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Automatic Detection and Notification of Landslides and Earthquake Using IOT

[1]Rutuja Phalke, [2]Rupali Shelke, [3]Dipti Baykar, [4]Prof. J. S. Khot

[1,2,3]Student, Electronics and Telecommunication Engineering, Hon. Shri. Babanrao Pachpute Vichardhara Trust's GOI Faculty of Engineering, Kashti., Ahmednagar, Maharashtra, India

[4]Assistant Professor, Electronics and Telecommunication Engineering, Hon. Shri. Babanrao Pachpute Vichardhara Trust's GOI Faculty of Engineering, Kashti., Ahmednagar, Maharashtra, India

***Abstract* - Our lives have been ruthlessly destroyed by natural calamities in a multitude of ways. Because landslides and earthquakes can occur at any time, their effects are quite severe. Early warning systems are crucial in mitigating the issue. Since it is impossible to predict when or where a seismic event will occur, early detection—which necessitates a real-time architecture and effective communication—is essential to minimizing damage to infrastructure and loss of life. Using cutting-edge IoT technology, we describe a novel landslide monitoring system in this paper. The primary goal of this is to put in place an automated system for identifying landslides. The goal of this initiative is to identify landslides early on. An alert message is sent out in the event of a landslide.**

Keywords: PIR sensor, Vibration sensor, Alert message, etc.

I. INTRODUCTION

Landslides are natural disasters that can cause massive destruction to life and property in the affected area. Certain regions are prone to such events and northeast India, including Manipur, is located in Zone-V (very severe intensity earthquake zone). Landslides are largely unpredictable and occur within short spans of time, which can cause great property losses and casualties. Therefore, landslide monitoring and warning are imperative to save lives and reduce damage.

Because Manipur is located at the meeting point of the Indian and Eurasia plates, there will be more earthquakes there than in other lower seismically active zones. In hilly parts of the state of Manipur, landslides happen regularly during the monsoon. Research findings indicate that landslides in Manipur are primarily caused by human activity, as road expansion and urbanization heighten the likelihood of landslides. There are numerous sensors and sensing techniques available for monitoring landslides, and they can be used to detect the soil movement, and it's essential for landslides to develop surveillance programs. Rain and sun are a couple of these sensors. Numerous sensors and sensing methods are available for landslide monitoring, which is equipped to identify the soil movement, and it's essential for landslides to develop surveillance programs. These sensors include strain gauges, tilt meters, piezometers, rain gauges, moisture sensors, and geophones, to name a few.

One way to stop and lessen the damage from landslides and earthquakes is to install monitoring and warning systems. This system consists of vibration, PIR, and seismic sensors. The alert is sent to distant individuals through infrastructure. The Internet of Things (IOT) encompasses everything that is connected to the internet and other networks, including various sensors that can gather and transmit data wirelessly without the need for human intervention. Here, a vibration sensor that detects earthquakes and reports the event to an IOT platform is used to create a smartphone-based sensor network.

One term for these geological phenomena that are difficult to forecast but can cause property damage and even fatalities is landslides. During rainy seasons, landslides are a frequent geological hazard that causes fatalities, property destruction, and significant financial losses not only in Rwanda but globally as well. According to estimates, landslides account for more than seventeen percent of global natural cause fatalities. There are frequent geological events in Rwanda, particularly in the western province's Nyabihu district, which cause millions of dollars' worth of annual infrastructure damage and fatalities.

Many technologies have been proposed and used for landslide monitoring, according to an analytical study. These technologies comprise the following: geotechnical methods, including geodetic methods based on satellites and the ground. The process of assessing the likelihood of landslide hazards has improved recently due to the application of new technologies such as information and geospatial technologies in various areas. Remote sensing and geographic information systems (GIS) are two examples of these technologies. Currently, the majority of these methods are applied in real-world landslide monitoring. Unfortunately, a number of these methods are highly costly, cannot be applied widely across numerous landslide locations, and are not appropriate for the African environment, where power and connectivity are

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scarce. For landslide monitoring, digital elevation maps (DEM) were suggested for Portland, for instance. This method's mapping cost ranged from $400 to $600 per square mile. Portland was not able to implement the system due to its high cost. Comparably, the cost issue affects other traditional landslide monitoring techniques as well, such as the use of unmanned aerial vehicles (UAVs), satellite-based monitoring, ground-based geodetic monitoring, and geotechnical methods.

