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IOT-BASED LANDSLIDE DETECTION AND MONITORING SYSTEM WITH ACCELEROMETER AND SOIL MOISTURE SENSOR

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Abstract - Landslides are a significant natural hazard that can cause damage to infrastructure, property, and human lives. In this study, we propose an IoT-based landslide detection and monitoring system that utilizes various sensors and communication technologies to collect and analyze data onslope stability, precipitation, and other environmental factors. The proposed system consists of hardware components such as sensors, microcontrollers, and communication devices, as well as software components for data processing and visualization. We conducted field tests to evaluate the performance of the system in detecting and monitoring landslides and compared the results with existing methods. Our study shows that the IoT-based system can provide real-time and accurate information on landslide risk, and can help to improve early warning and risk management efforts. The implications of our findings for future research and practical applications are discussed.

I. INTRODUCTION

Landslide is the movement of a mass of rock, debris, or earth down a slope. In monsoons, the rainwater 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, and road transport destroys the earth's natural environment causing great loss of life. Landslides can also be said of "Mass Wasting", which refers to any down slope movement of soil androck due to gravity. It causes property damage, injury, and death.

IoT-based systems can help in achieving this goal:

IoT-based systems can provide a more efficient and cost-effective solution for landslide detection and monitoring. By integrating sensors and data communication technologies, IoT-based systems can collect and transmit real-time data on soil moisture, temperature, and other environmental factors that can affect landslide activity. This data can be analyzed using machine learning and other advanced techniques to provide early warning systems and accurate predictions of landslide activity. IoT-based systems can also enable remote monitoring of landslide-prone areas, reducing the need for manual surveys and increasing the safety of monitoring personnel. Overall, IoT-based systems have the potential to improve the accuracy and timeliness of landslide detection and monitoring, reducing the risk of loss of life and property damage.

II. PROBLEM STATEMENT

To design a system that monitors and provides early warning of landslides and risk assessments to the inhabitants of the area using a sensornetwork and internet of things technology.

III. OBJECTIVE

[1] To develop a system that detects a real-time change in land using a sensor network to study the landslide and gives early warning

[2] To avoid the loss due to landslide and save human lives.

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IV. LITERATURE SURVEY

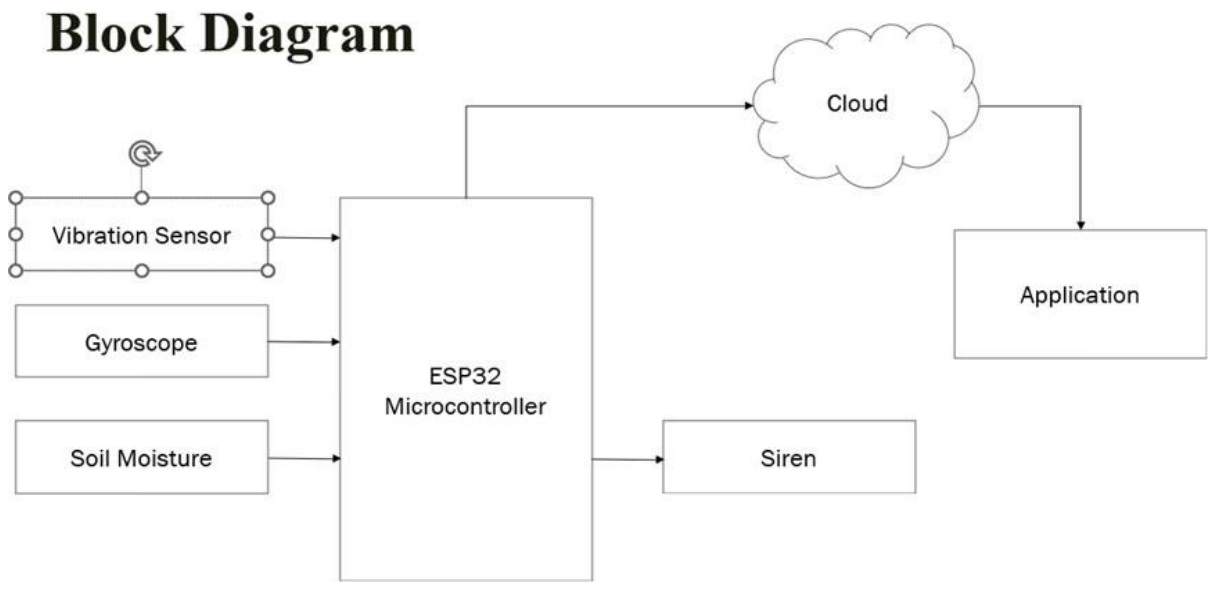
"Landslides: causes, consequences and risk assessment" by Robert B. Olshansky and Lisa M. Olson, Natural Hazards Review, 2019. This articlereviews the current state of knowledge on landslides, including their causes, consequences, and methods for assessing the risk of landslides. Theauthors discuss the importance of interdisciplinary approaches to understanding and managing landslide risk.

