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Location Based Reminder and Emergency Alert System for Landslides Using IoT

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Abstract: *This project presents an IoT-based Location-Based Reminder and Emergency Alert System designed to enhance safety in landslide-prone regions. The system employs soil moisture, vibration, and rainfall sensors integrated with an ESP8266 microcontroller and GPS module to continuously monitor environmental conditions. Sensor data is transmitted to Adafruit IO, which serves as the cloud platform for real-time data visualization, analysis, and remote monitoring. When the collected parameters exceed predefined thresholds, the system automatically identifies the user's location and sends instant alerts via SMS or mobile notifications to nearby individuals and authorities, enabling timely preventive action. Salient features of the system include real-time multi-parameter monitoring, GPS-based location tracking, automated cloud-connected alerting, user-friendly Adafruit IO dashboards, continuous data logging, and high scalability. The results demonstrate that the integration of IoT sensing, cloud analytics, and location-based notifications significantly improves early detection and response to landslide risks. This cost-effective and adaptable framework can be extended to other natural disaster warning applications as well.*

Keywords: Internet of Things (IoT), Landslide Detection, Location-Based Alert System, Emergency Warning System, Real-Time Monitoring, Disaster Management, ESP8266 microcontroller, Adafruit IO, GPS-based location tracking, IoT sensing, Hardware Verification

I. INTRODUCTION

Landslides, often triggered by factors such as excessive rainfall, seismic activity, or human interference with natural terrain, pose a grave threat to life and infrastructure. The consequences include fatalities, loss of property, agricultural damage, and environmental degradation. Despite advancements in geotechnical research and remote sensing, most landslide-prone regions still lack effective, real-time monitoring systems due to high costs and infrastructure limitations. This project seeks to address these challenges with an IoT-based smart monitoring and alert system. The core objective is to design a system that monitors environmental parameters, evaluates risk levels, and provides timely alerts and reminders to end users, helping prevent or mitigate landslide disasters. Unlike manual or passive systems, this solution actively measures soil moisture—a key precursor to slope failure—and tracks geographical location using GPS. It operates autonomously, generating alerts through GSM-based SMS communication to warn users and stakeholders before conditions become critical. The innovation lies in the dual-purpose design: while the system acts as an early warning mechanism, it also provides location-based task reminders. For instance, as a user enters a high- risk zone, the system can remind them to check equipment or avoid certain paths. This practical application is not only valuable in landslide zones but also adaptable to other environmental use cases like flood warnings or fire-risk areas.

II. OBJECTIVE

• Develop a location-based reminder system for landslide-prone areas.
• Design an IoT-based emergency alert system to improve disaster management.
• Deploy IoT sensors such as soil moisture, vibration, rainfall, and tilt sensors to continuously monitor environmental conditions.

• Identify early indicators of potential landslides and generate automatic alerts.
• Deliver instant notifications through SMS, mobile app, siren systems, or public display units.

III. PROBLEM STATEMENT

Landslide-prone regions face serious threats due to the lack of reliable real-time monitoring and early warning systems. Existing landslide detection methods rely mainly on manual observation and periodic inspections, which are slow, labor-intensive, and ineffective during extreme weather conditions such as heavy rainfall. As a result, critical environmental changes often go undetected until a landslide occurs, leading to loss of life, infrastructure damage, and disruption of transportation networks. Moreover, traditional systems fail to continuously monitor essential parameters such as soil moisture, ground vibration, and rainfall intensity, which are key indicators of slope instability. The absence of automated alert mechanisms further delays communication of imminent risks to residents and authorities. Therefore, an IoT-based automated monitoring and early warning system is required to provide continuous sensing, real-time data analysis, and instant location-based alerts, enabling timely preventive action and improved disaster management in landslide-prone areas.

IV. METHODOLOGY

The proposed Location-Based Reminder and Emergency Alert System for landslides adopts an IoT-driven methodology for real-time environmental monitoring and early warning. Key landslide-related parameters such as soil moisture, rainfall intensity, ground vibration, tilt, temperature, and gas/flame presence are continuously sensed using appropriate sensors. An Arduino Uno serves as the primary data acquisition and processing unit, while a NodeMCU (ESP8266) module enables wireless communication and cloud connectivity. A GPS module (NEO-6M) is integrated to obtain accurate geographical coordinates for location-based alerting. Sensor data is transmitted to the Adafruit IO cloud platform through Wi-Fi for real-time visualization, storage, and analysis. Predefined threshold values based on environmental risk indicators are used to evaluate sensor readings and detect abnormal conditions that may indicate potential landslide occurrence. When critical thresholds are exceeded, the system automatically initiates alert mechanisms to ensure timely preventive action.

