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Landslide Detection System Using Arduino

Gaurav Agrawal¹, Rutuja Shinde², Sayli Dabhade³, Akash lokhande⁴, Prof. Vandana Khobragade⁵

U.G. Student, Department of Electronics and Telecommunication, Lokmanya Tilak College of Engineering,
Koparkhairane, Navi Mumbai, India¹

U.G. Student, Department of Electronics and Telecommunication, Lokmanya Tilak College of Engineering,
Koparkhairane, Navi Mumbai, India²

U.G. Student, Department of Electronics and Telecommunication, Lokmanya Tilak College of Engineering,
Koparkhairane, Navi Mumbai, India³

U.G. Student, Department of Electronics and Telecommunication, Lokmanya Tilak College of Engineering,
Koparkhairane, Navi Mumbai, India⁴

Guide, Professor at Department of Electronics and Telecommunication, Lokmanya Tilak College of Engineering,
Koparkhairane, Navi Mumbai, India⁵

ABSTRACT: Downslope landslides or landslides are common. Asian nations experience the greatest frequency of landslides. Both natural and human factors are to blame for the movement of rock or soil under gravity. The natural causes of the landslip are an increase in the hydrostatic pressure caused by rainwater saturation, snow melting, an increase in groundwater level, an increase in pore water pressure, volcanic eruptions, and earthquakes. Deforestation, cultivation, machine vibrations, blasting, mining, and other human activities are examples. The change in the slope's stability is caused by an increase in material-borne shear strain and a decrease in shear stress. Because landslides result in a significant loss of life and property, it is essential to monitor and develop early warning systems. An attempt is made to develop an IOT-based landslide detection system that is both inexpensive and efficient.

KEYWORDS: Landslide, Arduino, Wireless sensor network, soil, Sensor Development, Automatic Detection, Internet Of Things

I. INTRODUCTION

Downslope landslides or landslides are common. Asia is home to the majority of landslides. There are both natural and human-caused causes for the movements of rock or soil under gravity. The natural causes of the landslip are an increase in the hydrostatic pressure caused by rainwater saturation, snow melting, an increase in groundwater level, and an increase in pore water pressure, volcanic eruptions, and earthquakes. Deforestation, cultivation, machine vibrations, blasting, mining, and other human activities are examples. The change in the slope's stability is caused by an increase in material-borne shear strain and a decrease in shear stress. Because landslides result in a significant loss of life and property, it is essential to monitor and develop early warning systems. The serious landslides that have occurred in India in the past are detailed in Table 1

Guwahati landslide, Assam	On September 18, 1948 due to heavy rain landslide is took place. Over 500 people died in the landslide
Darjeeling landslide, West Bengal	On October 4, 1968 due to flood landslide was happened. Thousands of people died in the landslide and damaged to the highway occurred
Malpa landslide, Uttarakhand	Two landslides occurred between August 11 and August 17, 1988 in the village Malpa. Over 380 people died and entire village washed away in Landslide. This landslide slide has considered one of worst landslides I India.
Mumbai landslide,	In the month of July 2000, this landslide occurred due to the heavy rain and followed



Maharashtra	by the soil erosion. Around 67 people died in this landslide and local trains has affected
Kedarnath landslide, Uttarakhand	On June 16, 2013 due to flood landslide occurred. Over 5700 people died and the flood and post flood landslides had affected 4200 villages

Table 1: Serious Landslides occurred in India

The regions with the greatest risk of landslides are the northwest Himalayan Mountain Range, which includes Uttarakhand, Himachal Pradesh, and Jammu and Kashmir. Due to heavy rainfall, landslides probably occurred annually in this region. According to Table 1, India is more susceptible to landslides. Using Landslides detection systems to keep an eye on the landslides, this becomes essential. However, due to a lack of monitoring systems, real-time landslide monitoring is difficult in India, where it is not widely practiced

Paper is organized as follows. Section II describes previous models that have been developed using different microcontrollers and different sensors Section III consist of working and implementations. Section IV presents experimental results and model. Finally, Section V presents conclusion