"Landslide risk management: a review" by Francesco Silvestri et al., Natural Hazards, 2018.This article provides a review of the current state oflandslide risk management, including the various strategies used for reducing landslide risk. The authors discuss the importance of stakeholder engagement, risk communication, and monitoring systems in effective landslide risk management.

"Landslide monitoring using terrestrial laser scanning: a review" by Matjaz Miksa et al., Remote Sensing, 2019. This article provides a review ofthe use of terrestrial laser scanning for landslide monitoring. The authors discuss the various applications of this technology, including the monitoring of landslide movement and deformation, and the assessment of landslide hazards.

V. METHODOLOGY

[1] The landslide monitoring system enables early detection of hazardous slope movements.
[2] If having identified pre-failure slope deformations, the system automatically informs human individuals about potential landslides.
[3] Relevant measurements taken from the observed slope are continuously stored and available for detailed diagnoses of the slope movements.
[4] The landslide monitoring system automatically calculates the inverse velocity and determines whether and when landslides can beexpected. The system is composed of two subsystems, a wireless sensor network, and a server system.



VI. REQUIREMENTS

Hardware Required

[1] Microcontroller – ESP32
[2] Sensors – Vibration sensor, Gyroscope, Soil Moisture
[3] Power Supply – 5v DC
[4] Other – Relays, Siren, LEDs

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Software required

1. Programming Language – Python
2. Libraries – Paho-MQTT, TensorFlow
3. Algorithm – Naïve bays
4. Tools – Visual Studio Code, Arduino IDE

User requirements

1. Any device like a smartphone, tablet, or Desktop / Laptop with a working internet connection to monitor the system.

System requirements

1. To continuously monitor the landslide data, the system required a 24x7 power supply and internet connectivity.

Functional requirements

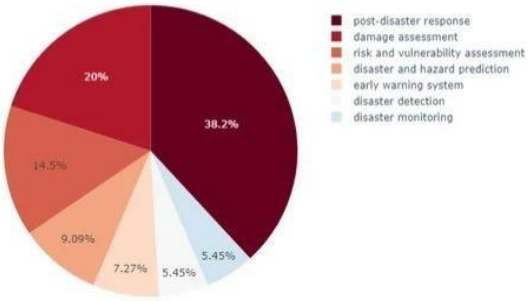
1. System should be scalable, and 100 % available.
2. An application should be accessible on any device – Mobile, Tablet, etc.
3. Power consumption should be kept to a minimum.
4. System should be easy to install and maintain.

Non-functional requirements

1. Performance Requirements - The system should take immediate action and show results as fast as possible
2. Safety Requirements - The system/application is currently in the developing phase so, shouldn't use in the real world before thetesting.
3. Security Requirements - Maintenance should be done after shutting down the system

VII. RESULT

The results would include the accuracy and reliability of the system in detecting and predicting landslides. This would be presented through graphs, charts, and tables that show the performance of the system under different conditions and scenarios. The results would also include thenumber of false alarms generated by the system, the response time of the system, and the overall efficiency of the system in terms of cost and maintenance.



VIII. EVALUATION AND VALIDATION

Testing was performed at the landslide site to ensure suc- cessful communication between the nodes and the SigFox.The landslide area where the IoT-enabled monitoring system has been deployed. The landslide has taken place in the area on the left of the rails. At the top of the picture,the damaged public access buildings are visible, as well as the damage inflicted on the rail of the rail-wagon (used to facilitate public access to the beach). The red circles denote the positions of the installed sensing devices.

