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Smart Landslide Detector

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Abstract—*A landslide is geological phenomenon that includes wide range of ground movements. It is in general mass movement across steep slopes and occur in regions with heavy precipitation and some activity in tectonic plates. A Smart Landslide detector can help us in monitoring of the saturation of the soil as well as vibrations from the ground, through this we can effectively can keep eye on upcoming disaster before it hits a geographical area. This can help to save the number of lives and prevent the losses of life and property as people be aware of upcoming landslide. Internet of Things (IoT) plays very crucial role in connecting all the necessary components with each other in such a manner that the real time values could be detected and sent over to control unit . Moisture sensor and vibrating sensor employed that detects and send real time data values to the control unit as some critical value will be set for this sensor, if the value exceeds critical value the people will be notified about Landslides through WebApp and SMS system such that premature evacuation can be done.*

Keywords—*Geological phenomenon, mass movement, tectonic plate, IoT, premature evacuation, moisture sensors, real time data values*

I. *INTRODUCTION*

Landslides refers to several forms of mass wasting that may include a wide range of ground movements, such as rock falls, deep seated slope failures, mud-flows, and debris flow. Landslides occur in a variety of environments, characterized by either steep or gentle slope gradients, from mountain ranges to coastal cliffs or even underwater. Gravity is the primary driving force for all and slide to occur, but there are other factors affecting slope stability that produce specific conditions that make a slope prone to failure.The landslides occur when the slope changes from a stable to an unstable condition. This change in the stability of a slope can be caused by many factors together or alone. The Natural causes, such as, ground water pressure acting to destabilize the slope, erosion at the bottom of a slope by rivers or ocean waves, earthquakes adding loads to barely stable slope, earthquakecaused liquefaction destabilizing slopes.

II. LITERATURE REVIEW

Landslide hazard analysis and mapping can provide useful information for catastrophic loss reduction, and assist in the development of guidelines for sustainable land use planning. The analysis is used to identify the factors that are related to landslides, estimate the relative contribution of factors causing slope failures, establish a relation between the factors and landslides, and to predict the landslide hazard in the future based on such a relationship.

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Listed here are the relevant papers and research analysis which were involved in the research.

Table 1 Literature Survey Table

Author/Year	System Type	Sensors	Merits
Mohammad Omar Kebaili Et, 2008	WSN/MQTT	Precipitation sensor, accelor.	Traffic reduction
Pawar Pitambar Patil IJRAR 2019	WSN/Raspberry-Pi	3 axix capacitive, accelero.	Energy efficient
Rihab Feik et.al 2017	LoRa	Magnetometer,rainguage	Low power, low cost
Giorgetti Andrew et.2018	WSN	Pressure sensor,hygrometer	Energy efficient, wireless
Mehta Prakshep IJRAR 2016	GPRS/MQTT	Esp8266,ADLX335	Low cost,easy implementation

III. METHODOLOGY

The basic distinction of a Landslide prone zone is that it differs from that of a normal soil zone. Hence, the need for an integrated early Landslide Detection system was realized. The structure and design involves series of hardware and software components. Hardware components comprise of Vibration sensors , soil moisture sensors, Node MCU, Arduino UNO. Similarly, back-end , that is the software of this system , involves codes from python language, PYcharm Application , Proteus Design software, HTML and Twilio messaging service.

A. Design and Structure

There are two sensors at each Nodes, NodeMCU 1 is connected with vibration sensor and soil moisture sensor and the same is the case with NodeMCU 2. All the sensor will detect the sudden change in vibration and soil saturation difference will bedetected. The control room will be activated as soon as the sensors detect the difference and signal would be sent over Python on windows system to web app, SMS would be generated and alarms would put on.

A-1. Block Diagram

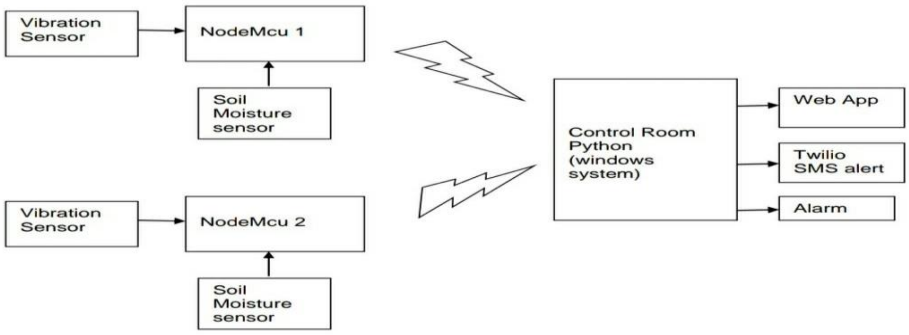

Fig. 1 Block Diagram

B. Hardware

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As shown in Figure 1 , the present system consists of two nodes, namely NodeMCU 1 and NodeMCU 2. Each node receives data inputs from the two sensors attached to it , i.e. the Soil moisture sensor and Vibration sensor. These nodes are placed at two different geographical locations to increase the extent of our detection and monitoring system. NodeMCU unit is integrated with the Arduino UNO. The data received by the NodeMCU from the two sensors is then uploaded to our server with the help of Wi-fi modules which are present on Arduino UNO.

