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IoT- Enhanced Monitoring and Alert System for Flood and Landslide Disasters

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Abstract*:* *Flood and landslide are one of the devastating natural disasters in the forest. Such natural disaster affects the environment live of human and fauna. This system warning and alert to monitor the critical area flood and landslide in the presence of human area. It proposes a system of flood and landslide detection while using Wi-Fi module device and sensor for water and vibration condition. Sensor should detect the indication of flood and landslide end the data through Wi-Fi. So we should have introduce this proposed system based on IOT technology give a real time analysis of flood and landslide detection.*

Keywords: Flood, Landslide, Warning system, IoT technology, Wi-Fi module

I. INTRODUCTION

A landslide is movement of a mass of rock, debris, or earth down a slope. In monsoons the rain water percolates and develops hydraulic pressure which exceeds the elastic limit of the soil or rocks. Due to this the strain gets accumulated which forces the soil and rocks to loosen their adhesive strengths entailing landslides. Landslides destroy agricultural/forest lands, road transports, destroys earth's natural environment as a whole causing great loss to life. Landslides can also be said of "Mass Wasting", which refers to any down slope movement of soil and rock due to gravity. It causes property damage, injury and death. Also, it adversely affects a variety of resources such as water supplies, fisheries, sewage disposal systems, dams and roadways for years after a slide event. The landslides occur when the slope changes from a stable to an unstable condition. This change in the stability of a slope can be caused by many factors together or alone.

Internet-based sensor networks have gained attention for their role in creating self-monitoring and self-protecting environments. Sensors, microcontrollers, and applications enable real-time data collection and alert systems via SMS and calls. Landslide pose significant threats, with millions of casualties recorded in the 20th century alone.

Deadly landslide of the past five centuries are concentrated along coastal regions and seismic belts across Central America, the Caribbean, South America, Indonesia, Europe, the Middle East, Iran, Pakistan, India, China, and Japan. Shallow landslide with magnitudes above 6 can be devastating in densely populated areas.

II. EXISTING SYSTEM

Remote Sensing Technologies

Remote sensing technologies, including satellite imagery, aerial photography, and drones, are used to monitor large areas from a distance. Satellites equipped with sensors can capture data on land cover, topography, and hydrological features, allowing for the identification of potential flood and landslide risk zones.These technologies offer comprehensive coverage and the ability to monitor inaccessible or hazardous terrain, but they may be limited by cost, resolution, and cloud cover.

III. LITERATURE SURVEY

APPLICATIONS OF THE RUA-RAI-SAI FOR DISASTER MONITORING AND WARNING IN THAILAND

This paper provides an overview of the ongoing developments and applications of the Rua-Rai-Sai (RRS) system in Thailand. RRS is a system for monitoring and issue warnings about natural disasters to its local communities.

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HIGH-RESOLUTION SOIL-MOISTURE MAPS OVER LANDSLIDE REGIONS IN NORTHERN CALIFORNIA GRASSLAND DERIVED FROM SAR BACKSCATTERING COEFFICIENTS

High-resolution soil-moisture maps for a grassland landslide in California's coast ranges are generated using NASA's UAV synthetic aperture radar. A radar scattering model retrieves near-surface soil moisture with good agreement between forward modeling and retrieval, with RMSE values of 1.93 dB for VV and 1.88 dB for HH polarizations, and 0.054 m3/m3 for soil-moisture retrieval. The successful retrieval benefits from surface and double-bounce scattering, showing saturated conditions within landslide boundaries. Sensitivity tests for incidence angle indicate weak dependence, especially with copolarized HH and VV inputs, and orientation angle changes do not significantly affect retrieval when using copolarized inputs**.**

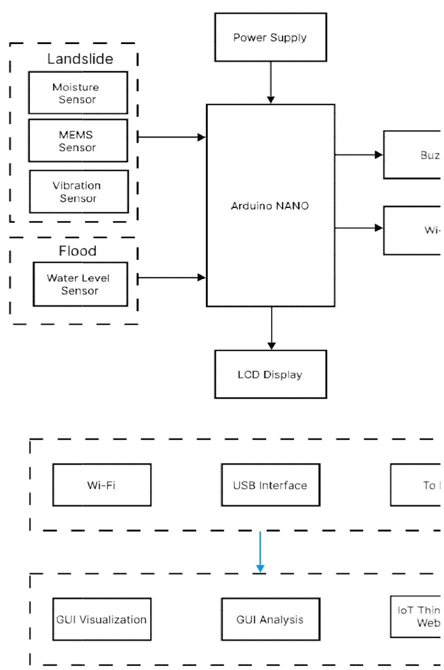
AUTOMATIC INCREMENTAL TRAINING OF OBJECT DETECTION BY USING GAN FOR RIVER LEVEL MONITORING

