Automatic Sensor Network analysis for Landslide Detection System

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Abstract. Landslides is one of the most dangerous geologic hazards that can occur in almost any country on the planet. Landslides kill and injure thousands of people each year around the world, as well as cause significant losses in a short period of time. To save many lives, effective technology must be developed in a timely manner. Sensor Networks is a vital role to monitor the environment. Several online and real-time intensive care studies on landslide recognition were conducted on soil dislocation caused by non-natural rainfall and earthquake. To build an advanced level early warning landslide monitoring system based on the “Internet of Things” using a wireless sensor network. This is a high-level project that can monitor the earth's vibrations, temperature, humidity, and soil moisture. All of these sensors are linked to various IoT Nodes, which form the entire network. The number of nodes may be increased or reduced depending on the situation. A single Blynk-designed smart phone software is used to track all of the Landslide detection nodes. Data from sensors reveals that each parameter has the potential to be used in landslide monitoring.

Keywords: Sensor networks, Landslides, Detection systems, IoT, Data processing.

1. Introduction
Landslides are one of the most damaging normal phenomena, arising from geographical, hydrological, and human causes. It's crucial to investigate the landslide-induced vibrations that occur under the earth's crust, interpret them, and link them to landslide events. Landslides, defined as the movement of terrestrial or stalwart down or out of a slope as a result of a disruption in mud firmness or slope essential rocks, are a common natural disaster, particularly during the showery season, and can also be generated by earthquakes. Conferring to data, landslides occurred 3,753 times between 2012 and February 2019, resulting in 1,661 deaths. The landslide tragedy has been designated as Indonesia's most dangerous disaster since 2017. The viscosity of the population in disaster-prone areas (at hilltop) contributes to the increase in casualties, ensuing in a disproportionate number of loss of life. It also results of dwellers' proclivity construct payments under triumph-prone slopes [1].

Till present day, only 40.9 million have lived in the area that is vulnerable to landslides on a medium to large scale. Meanwhile, some tracking analysis using specialized approaches has been agreed by specialists in the geology field, who have performed data recovery directly in the field on a regular basis, such as every quarter or every six months in some regions. This is usually sufficient to monitor topography and land changing conditions in order to provide a suggestion of land situation managing landslide potential to the community and native government as a starting point for initial mitigation.
details. However, since the system does not have constant details, the evacuation process during a landslide tragedy is not always practicable. As a result of this context, we decided to enrich the bottom shifting by capturing bottom data in real-time using sensor detection [2].

There are a variety of sensing techniques and sensors for landslide monitoring that can detect soil movement and are important in the development of landslide monitoring systems. Rain gage, moisture monitor, piezometer, geophone, and strain gage are examples of these sensors. Each sensor performs a specific role in terms of monitoring, predicting, and analysing possible landslides. Since flooding was a major factor in the landslide crisis, which was used before the landslide. Moisture sensor may be used to track soil humidity, as well as thirsty and showery weather [3].

Dielectric moisture sensors are one kind of wetness sensor used to quantify soil wetness by implanting the sensor vertically in soil and thereby extracting information on water penetrating. Since land vibration sources can cause slope instability, piezoelectric sensors are frequently used to test them. Geophones can sense vibrations caused by slope instability [4].

2. Survey in Hill Station

Landslides have a long history in the Nilgiris district of Tamil Nadu. Landslides occur in the district on a nearly seasonal basis in figure 1. Landslides are most likely in the months of October and November. In the past of the Nilgiris district, noteworthy years for landslides include 1902, 1978, 1979, 1993, 2001, 2006, and 2009, so on.,

![Figure 1. Hazardous area of Nilgiris carried out in 2000’s](image1)

3. Reason with parameters of landslide

Landslide causing mechanisms vary from region to region, depending on landscape conditions and other variables in figure 2.