Studies focused at landslide prediction in order to lessen the effects of such occurrences have been conducted with notable progress in attempts to address the problem of landslides. The growing necessity for creating and constructing frameworks that can aid in monitoring and warning people when landslides occur is emphasized in

According to the study, an efficient landslide and monitoring system should be able to:

1. Gather data in real-time from landslide-prone areas and sense the properties and movement of the soil.
2. Transmit the data collected to a remote cloud platform
3. Enable the possibility of analyzing the data collected in the cloud and
4. Notify people via mobile phone applications of the possibility of landslides before they occur.

II. LITERATURE REVIEW

In this author Venita Babu[1] The vibration sensor like accelerometer, gyroscope helps to provide attentive signal to registered authority with the help of GSM module . IOT approach is done to fasten the information about the system and helps to analyze the results in a more effective way. ESP wi-fi module act as a gateway to transmit the data to ThingSpeak cloud server.

By using G4-61, an analog sensor and aid in detecting pre-earthquake quivering using ESP8260 and Cayenne app software. Cayenne yields an SMS to alert people [2]. This paper proposed a model which brought a minute of forward moving warning signal that depends upon the location of epiccentre[3].

In this author T.Nagaosa, Daichi[4] proposed a system where server in earthquake early warning system was constructed and mobile with android OS act as a seismometer about transmission of acceleration data. With this system, decision of acceptable values of threshold is analyzed which aids in the detection of given earthquakes.

This paper shows the ability of some animal species to react against the approaching earth tremling signal with the help of the data analysis and processing at main core part [5].

Monitoring system include multiple sensors and three major disaster analysis earthquake, landslide and fire. Proposed system includes the web-based portal to monitor the threshold value. All sensor data shows in android mobile phone application and it totally worked on wireless sensor network. In message, map link is also shared with user to show the safe place in disaster [6]. This paper shows the use of WSN (wireless sensor network) with IOT to enabled all the connected elements and commute between them [7]. In this alarm detector system, Boolean sensing range is created and analyzation is done on how an inner and outer circle identify seismogenic zone [8].

In this author Mr. sagar.D.Kharde [9] RF based network is proposed for alert system. Here, master request and slave response protocol is applied. Master sends the request to all the slave and slave in that region check for the slave ID. If the slave ID is matched, then they accept the frame and send the parameter back to master. Slaves are equipped with sensors and sends the warning frame with the sensor data to the master which have VB software to show all the data on its graphical user interface. The collection of large number of interconnected devices leads to applicable amount of data that helps to create brand new services and opportunity for society, economy, environment and individual citizens [10].

III. PROBLEM STATEMENT

Natural disasters have mercilessly devastated our lives in so many different terms. The impact of Earthquake and landslides are very severe because of their unpredictability.

Landslides are one of the worst geological hazards the causes of landslides are mainly to due to intense rainfall or earthquake.

IV. METHODOLOGY

The system uses an Arduino as the microcontroller to control all of the components. It is using software Arduino IDE as a platform to make the coding.

The AT-Mega 328 Microcontroller in this system gathers data from multiple sensors and sends it over the Internet of Things. The ATmega328p microcontroller serves as the system's brains and gathers data. After that, it processes the data in accordance with the written code. The signal is generated appropriately if the generated value exceeds the threshold value. The microcontroller generates a signal that is sent to the LCD display, NodeMCU, and Thingspeak platform. This entire process will take place on the transmitter side. The ThingSpeak platform updates the user on the receiver side, and a buzzer serves as an alert. One location where real-time sensor data is uploaded is called ThingSpeak.

