

A Soil Moisture Sensor and Accelerometer are Part of an Internet of Things-based Landslide Detection and Monitoring System

*Jayapal N, **Dharanidharan S A, Ajay Aravinth M, Ajithkumar R, Gokul R

*Assistant Professor, Department of Electronics and Communication Engineering, Kongunadu College of Engineering and Technology, Trichy

**Final ECE Student, Department of Electronics and Communication Engineering, Kongunadu College of Engineering and Technology, Trichy

Abstract- One major natural hazard that can harm property, infrastructure, and human life is landslides. In this work, we suggest an Internet of Things (IoT)-based landslide monitoring and detection system that gathers and analyzes data on precipitation, slope stability, and other environmental conditions using a variety of sensors and communication technologies. In addition to software components for data processing and visualization, the suggested system also includes hardware components including sensors, microcontrollers, and communication devices. To assess the system's effectiveness in identifying and tracking landslides, we carried out field tests and contrasted the outcomes with those of other approaches. Our research demonstrates that the Internet of Things-based approach can enhance early warning and risk management initiatives by offering precise and up-to-date information on landslide risk. The consequences of our findings' ramifications for further study and real-world applications are examined.

Index Terms- Soil moisture sensor, Accelerometer, MQTT protocol

I. INTRODUCTION

The movement of a mass of rock, rubble, or dirt down a slope is called a landslide. Rainwater seeps through during the monsoon season and creates hydraulic pressure that is greater than the rocks' or soil's elastic limit. Landslides result from the accumulation of strain, which causes the rocks and soil to lose their adhesive qualities. Road transportation devastates the earth's natural ecosystem and causes a significant loss of life, while landslides ruin agricultural and forest areas. "Mass Wasting," which describes any downward movement of rock and dirt brought on by gravity, is another term for landslides. It results in harm, death, and property damage. IoT-based systems can help in achieving this goal:

IoT-based technologies have the potential to offer a more economical and effective way to monitor and identify landslides. Real-time data on temperature, soil moisture, and other environmental variables that may impact landslide activity can be gathered and transmitted by IoT-based systems through the integration of sensors and data connection technologies. In order to create early warning systems and precise predictions of landslide activity, this data can be evaluated using machine learning and other cutting-edge approaches. Additionally, by enabling remote monitoring of landslide-prone areas, IoT-based solutions can decrease the

need for human surveys and improve the safety of monitoring staff. In general, IoT-based solutions have the potential to decrease the danger of property damage and fatalities by increasing the precision and promptness of landslide monitoring and detection.

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 sensor network and internet of things technology.

Objective

- To develop a system that detects a real-time change in land using a sensor network to study the landslide and gives early warning
- To avoid the loss due to landslide and save human lives

II. LITERATURE SURVEY

"Landslides: causes, consequences and risk assessment" by Robert B. Olshansky and Lisa M. Olson, Natural Hazards Review, 2019. This article reviews the current state of knowledge on landslides, including their causes, consequences, and methods for assessing the risk of landslides. The authors 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 of landslide 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 of the 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.

III. METHODOLOGY

- Early identification of dangerous slope movements is made possible by the landslide monitoring system.
- The system automatically alerts people about possible landslides if it detects pre-failure slope deformations.
- If the system notices pre-failure slope deformations, it automatically notifies users of potential landslides.
- The inverse velocity is automatically calculated by the landslide monitoring system, which also establishes whether and when landslides are likely to occur. A wireless sensor network and a server system make up the system's two subsystems.

IV. REQUIREMENTS

Hardware Required

- Microcontroller – ESP32
- Sensors – Vibration sensor, Gyroscope, Soil Moisture
- Power Supply – 5v DC
- Other – Relays, Siren, LEDs

Software required

- Programming Language – Python
- Libraries – Pa ho-MQTT, TensorFlow
- Algorithm – Naïve bays
- Tools – Visual Studio Code, Arduino IDE

User requirements

Any gadget that has a functional internet connection, such as a desktop or laptop, tablet, or smartphone, can be used to monitor the system.