II. RELATED WORK

Using development boards like Raspberry Pi, many researchers have worked on a landslide detection system based on the Internet of Things. Referred paper for brief understanding of the topic was, Madhusudhan.Y.V, Renuka.H.C , Bhavya.S.S, Alfred D’souza, Kavyashree.B of Department of ECE, Vidyavardhaka college of engineering, Mysuru, Karnataka, India and Manjunatha.M.N, CAM Engineer, of Wuerth Electronik India Pvt Ltd, Mysuru, Karnataka, India in their paper “Landslide and Rockslide Detection System with Landslide Early Warning System for Railways” published in the “International Journal of Engineering Research & Technology (IJERT)” (et el.,2018) . Their aim is to developed safety for passengers of railways by detecting the landslides in the area using their landslide early warning system. They have used Arduino UNO MCU and camera that uses the code developed with the help of MATLAB. This also includes GSM 800 Module, Vibration sensor. Their early warning system detects the vibration in the earth surface with the help of vibration sensor and sends it to the ArduinoUNO that sends the signal to the buzzer. Buzzer will start generating sound and alert is shown on the LCD screen and SMS is send to the regulating authority on the landslide. [1]

Pawar Pitambar, Patil Akshay, Rathod Hardik, Hadale Ravi, and Kharche Shubhangi of SIES Graduate School Of Technology, Nerul, Navi Mumbai in their paper “IoT Based Landslide Detection and Monitoring” published in IJRAR (ET el., 2019) used soil moisture sensor and accelerometer sensors. All the real time data is sending to the server via MQTT protocol that uses Raspberry Pi (Rpi). They have split the interface in the SAFE, MIDDLE and DANGER zones based on the real time data collected by the connected accelerometer andsoil moisture sensor on the cloud storage facility servers. Rpi is an open source and very cheap alternative to the costly computers available in the market. The cloud storage server used in their project based on the ThingSpeak available for the IoT platform instruments. Their prototype landslide detection system is very efficient and low cost approach. NodeMCU detects the vibration and moisture in the soil than transfer the data to the Rpi and later to the ThingSpeak Cloud service. They have showed that for a 1000 sq.ft area approximately 375 nodes are required to cover the desired area. The future scope of their prototype can be use with the machine learning process by using python for more accurate analysis. [2]

Referred paper for brief understanding of different types of soils and their properties was M Kamalanandhini, R Annadurai of Department of Civil Engineering, SRM Institute of Science and Technology, Kattankulathur Tamilnadu, India “Assessment of Drought Condition Based on Standardized Precipitation Index and Soil Moisture Condition– A Case Study in Parts of Chengalpattu District, Tamilnadu, India” .In this the collected soil sample was subjected to gravimetric analysis by finding water holding capacity and thus their reflectance characteristics Based on this, the moisture values obtained by both gravimetric analysis and the soil moisture sensor was compared for the pre-monsoon and monsoon season. The resultant value determines the soil moisture of the samples collected and analyzed in both the seasons.[3]

III. METHODOLOGY

The development of a low-cost and effective IOT-based landslide detection and warning system is the primary focus of this project. The system is built with the help of an Arduino board and various sensors. The open-source microcontrollers Arduino is simple to program, erase, and reprogrammed at any time. An ATmega328-based microcontroller is the basis for the Arduino Uno board. A 16 MHz ceramic resonator, an ICSP header, a USB connection, six analog inputs, a power jack, and a reset button are among its 14 digital input/output pins. A jump wire is an electrical wire or group of wires in a cable that is typically used to connect the parts of a breadboard or other prototype or test circuit internally or with other equipment or parts without using solder. The volumetric water content of the soil is measured by soil moisture sensors. Rainfall conditions that are comparable to the real thing are simulated, and the intensity of the rain is controlled so that the change in moisture content and characteristics of the moisture can be determined as the intensity changes. It only results in the slope beginning to slide because it has a warning system built into it.

The following is how this moisture sensor works: when the sensor is completely dry, it sends a specific analog reading to the micro controllers. The sensor exhibits a decrease in analogue readings as the dampness increases, making it less able to transmit these analog readings. Based on this principle, the sensor is calibrated to determine the soil dampness percentage. A viable option for identifying the issue will be a sensor embedded in the soil. The sensors will be programmed to notify the appropriate authority to stop and evacuate the area whenever a specific soil moisture level is reached, which is more critical in real-world scenarios like earthquake, cracks and dynamic loading.