C. Software

As Figure 1 shows, the data received by the control room from the two nodes is processed and the analog values received are compared to the threshold values present in the system. Python is used for the purpose of designing and creating web application which interprets the input data. Also PYcharm is used for designing the web application with python. When input data is processed, output is generated accordingly to the control room / operating end. The user interface for the web application is designed with the help of HTML. Along with an output on the web application , a message alert is sent to the user's phone when system detects danger. Twilio messaging system is used for the same. Along with a message alert , the web application is designed such that if an alert is detected , it immediately activates the alarm system, which alerts the operator of an alert, making the whole system delay-free. Also , Proteus design suite is used for the simulation purpose and to check the functionality of the system.The HTML[HyperText Markup Language] is the standard markup language for documents designed to be displayed in a web browser. It can be assisted by technologies such as Cascading Style Sheets (CSS) and scripting languages such as JavaScript. Web browsers receive HTML documents from a web server or from local storage and render the documents into multimedia web pages. HTML describes the structure of a web page semantically and originally included cues for the appearance of the document. we will be using HTML for the creation of our Hyperlink or Website.We were able to create a friendly user interface with the help of HTML successfully. The contexual website is designed such that user experience is maintained flawlessly. We have a secure Username and password system.

D. Implementation

Python 3.9 (64 bit) is used for giving inputs of sensors from node mcu, another reason for choosing Python is that it works in synchronization with Arduino. Here, we design the project module, webapp view and workspace. For implementing the python codes we use "PyCharm" , it receives real time inputs from the cloud database i.e, Firebase console. Arduino is used in this project for software as well as for hardware purposes. Arduino IDE is used as virtual compiler for the components and all connections to it are made. For each node, program is to be written for vibration sensor as well as soil moisture sensor. Thus two programs are written for the input values at each node wise Node1 and Node2.For inputs analog data is provided by the vibration sensor and digital input is provided at each node from both the sensors.. Here we use the version 1.8.13 At the Firebase console we create a new project " Smart Landslide Detector" at 'console.firebase.google.com' then by entering the real time database window. The necessary sensors are added in the project which will be the values required named wisely; moisture1, moisture2, vibration1 and vibration2 in accordance with their specifications.

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Each sensor can have either of two values; 0 or 1. These values from the sensor database are compared with the limits set in the python codes and output is expressed accordingly.