System requirements

The system needed internet access and a power source that was available around-the-clock in order to continuously monitor the landslide data.

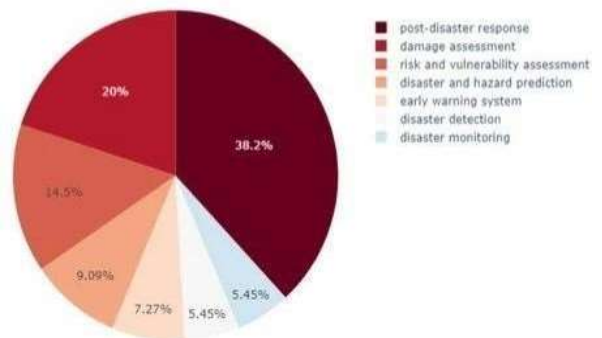
Functional requirements

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

Non-functional requirements

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

V. RESULT



The outcomes would include the system's precision and dependability in landslide detection and prediction. The system's performance under various circumstances and situations would be displayed via graphs, charts, and tables. The system's response time, the quantity of false alerts it issues, and its overall cost and maintenance efficiency would also be included in the results.

VI. EVALUATION AND VALIDATION

To make sure that the nodes and the Sig Fox could successfully communicate, testing was done at the landslide site.

The IoT-enabled monitoring system has been installed in the landslide area. The region to the left of the railroads is where the landslide occurred. The destroyed public access buildings and the rail of the rail-wagon, which is used to allow public

access to the beach, are visible at the top of the image. The locations of the mounted sensing devices are indicated by the red circles.