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Depending on the needs, the cloud channel can be set up as either private or public here.

V. SYSTEM DESIGN

The system is composed of components: ATMEGA328, vibration sensor, PIR sensor, ESP8266 Wi-Fi Chip.

The sensed data was sent to the microcontroller.12v power supply provided to this system. A vibration sensor is a device that measures the amount and frequency of vibration in a given system. PIR sensors are used in thermal sensing applications, such as security and motion detection of the earthquake area.

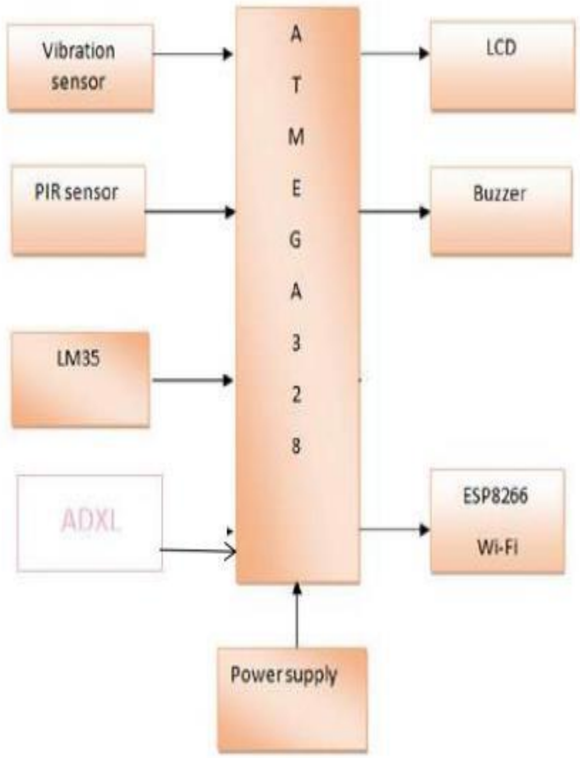

Figure 1: Block Diagram

Here we use IOT module to the save the data of sensor. The data will be present in the graphical format using thingspeak channel.

If any sensor detects or rises about the threshold value, then turn on the buzzer and display on the LCD display. And data will be saving on the IOT platform.

VI. ALGORITHM

Step 1: Data Acquisition:

- Collect data from deployed sensors, including accelerometers, tilt sensors, and environmental sensors.
- Sensor data includes seismic activity readings, slope angles, and environmental conditions.

Step 2: Preprocessing:

- Clean and filter sensor data to remove noise and outliers.
- Normalize and standardize data for consistency across different sensors.

Step 3: Earthquake Detection:

- Analyze accelerometer data for sudden and intense movements.
- Implement threshold-based detection to identify seismic events.

Step 4: Landslide Detection:

- Monitor tilt sensor data to identify changes in slope angles.
- Establish a baseline for normal slope conditions.

Step 5: Notification System:

- Once a potential earthquake or landslide is detected, activate the notification system.

Step 6: User Interface:

- Develop a user interface to display real-time sensor readings, detected events, and alert statuses.
- Provide visualization tools for better monitoring and decision-making.

Step 7: Continuous Monitoring:

- Implement continuous monitoring and periodic recalibration of sensors.
- Regularly update the system to adapt to changing environmental conditions and improve accuracy.

VII. RESULT AND DISCUSSIONS

The landslide detection system is successfully implemented as a prototype. All the sensors and other stuff works as per the expectations. The sensors effectively sense the surrounding conditions and give the readings. Based on readings, the prediction of landslide is achieved successfully. The system senses data and transmits it continuously.