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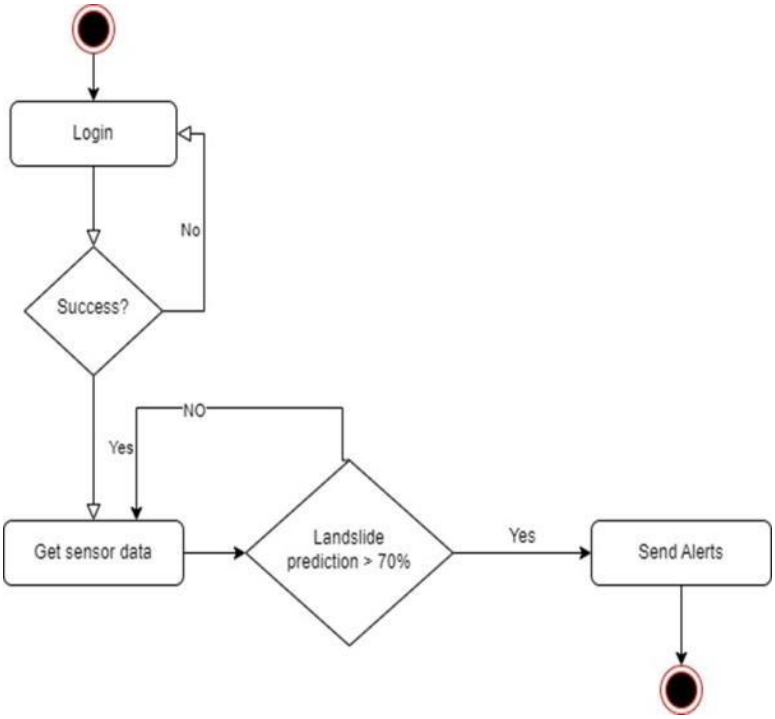

Fig. Activity Diagram

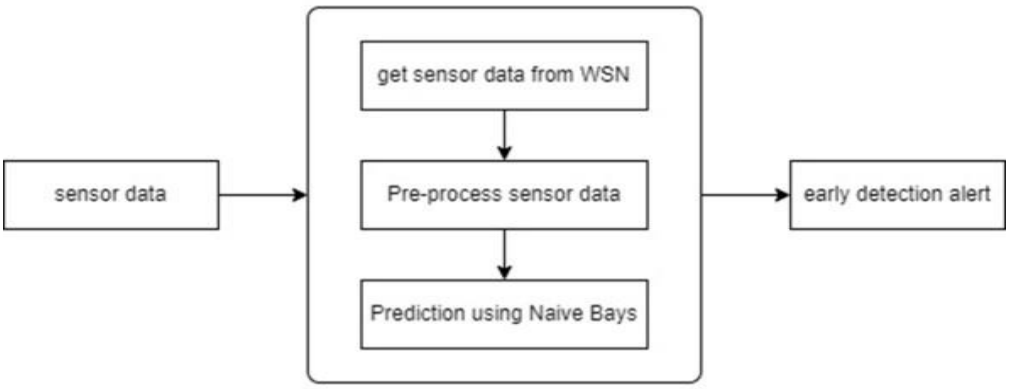

Fig. Data Flow Diagram 1

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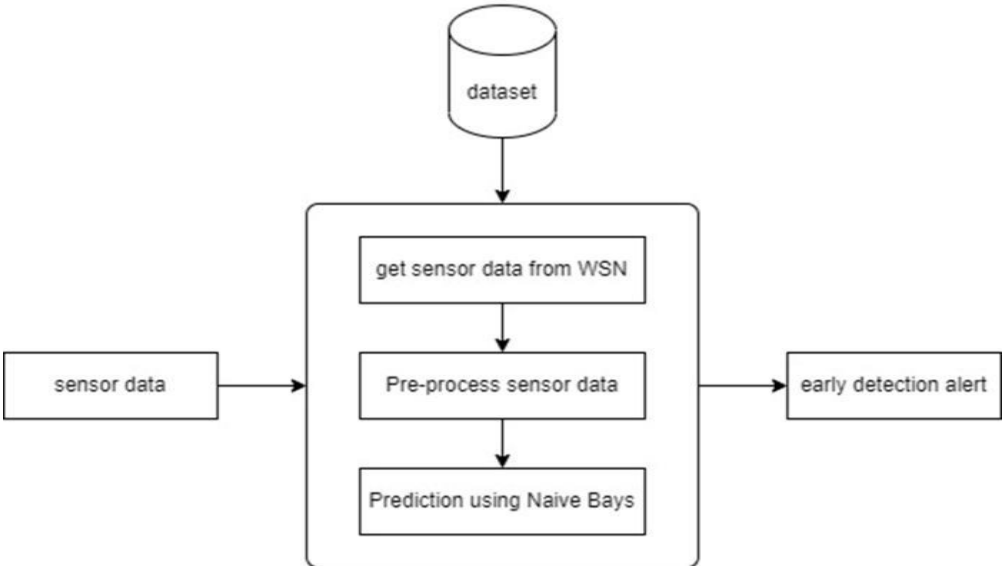

Fig. Data Flow Diagram 2

CONCLUSION

Real-time monitoring of landslides is one of the challenging research areas available nowadays within the field of geophysical research. The event of an actual field deployment of a wireless device network primarily based landslide detection system. This system uses wireless sensor nodes, and MQTT protocol for efficient delivery of real-time data to the system for monitoring and providing warnings and risk assessments tothe inhabitants of the area. This network will be used for understanding the capability and usability of wireless sensor networks for critical andemergency application.

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