Understanding the state of the environmental process and structure of the landmass is needed to forecast possible landslides in a given area. Past landslides and their distribution, bedrock, slope steepness, hydrologic conditions, and human effects are all issues related with victory movement in slightly region [5].

![Figure 2. Severity and population exposure in the Nilgiris District](image2)
Report of the Survey
Geographic, direct mapping techniques, and multiclass methods we're looking at. Despite the fact that many studies on land and graphical areas are conducted in the Nilgiri district. This survey is being used to update current data as well as our study data [6-10].

Disaster analysis in Nilgiris District
As of accurate information on the news articles between 2019 to 2020 in figure 3-4.

Figure 3. landslide occurrence in Nilgiris District year wise

Figure 4. landslide map of the Nilgiris District (1825 -2018)

4. Experimental Hardware setup
Many new nodes can be linked to the design system using IoT-based technologies without disrupting other nodes. Larger areas can be watched in real time, and each region can be protected in figure 5.
Majority of people use Lora and Xbee to build wireless sensor networks, which can be very costly and require complex programming since data must be sent from one node to another, then to another, before it reaches the final receiving module. Why do we have to go through this? This technique can only be used in places where 3G or 4G equipment is not usable [11-12].

Since technology has evolved to the point that the internet is open anywhere, we can use wifi-enabled computers to create a full network instead of Lora or Xbee. The data is transmitted from all of the nodes to a single receiving computer, which may be a smartphone or an IoT platform.

**Landslide Detection System Node 1:**

The Nodemcu ESP8266 Wifi module is wired to a vibration sensor "SW-420" in node 1. This Node is in charge of vibration control. The vibration data is sent to the Blynk application every 1 second. An alarm is also given once the vibration level reaches a predetermined level.

**Landslide Detection System Node 2:**

The Nodemcu ESP8266 Wifi module is attached to the DHT11 temperature and humidity sensor in node 2. This Node is in charge of keeping track of the temperature and humidity. The temperature and humidity data are sent to the Blynk app every 1 second, where it is reflected on the gauges. A warning is produced when the temperature and humidity values surpass the predefined thresholds.

**Landslide Detection System Node 3:**

A soil moisture sensor is attached to a Nodemcu ESP8266 Wifi module in node 3. This Node is in charge of soil moisture control. The soil moisture data is sent to the Blynk application every 1 second. An warning is produced when the soil moisture level reaches a predetermined level. The soil moisture is also measured in real time, allowing for proactive measures to be taken.

The Arduino pin12 is attached to the Dht11 sensor. The Nodemcu module's TX and RX pins are attached to the Arduino's pins 2 and 3. As a result, the Nodemcu can communicate serially with the Arduino Uno through pins 2 and 3. Pins 2 and 3 are RX and TX, respectively, and will be programmed using the device serial library.

The soil moisture Vcc pin is connected to the 3.3v Nodemcu ESP8266 Wifi module, the ground is connected to the Nodemcu ground, and the moisture sensor's A0 pin, which is the analog output pin, is connected to the Nodemcu analog pin A0. While the moisture sensor's digital output pin is not attached. The SENS 1 and SENS 2 are linked by the two-legged lead in figure 6.
5. Final testing of the landslide warning system and Result

All the nodes and successfully monitored all the nodes in real time. It was able to generate the alerts in two ways one is light warning with sound system and another one is automatic message alert to registered mobile number in blynk application.

Once the sensors detected then the landslide alert is given based on two needs in figure 7-8.

Figure 6. Design of Landslide warning system

Figure 7. Output of Landslide Detection System

Figure 8. Application output of each sensor working
6. Conclusion

Landslides vary from one site to the next, depending on the existence of the research area and its surroundings. Danger studies should bear that the scale and map unit can varies from location to place depending on the needed. As a result, by using the architecture of landslide early warning system, we will give alert catastrophe and take preventative steps. In the future, we expect to incorporate several modules to keep the architecture consistent throughout the Nilgiris region.

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