The system takes only less time to collect data from sensor and transmit it to arduino and also to upload data from arduino to IoT cloud. The Hardware setup of project as shown below:

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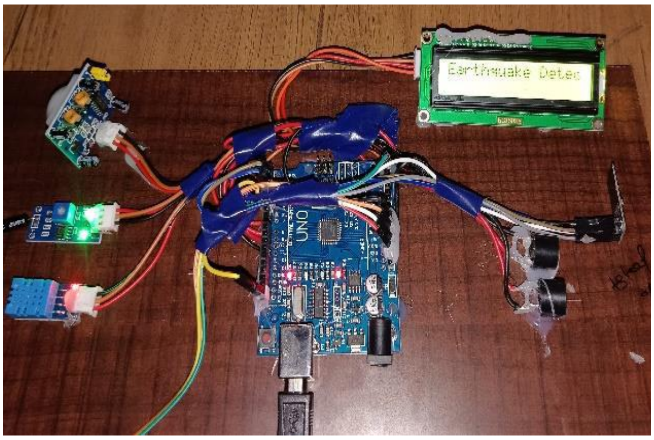

Figure 2: Hardware Setup

The system was simulated in proteus software to test its performance. The vibration and PIR sensors were interfaced with the microcontroller. The vibration and PIR sensor were tuned at a sensitivity level and the PIR sensor at detected motion. The functionality of the system was checked to meet the following objectives:

- To monitor the landslides using appropriate sensors.
- To send the disaster alert message and the affected area coordinates.
- To send the data retrieved by the sensors through IoT technology.
- To analyze the data using the ThingSpeak platform.

The output graphs of temperature, vibration, and PIR sensor are shown below:

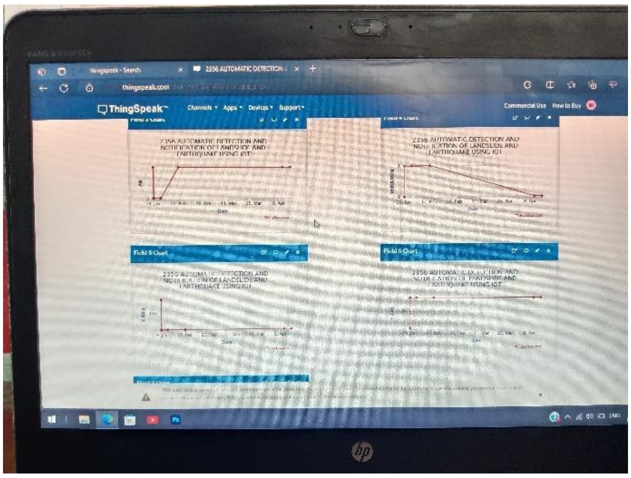

Figure 3: Thingspeak Output 1

VIII. CONCLUSION

There are landslides in many places of the world. Because of the physical features of the region, the type of soil, and the heavy rainfall in the western part of Rwanda, landslides are more common there. Unfortunately, there is currently no system in place for data collection, monitoring, or early warning alerts, which is why the suggested solution is necessary. In this study, we were able to: (i) effectively design and implement a landslide prediction system using fuzzy logic inference. The FIS was deployed on an embedded system, which is an advancement over current cloud-based solutions. Comparing the outcomes reveals that when the FIS is optimized for use with an Arduino, its performance remains unchanged. (ii)a fuzzy-based early warning system and an Internet of Things-based landslide monitoring system were successfully designed and prototyped. If put into practice, this solution will aid in reducing the impact of landslides.

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AUTHORS BIOGRAPHY

Rutuja Phalke,
Student, Electronics and Telecommunication Engineering, Hon. Shri. Babanrao Pachpute Vichardhara Trust's GOI Faculty of Engineering, Kashti., Ahmednagar, Maharashtra, India.

Rupali Shelke,
Student, Electronics and Telecommunication Engineering, Hon. Shri. Babanrao Pachpute Vichardhara Trust's GOI Faculty of Engineering, Kashti., Ahmednagar, Maharashtra, India.

Dipti Baykar,
Student, Electronics and Telecommunication Engineering, Hon. Shri. Babanrao Pachpute Vichardhara Trust's GOI Faculty of Engineering, Kashti., Ahmednagar, Maharashtra, India.

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