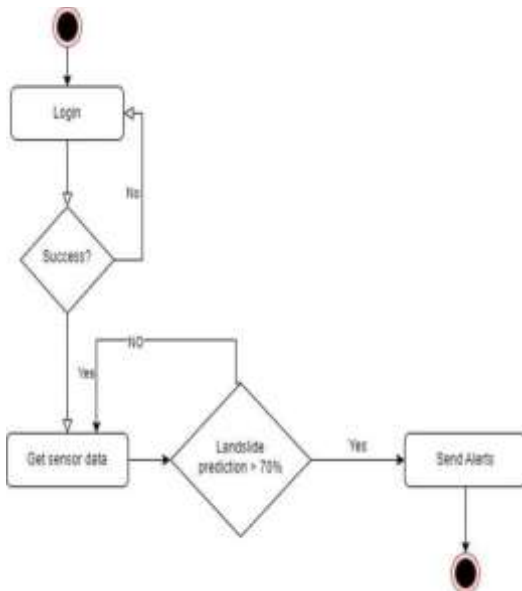


Fig. Activity Diagram

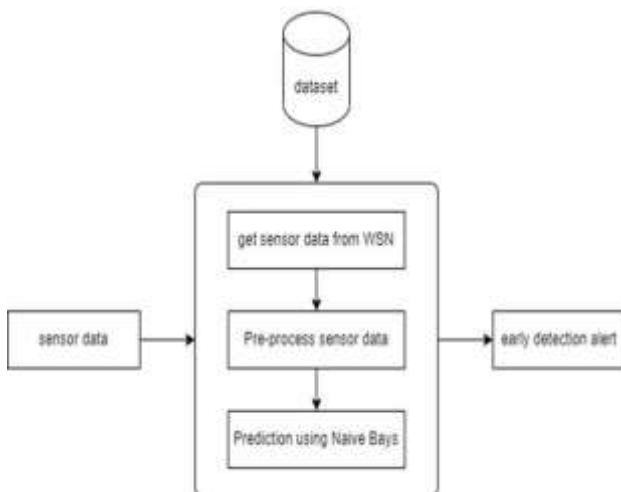


Fig. Data Flow Diagram 1

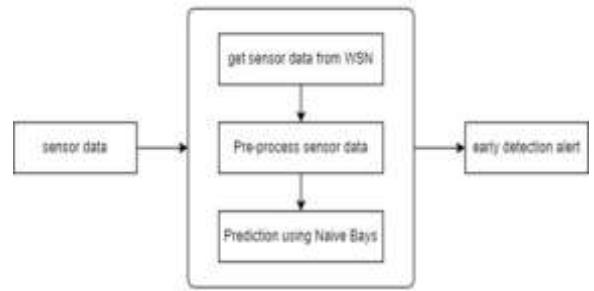


Fig. Data Flow Diagram 2

VII. 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 to the inhabitants of the area. This network will be used for understanding the capability and usability of wireless sensor networks for critical and emergency application.

REFERENCES

1. H. Zhang, G. Zhang and Q. Jia, "Integration of Analytical Hierarchy Process and Landslide Susceptibility Index Based Landslide Susceptibility Assessment of the Pearl River Delta Area, China," in *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, vol. 12, no. 11, pp. 4239-4251, Nov. 2019, doi: 10.1109/JSTARS.2019.2938554.
2. T.-H. Liao, S. -B. Kim, A. L. Handwerger and E. J. Fielding, "Soil Moisture Retrieval Using L-Band SAR Over Landslide Regions in Northern California Grasslands," *2021 IEEE International Geoscience and Remote Sensing Symposium IGARSS, 2021*, pp. 5881-5883, doi:10.1109/IGARSS47720.2021.9554160.
3. S. T. Sadasivuni and Y. Zhang, "A New Method for Discovering Daily Depression from Tweets to Monitor Peoples Depression Status," *2020 IEEE International Conference on Humanized Computing and Communication with Artificial Intelligence (HCCAI), 2020*, pp. 47-50, doi: 10.1109/HCCAI49649.2020.00013.
4. H. Lin, H. Huang, Y. Lv, X. Du and W. Yi, "Micro-UAV based remote sensing method for monitoring landslides in Three Gorges Reservoir, China," *2016 IEEE International Geoscience and Remote Sensing Symposium (IGARSS), 2016*, pp. 4944-4947, doi: 10.1109/IGARSS.2016.7730290.
5. Y. Liu, G. Tang and W. Zou, "Video monitoring of Landslide based on background subtraction with

- Gaussian mixture model algorithm,"2021 IEEE International Geoscience and Remote Sensing Symposium IGARSS, 2021, pp. 8432-8435, doi: 10.1109/IGARSS47720.2021.955306
6. Malarski, K. M. et al. 2020. Internet of Reliable Things:Toward D2D-enabled NB-IoT. 2020 5th International Conference on Fog and Mobile Edge Computing, FME 2020, pp. 196–201.
 7. Raju, K. L., Hussain, M. A., Chandra, U., Phanendhra, V. N., & Narendra, D. 2019. IoT Based Dust bin Monitoring Using Node MCU. 2019 Innovations in Power and Advanced Computing Technologies, i-PAC2019, 1–5.
 8. M. H. Zohari, V. Bala, and A. S. Abd Ghafar. 2019. Server monitoring based on IoT using Thing Speak .Journal of Electrical Power and Electronic Systems, vol.1, no. 2.
 9. Susanto, E., Budiman, F., Mukhtar, D. P. H., & Latief, M. H. 2019. Slope, humidity and vibration Sensorsperformance for landslide monitoring system.Proceedings - 2019 IEEE Asia Pacific Conference Wireless and Mobile, APWiMob 2019, 139–142
 10. Taqwa, A., Silvia, M. F. S. S. A., & Suroso, H. 2021.Prototype Design of Landslide Early Detection System Using LoRa and IoT. In 4th Forum in Research, Science, and Technology, Atlantis Press (2020) , 495-499.