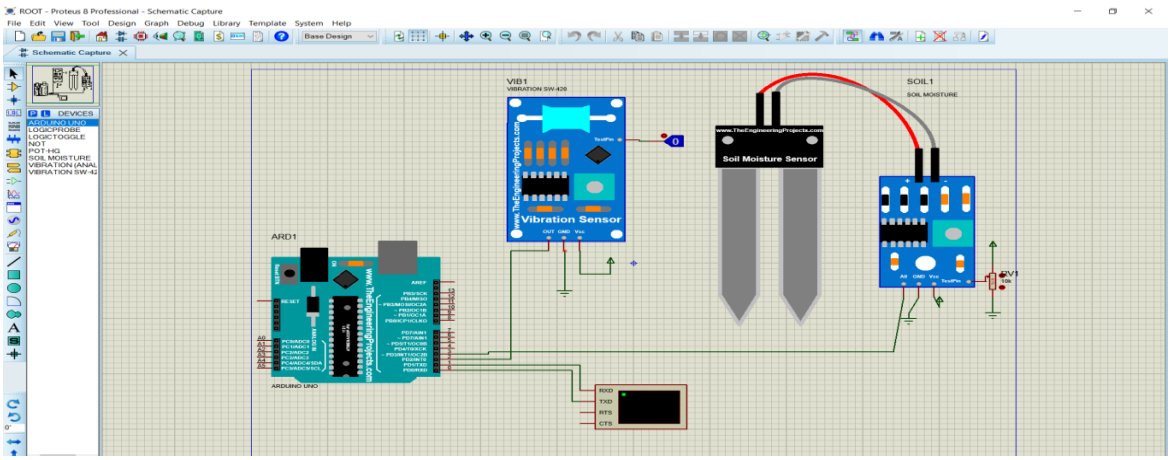

Fig. 2 Various components implemented using Proteus 8

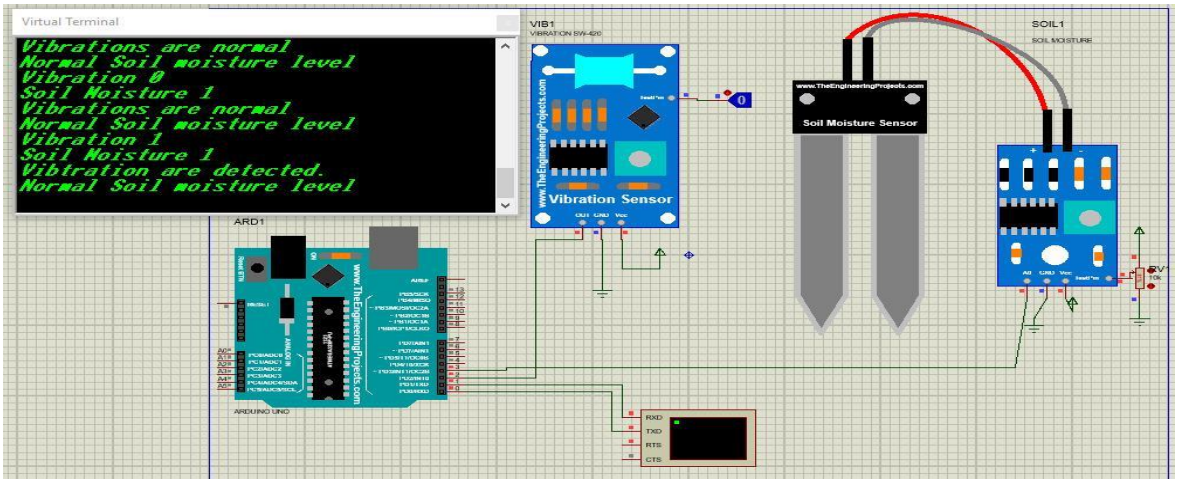

Fig. 3 Virtual Simulation when landslide has been detected

IV. RESULTS

We see the results in a statistical manner. For soil moisture sensors , the low value meant that the soil moisture was more than threshold value , and thus sent an alert. Whereas , high value meant that soil moisture level is well within the threshold limits . in the above table , 1 represents low value , while 0 represents high value. Levels (high/low) represents the assigned sensor output value . The conclusion

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table in the above table which has values alert and normal represent the message that will be sent to the user. Alert signifies that the situation is a crisis. Normal indicates that the situation is well in control. For moisture sensors , Low or 1 value will indicate normal. And high or 0 will send a alert message to the user's phone through twilio SMS messaging system. Vibration sensors at each node is represented by vibration1 at node1 and vibration2 at node2. If input value for vibration1 is 0 then it is low that means that no vibrations are detected . At node2 if vibrations are detected for value 1 i.e, high an alert SMS will be send to user's phone via Twilio SMS app.

Serial No.	Sensors	Input Value	Levels (High/Low)	Conclusion
1)	Moisture1	0	High	Alert
		1	Low	Normal
2)	Moisture2	0	High	Alert
		1	Low	Normal
3)	Vibration1	0	Low	Normal
		1	High	Alert
4)	Vibration2	0	Low	Normal
		1	High	Alert

Table 2 Results for different input values from the sensors.

V. CONCLUSION

Landslide is a natural disaster damaging both life and property in every aspect. Many lives are lost to landslides every year. A growing interference of humans in nature's cycle is also a cause for the great catastrophic disaster. It is a mass movement of large debris along steep sides of mountains. Asia has been accounted for major landslides in the world. India , especially accounts for a great percentage of this disaster every year. So to cope up with this , various scientists and engineers have been finding various instruments for saving lives and property. "SMART LANDSLIDE DETECTOR" uses IoT via real time database and sends an alert at the earliest , so as to notify the user before the disaster takes place. The proposed system uses arduino UNO , arduino[1.8.13] and ESP8266 micro-controller with embedded Wi-fi module. Various software platforms have also been used like Proteus8 , python , pycharm which help in the software configuration. For real time cloud database , we have used Firebase console. SMS alerts and notifications are arranged through the Twilio, which is an API based SMS messaging system . For monitoring and displaying all the necessary changes in system we have created a simple website using HTML. HTML is an easy to use global interface. We have also discussed the results of the system. Henceforth , it can be added that this project "SMART LANDSLIDE DETECTOR" has been successfully implemented as a prototype using IoT.

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