The proposed approach can effectively reduce labeling effort and achieve the recall closing to the model with manually labeled and training by human

IV. PROPOSED SYSTEM

Landslides and floods are among the most devastating natural disasters, causing loss of life, property damage, and disruption to communities. Traditional monitoring methods often lack scalability, real-time capabilities, and cost-effectiveness. Wireless sensors equipped with Wi-Fi modules are strategically placed in susceptible areas. These sensors continuously collect a data on environmental conditions such as water level and ground vibration.The collected information is transmitted wirelessly to a central station, where advanced algorithm analyse the data in real time.

4.1 PROPOSED BLOCK DIAGRAM



4.2 HARDWARE DESCRIPTION:

Arduino NANO

Arduino NANO can be used for flood and landslide monitoring by connecting sensors to detect water levels, soil moisture, and ground movement, providing real-time data for early warning systems.

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Input data

- Analog Sensors
- Digital Sensors
- Communication Interfaces
- Analog Inputs

Output Data

- Actuators,
- Digital Outputs:
- Communication Interfaces,
- Analog Outputs

Water Level Sensor

A water level sensor is utilized in flood and landslide monitoring to measure the height of water levels in rivers, streams, or rainfall, aiding in early detection and alerting of potential flood risks.

Input Data

- Water Level Sensor Data
- Rainfall Data
- Soil Moisture Data
- Temperature Data

Output data

- Water Level Status
- Rainfall Intensity
- Soil Stability

Moisture sensor

The soil moisture sensor is one kind of sensor used togauge the volumetric content of water within the soil. As the straight gravimetric dimension of soil moisture needs eliminating, drying, as well as sample weighting. These sensors measure the volumetric water content not directly with the help of some other rules of soil like dielectric constant, electrical resistance, otherwise interaction with neutrons, and replacement of the moisture content.

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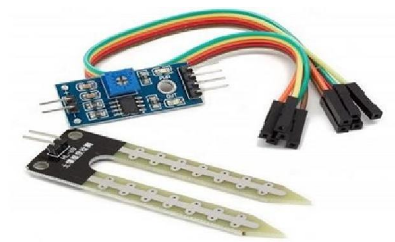

Vibration Sensor

A vibration sensor is employed in flood and landslide monitoring to detect ground movement or tremors, enabling early warning systems to alert authorities and communities of potential landslide risks.

Input Data

- +5V

Output data

- Acceleration, Velocity RMS

MEMS Sensor

MEMS (Micro-Electro-Mechanical Systems) sensors are employed in flood and landslide monitoring to detect minute changes in ground movement or tilt, enabling early warning systems to predict and mitigate potential disasters.

Input Data

- +5V

Output Data

- Physical quantities

V. WORKING

- **Sensor** : The first step involves deploying sensors in landslide and flood-prone areas. These sensors can include devices such as water level sensors, soil moisture sensors, rainfall gauges, and ground movement sensors.
- **Data Collection**: The sensors collect data on various parameters such as water levels, soil moisture, rainfall intensity, and ground movement. This data is gathered autonomously and continuously, providing real-time information about the conditions in the monitored areas.

- **Data Processing**: The collected data is processed by a central system or microcontroller, which analyzes the data to detect any anomalies or patterns indicative of potential landslide or flood events
- **Alert Generation**: If the data analysis identifies a significant risk of landslide or flood occurrence, the system generates alerts. These alerts may be based on predefined thresholds for specific parameters or on the detection of abnormal trends.
- **Notification**: Once an alert is generated, the system sends notifications to relevant stakeholders, including local authorities, emergency responders, and residents in the affected areas.

VI. METHODOLOGY APPLIED

IoT technology presents a valuable toolkit for flood and landslide monitoring, offering real-time data collection and analysis capabilities crucial for disaster preparedness and response.

To deploying IoT sensors in flood-prone and landslide-prone areas, environmental parameters such as water levels, soil moisture, rainfall intensity, and ground movement can be continuously monitored.

These sensors transmit data to centralized systems, enabling early detection of potential hazards.

