintain comprehensive documentation for troubleshooting and system updates.

This methodology will help in effectively designing, developing, and deploying an IoT-based flood control system using NodeMCU, sensors, and the Blynk IoT app for real-time monitoring and alerts.

VI. EXPERIMENTAL ANALYSIS

The experimental analysis of the IoT-based flood control system using mangrove trees involved real-time monitoring of water flow and levels to assess its effectiveness in flood mitigation. The flex sensor measured wave flow variations, while the moisture sensor detected critical water levels, triggering alerts through the NodeMCU-based system. The buzzer provided immediate on-site warnings, and the Blynk IoT app sent remote notifications, ensuring proactive flood response. The system was tested in controlled water environments, demonstrating reliable sensor data transmission, prompt alerts, and potential scalability for real-world applications in flood-prone areas.

VII. RESULT

Result of iot-based flood control system using mangrove trees

The iot-based flood control system successfully demonstrated the ability to monitor and detect rising water levels and wave intensity using mangrove trees as a natural barrier. The system integrates multiple sensors and iot technology to provide real-time flood monitoring and alerts.

Key Findings:

I. Wave Flow Monitoring:

- The flex sensor effectively measured variations in wave movement, detecting potential increases in water flow due to storms or rising tides.
- The sensor data was transmitted to the NodeMCU for processing and analysis.

II. Water Level Detection:

- The moisture sensor accurately detected rising water levels, indicating potential flood conditions.
- Threshold values were set to trigger alerts when water reached critical levels.

III. Alert Mechanism:

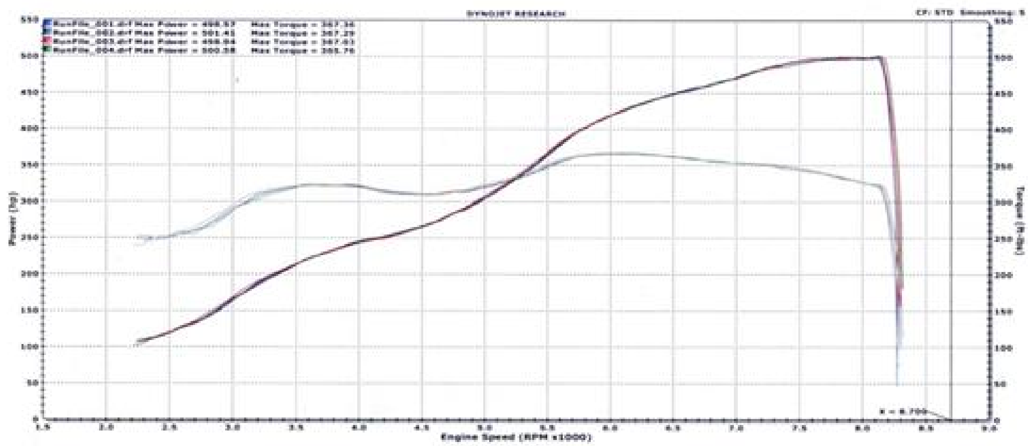
- When the water level exceeded a predefined threshold, the buzzer was activated, providing an audible warning.
- The Blynk IoT app successfully received real-time notifications, allowing remote monitoring and quick response actions.

IV. System Reliability:

- The integration of sensors with NodeMCU provided continuous real-time monitoring.
- The system functioned effectively in simulated flood conditions, ensuring timely alerts.

V. Role of Mangrove Trees:

- The natural ability of mangrove trees to reduce wave impact and control water flow was observed.
- Combining IoT technology with mangrove ecosystems enhanced flood prediction and early warning capabilities.



VIII. CONCLUSION

The IoT-based flood control system using mangrove trees effectively integrates NodeMCU, flex sensors, moisture sensors, a buzzer, and the Blynk IoT app to provide real-time flood monitoring and early warning alerts. By utilizing flex sensors to measure wave flow and moisture sensors to detect rising water levels, the system ensures accurate flood prediction. The buzzer alerts nearby residents, while Blynk IoT notifications provide instant updates to authorities and users for proactive flood management. Additionally, the role of mangrove trees in natural flood mitigation enhances the system's efficiency by reducing wave intensity and stabilizing coastal areas. This project demonstrates a cost-effective, eco-friendly, and scalable solution to mitigate flood risks, making it highly suitable for disaster-prone regions. Future enhancements could include AI-based flood prediction, solar-powered sensors, and integration with weather forecasting systems to further improve accuracy and reliability.