V. WORKING

During operation, the system continuously monitors environmental conditions through connected sensors and processes the collected data in real time. The Arduino Uno reads sensor values and evaluates them against predefined safety thresholds. Location information from the GPS module is combined with sensor data to identify the precise risk zone. When abnormal conditions such as excessive soil moisture, intense rainfall, or abnormal vibrations are detected, the NodeMCU uploads the data to the Adafruit IO dashboard for remote monitoring, while a GSM module (SIM800L) sends instant SMS alerts to nearby users and authorities. Simultaneously, a buzzer provides local warning, and system status is displayed on a 16×2 I²C LCD. The alerting workflow includes data acquisition, risk analysis, warning generation, and event logging, ensuring rapid communication and effective early warning. This integrated working mechanism enables timely detection, location-specific alerts, and improved disaster response in landslide-prone regions.

VI. SYSTEM DESIGN

The system design of the proposed Location-Based Reminder and Emergency Alert System integrates multiple hardware components to enable reliable environmental monitoring, location tracking, data processing, and alert generation. The core processing and communication unit is the ESP8266 NodeMCU, which provides built-in Wi-Fi connectivity for cloud communication and coordination with external modules. An Arduino Uno serves as the primary controller for sensor data acquisition, interfacing with environmental sensors such as soil moisture, rainfall, vibration, and a three-axis ADXL335 accelerometer for tilt and ground movement detection. A NEO-6M GPS module is incorporated to obtain precise real-time location information, enabling location-specific alerts. A SIM800C GSM module ensures reliable SMS-based communication in areas with limited internet connectivity. System status, sensor

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readings, and alert messages are displayed on a 16×2 I²C LCD, providing real-time visual feedback. All components are interconnected using jumper wires to allow flexible prototyping and easy integration. Together, these hardware modules form a compact, low-power, and efficient IoT-based system capable of continuous environmental monitoring, real-time data transmission, and rapid emergency alert dissemination.

VII. SOFTWARE REQUIREMENTS

The proposed system uses Adafruit IO as a cloud-based IoT platform for real-time data collection, storage, visualization, and device control. It supports MQTT, HTTP, and REST APIs, enabling seamless integration with microcontrollers such as Arduino and ESP8266. Adafruit IO provides interactive dashboards, data feeds, automation triggers, and secure communication, making it suitable for real-time monitoring and alerting applications. The Arduino IDE is used for programming and configuring the microcontrollers. It offers a simple development environment, extensive library support, serial monitoring for debugging, and strong community resources. Together, Adafruit IO and Arduino IDE enable efficient development, real-time monitoring, and reliable communication for the proposed IoT-based emergency alert system.