VII. CONSTRUCTION AND FABRICATION

- **Hardware Selection**: Choose appropriate Wi-Fi modules, PIR sensors, microcontrollers (such as Arduino or Raspberry Pi), and power sources suitable for outdoor deployment.
- **Sensor Placement**: Strategically place PIR sensors in areas prone to landslides and floods, ensuring optimal coverage for motion detection.
- **Weatherproof Enclosures**: Construct weatherproof enclosures to protect the electronic components from environmental factors like rain, humidity, and temperature variations.
- **Mounting**: Mount the sensors securely on stable surfaces, such as poles or structures, ensuring they have a clear line of sight and are positioned at the right height for effective detection.
- **Wiring and Connections**: Connect the PIR sensors to the Wi-Fi modules and microcontroller using appropriate wiring and connectors, ensuring reliable communication and power supply.
- **Programming**: Develop software for the microcontroller to handle sensor data acquisition, processing, and communication over the Wi-Fi network.
- **Network Configuration**: Configure the Wi-Fi network, including establishing mesh networking if needed, to ensure robust communication between the sensors and the central monitoring system.
- **Power Management**: Implement power management strategies to optimize energy usage and extend the lifespan of the monitoring system, such as sleep modes for sensors when not in use.
- **Data Visualization and Analysis**: Set up a central monitoring system to receive data from the sensors, visualize it in real-time, and analyze trends or anomalies indicative of potential landslides or floods.
- **Alerting Mechanism**: Develop an alerting mechanism to notify relevant authorities or stakeholders via SMS, email, or other communication channels in case of detected hazards.
- **Testing and Calibration**: Thoroughly test the monitoring system in simulated and real-world conditions, calibrating sensors and adjusting parameters as necessary to improve accuracy and reliability.

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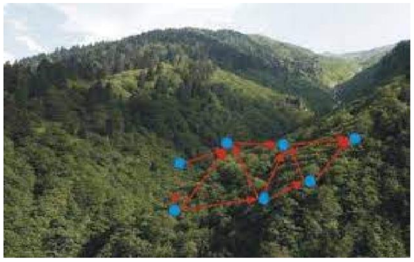
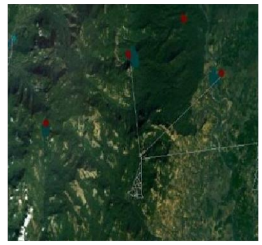
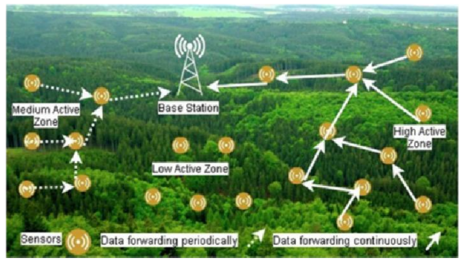
VIII. REAL SENSOR IMAGES







BENEFITS

- Integrating low-cost components and utilizing efficient resource management techniques, the system reduces overall project expenses, making it more accessible for deployment in various regions.
- the project's focus on optimizing resources while integrating low-cost, low-power, and long-range communication technologies enhances the efficiency and accessibility of landslide and flood monitoring and notification, contributing to improved disaster preparedness and response efforts.

ADVANTAGES

Customized sensor node and gateway node to monitor the changes periodically with low energy power consumption.
We evaluated the distinct metrics of

- spreading factor,
- sensitivity,
- time-on-air,
- energy consumption,
- low budget,
- battery life of sensor and
- gateway nodes

REAL INCIDENTS

Landslide in Himachal Pradesh (2023): Heavy rainfall triggered a landslide in the Kinnaur district of Himachal Pradesh, causing extensive damage to infrastructure and leading to several casualties. Rescue operations were swiftly launched to assist affected communities.

Floods in Kerala (2023): Monsoon rains resulted in severe flooding in various districts of Kerala, submerging homes, displacing thousands of people, and disrupting normal life. Relief efforts were mobilized to provide shelter, food, and medical assistance to those affected.

To this overcome of the proposed autonomous architecture could be deployed in this region to monitor water levels in rivers and flood-prone areas using sensors. By integrating low-cost, low-power, and long-range communication, such as cellular networks or satellite communication, the system could send real-time alerts to nearby communities and authorities as water levels rise, enabling timely evacuations and resource allocation.

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IX. CONCLUSION

Finally, this project concludes with challenges faced in real-time in which the sensor data received via a customized sensor node and gateway on the control center during disaster.

The wireless communication protocol plays a significant role.

Wi-fi is one of the prominent and emerging wireless connections that comply with IoT's minimum energy consumption and long-range communication standards.

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