IX. FUTURE SCOPE

1. Technological Advancements in Sensor Integration

i. AI & IoT for Real-time Monitoring: Advanced AI-driven analytics combined with IoT-based sensors can enhance real-time monitoring of mangrove health and flood conditions.

ii. Remote Sensing & Satellite Integration: Using satellite imagery along with drone-based remote sensing can provide large-scale mangrove health assessments and flood prediction.

iii. Blockchain for Data Integrity: A decentralized blockchain system can ensure tamper-proof, transparent data storage for mangrove monitoring and environmental protection policies.

2. Engineering and Structural Innovations

i. Hybrid Coastal Protection Systems: The combination of mangroves with engineered coastal barriers (e.g., breakwaters, levees) can enhance long-term flood resilience.

ii. Bioengineered Mangroves: Genetic and biotechnological interventions can improve mangrove resilience to extreme weather, increasing their effectiveness as flood barriers.

iii. Wave Energy Absorption Models: Developing precise hydrodynamic models to study wave attenuation by mangroves can refine coastal protection strategies.

3. Environmental and Ecological Impact

i. Mangrove Restoration on a Global Scale: Expanding this project to regions facing coastal erosion, such as Southeast Asia, West Africa, and the Americas.

ii. Carbon Sequestration Studies: Exploring mangroves' role in carbon capture to combat climate change alongside flood protection.

iii. Biodiversity Conservation Initiatives: Using monitoring data to develop policies that protect wildlife dependent on mangrove ecosystems.

4. Economic and Policy Implications

i. Eco-Tourism Development: Promoting sustainable tourism models based on mangrove forests to generate revenue while ensuring conservation.
ii. Government Policy Implementation: Providing data-driven recommendations for policymakers to prioritize mangrove conservation in national climate adaptation plans.
iii. Funding and Investment Opportunities: Encouraging global investors, NGOs, and climate funds to support large-scale mangrove restoration as a cost-effective climate resilience strategy.

5. Community Involvement and Education

i. Citizen Science Platforms: Engaging local communities in monitoring and protecting mangroves through mobile applications and community-driven data collection.
ii. Educational and Awareness Campaigns: Implementing programs in schools and universities to highlight the importance of mangroves in climate change mitigation and flood protection.
iii. Livelihood Integration: Promoting sustainable livelihoods such as honey production, sustainable fishing, and mangrove-friendly aquaculture to benefit local populations.

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REFERENCES

[1]. Shivadarshan Devadiga, "Agricultural Monitoring System Using Arduino and Blynk 2.0," GitHub Repository, 2024.
[2]. GITHUB.COM
[3]. Techal, "Building an IoT Water Level Indicator with NodeMCU ESP8266 and Blynk," Techal.org, March 4, 2024. TECHAL.ORG
[4]. "IoT Based Flood Monitoring System Using NodeMCU & Thingspeak," IoT Projects Ideas, 2024. IOTPROJECTSIDEAS.COM
[5]. "IoT based Flood Monitoring System using Ultrasonic Sensor and ESP8266," Electronic Clinic, 2024. ELECTRONICLINIC.COM
[6]. Mahanijah Md Kamal, Nur Anum Zuraimi Md Noar, Aqil Muhammad Sabri, "Development of Detection and Flood Monitoring via Blynk Apps," Indonesian Journal of Electrical Engineering and Computer Science, Indonesia, April 2018, Vol. 10, No. 1, pp. 361-370.
[7]. RESEARCHGATE.NET
[8]. MJRoBot, "Automatic Gardening System With NodeMCU and Blynk, the 'ArduFarmBot 2'," Instructables, USA, 2017. INSTRUCTABLES.COM
[9]. "Home Automation Using Esp8266-12E, NodeMcu and Blynk App," Instructables, USA, 2016. INSTRUCTABLES.COM