VII. EXPERIMENTAL RESULTS

Output 1

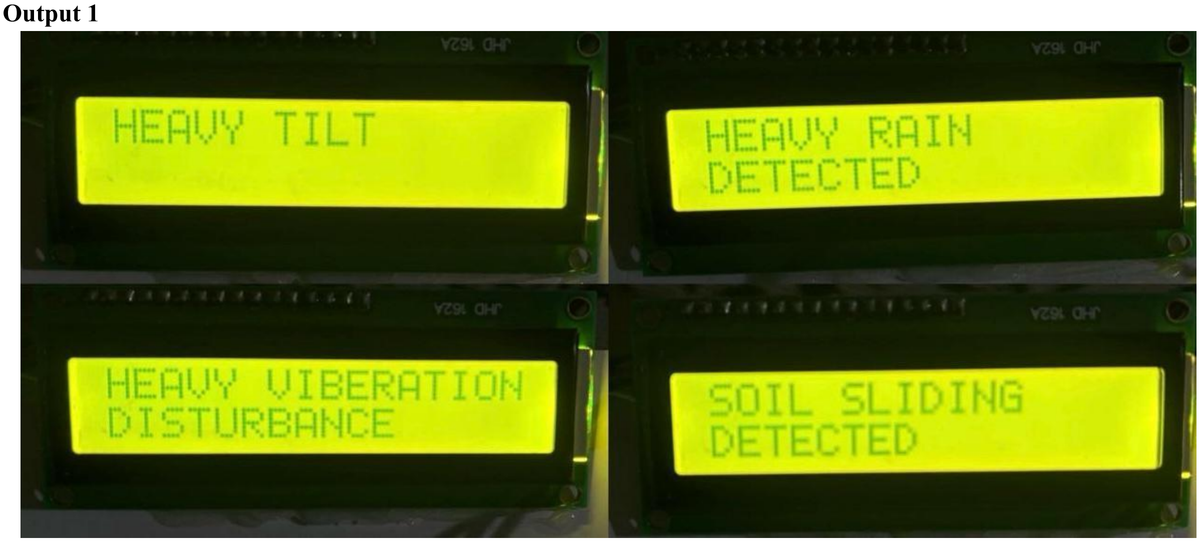

Figure : Output LCD Display

TABLE : ALERT CONDITIONS AND CORRESPONDING LCD OUTPUTS

LCD Message Displayed	Triggering Sensor(s)	System Interpretation
SOIL SLIDING DETECTED	Soil Moisture Sensor + Vibration / Tilt Sensors	High soil moisture combined with ground movement indicates possible soil displacement or an impending landslide.
HEAVY VIBRATION DISTURBANCE	Vibration Sensor (SW420)	Strong or abnormal vibrations detected, possibly due to soil instability, nearby machinery, or ground shaking.
HEAVY RAIN DETECTED	Rainfall Sensor	High rainfall levels detected, increasing soil saturation and the risk of soil weakening and landslides.

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HEAVY TILT	ADXL335 Accelerometer (Tilt Sensor)	Sudden or large change in tilt angle indicates ground shifting or structural movement.

Output 2

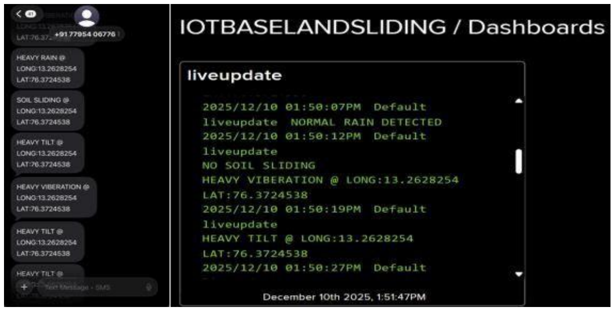

Figure : On Adafruit Io dashboard and Registered Mobile number

• The IoT-based Landslide Detection System generates real-time alerts through multiple output interfaces to ensure effective early warning.

• The LCD module displays warning messages such as “Soil Sliding Detected”, “Heavy Vibration Disturbance”, “Heavy Rain Detected”, and “Heavy Tilt”, each triggered by abnormal readings from soil moisture, vibration, rainfall, and tilt sensors, respectively.

• These alerts indicate different stages of soil instability and environmental risk.

• Live sensor data is transmitted to a cloud dashboard using Adafruit IO, enabling continuous remote monitoring of environmental parameters.

• GSM-based SMS notifications sent via the SIM800C module ensure alert delivery even when internet connectivity is unavailable.

• The system employs key performance metrics such as sensor accuracy, detection reliability, and response latency to evaluate effectiveness.

• Low response time and reliable detection enable timely preventive action and improved safety in landslide- prone areas.

VIII. CONCLUSION

The Location-Based Reminder and Emergency Alert System for Landslides using IoT provides a reliable, efficient, and real-time solution to one of the most dangerous natural hazards in hilly regions. By integrating IoT sensors, GPS technology, wireless communication, and cloud analytics, the system is capable of continuously monitoring critical parameters such as soil moisture, ground vibration, rainfall intensity, and slope movement. The collected data enables early identification of landslide risks, while the location-based alert mechanism ensures that residents, travelers, authorities, and emergency responders receive timely and targeted warnings. Through automated reminders, the system supports preventive actions such as evacuation, route diversion, and infrastructure inspection. Its sector-wise applicability—covering transportation, residential safety, agriculture, tourism, disaster management, and industrial operations—demonstrates the wide impact and scalability of the solution. The project not only enhances public safety but also contributes to the development of smarter and more resilient communities. In conclusion, this IoT-based landslide alert system successfully integrates technology with disaster preparedness, reducing potential loss of life, property damage, and disruption of services. With further improvements such as machine learning-based prediction, solar powered sensors, and wider deployment coverage, the system has the potential to become a critical tool for disaster mitigation and sustainable development in vulnerable regions.

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