The procedure's stages:

- 1) When the system is ON and the threshold is values are set in the first step.
- 2) The sensors begin gathering data and keeping an eye on it based on threshold values. These values are set based on other research papers which mainly focus on study of soil and its properties
- 3) The outcomes are determined by comparing the results of the collected data to the threshold values.
- 4) The alert is sent via SMS to the registered mobile phone number of the end user and also displayed on the LCD screen if the sensor's output is greater than the threshold value.

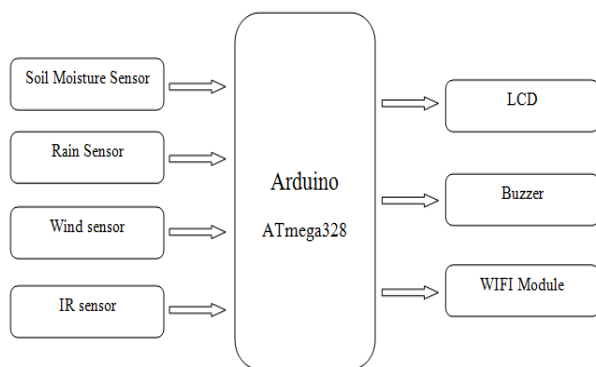


Fig 1: Block Diagram of Proposed System

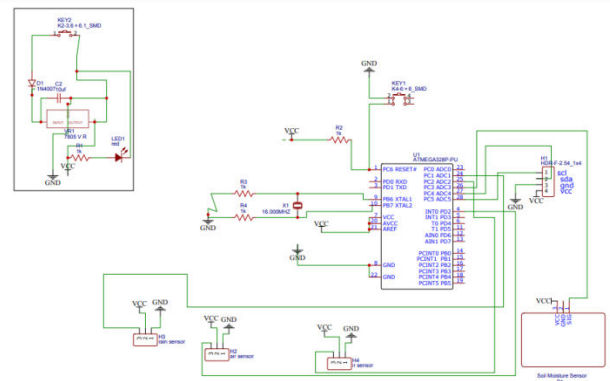


Fig 2: Schematics of Proposed System

IV. EXPERIMENTAL RESULT

The below figure show the model which was made to demonstrate and collect data with different inputs and factors like soil type, amount of rain, wind speed, giving us the necessary data which causes landslides which later on can used to predict potential landslides hence saving lives and preventing from damage to properties with precautionary measures

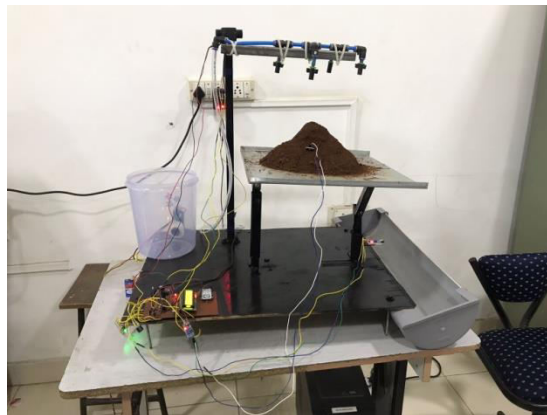


Fig 3: Working model of Proposed System

SOIL TYPE	WATER (ml)	TIME (min)	MOISTURE PERCENTAGE
RED SOIL	200	10	53%
	200	10	58%
	200	10	75%
	200	10	80%
BLACK SOIL	200	10	10%
	200	10	25%
	200	10	42%
	200	10	49%

Table 2: Soil Moisture Percentage

V. CONCLUSION

This prototype makes it possible to monitor and detect landslide. This is a low-cost and efficient system for landslide early warning and data monitoring in real time. The threshold values for the sensor are set so that the parameters for a landslide can be assigned. It has been discovered that the system is able to notify the end user when threshold values are exceeded. By adding more sensors to the Arduino, this prototype can also be used for large areas. Not only will the proposed system assist us in detecting a landslide, but it will also enable us to send a message to the relevant authority, where additional emergency messages can also be sent. Alert messages can be sent with the assistance of alarm systems, saving lives and preventing damage to vehicles, properties, etc.

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