Landslide Detection and Avoidance System

Prathamesh Deore, Aditya Desai and Shripad Bhatlawande

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Prathamesh Deore
Department of Electronics and Tele Communication Student, Vishwakarma Institute of Technology Pune, India
prathamesh.deore20@vit.edu

Aditya Desai
Department of Electronics and Tele Communication Student, Vishwakarma Institute of Technology Pune, India
aditya.desai20@vit.edu

Prof. Shripad Bhatlawande
Department of Electronics and Tele Communication Professor, Vishwakarma Institute of Technology Pune, India
shripad.bhatlawande@vit.edu

Abstract – **Landslides occur on downhill slopes. The Asian nations are the ones that experience landslides the most frequently. Gravity-induced rock mass or soil movements have an impact on both natural and human activities. Increased fluid mechanics pressure, rainwater saturation, snowmelt, an increase in level of water, an increase in pressure of pore water, volcanic eruptions, and earthquakes are all natural reasons for landslides. Deforestation, agriculture, mechanical vibrations, mine blasting, and other human activities are included. The stability of the slope is changed by an increase and decrease in shear stresses and shear strain respectively carried by the material. Landslides severely damage people's lives and property, necessitating observation and the development of early warning systems. An effort is undertaken to develop an inexpensive, reliable, and IOT-based landslide detection system. It is made up of an Arduino that is being exploited, moisture sensors, a Wi-Fi module and vibration sensors. Important time information must be tracked, and when a landslide occurs, an SMS alert is delivered to the top user indicating its location.**

Keywords- Landslide, Android, Vibration, Moisture, Arduino

I.   INTRODUCTION

The flow of material, debris, or soil down a sloped area of ground is referred to as a landslide.[1] A landslide happens as a result of both natural and human factors. Rainwater saturation, an increase in hydrostatic pressure, a rise in groundwater levels, earthquakes, and other conditions that make the down slope unstable can all result in landslides. Blasting, mining, deforestation, cultivation, etc. are examples of human actions.[2] Any downward sloping movement of dirt caused by gravity is referred to as "Mass Wasting," which is another name for landslides. One issue many nations experience is landslides. Because it endangers not just humans but also other properties and animal lives, it is extremely harmful, therefore early detection can help limit its damage. This cannot be prevented, i.e., the landslide cannot be controlled. [3] Monitoring the vibration level of the earth and the water content of the soil, however, can limit this impact. The Disaster Alert systems were put in place to warn people when a landslide was beginning. To prevent harm to living things, steps can be taken. [4] Landslides can be located in a variety of ways, such as visual inspection using image processing, satellite remote sensing, or machine learning methods. Wireless sensor networks can be used to identify landslides using data-driven methods. By spotting a landslide's early movement, researchers hope to minimize the effects of a natural calamity [5]. This will lessen property damage or prevent the landslide-related deaths of people. The suggested system consists of different sensors that track data in real time, including vibration sensors, soil moisture sensors, and ultrasonic sensors. The early warning landslide detection system helps to protect both people and animals from harm.

II.   LITERATURE REIVEW

A system [6] was made for Tangni Landslide, which focuses on the construction of an indigenous low-cost Landslide Early Warning System (LEWS), which will comprise the creation of sensors, an IoT network, and a cloud server. All characteristics, such as robustness, cost, and ease of access, will be taken into account by the system. Availability, warning accuracy, and readiness to deploy in the field the region is prone to landslides. The effectiveness of the developed LEWS will be tested. In another implementation [7] of the similar system which was IoT based, consists of soil moisture sensors and vibration sensors which monitor real time data and these all data is collected by Arduino board. The system also consists of a Wi-fi module so send SMS to the end user. Arduino sends all the data into the cloud storage Thing Speak. When real time data exceeds the threshold values the alert SMS are sent to the end users mobile phone which has registered. For sending the SMS the IFTTT execution service is used.

According to a similar concept [8] based on WSN, wireless sensor networks (WSN) are one of the inventions that may quickly respond to data changes and transfer information to the collector section in areas where wired or expensive cabling isn't available. The designed system can be disseminated and implemented across a fairly Brobdingnagian space at a reasonably low cost thanks to WSN. Unlike other landslide surveillance systems, the information gathered by this technology may be accessed using a smartphone application. The ground motion detecting device in a system [9] uses an accelerometer and an Arduino microcontroller board as its primary sensors. Prior to the landslide, information concerning earth movements is processed, which causes warning signals to be sent out. The three criteria are determined by the software: Stable, Warning Landslide. The system's reactions were calibrated to various angles during testing on a moist soil sample. The alerts, the LCD display, and the wireless channel all worked as expected.A system[10] was made to recognize landslides before it happens, which collects data from soil moisture and accelerometer sensors and with the help of a multiplexer it sends data to the microcontroller. Here the microcontroller is nothing but nodeMCU. Then this data is transferred to Raspberry Pi via MQTT protocol. With the help of Raspberry Pi all data is stored in the database, but it takes 20 min to upload data into the database.

Another system [11] was made to avoid loss of humans and their properties by alerting them before a landslide occurs. The system contains a vibration sensor, soil moisture sensor which collects data and this data is collected by Arduino Uno. A WiFi module was connected to the main Microcontroller to store data in the cloud and system send alert msg to the end user on the mobile about the landslide. It was a suitable solution [12] for a higher cost and maintenance system using an IoT based approach. It has improved object control and also detects remotely among various networks by creating direct communication between computer and physical world. A landslide monitoring system [13] was proposed to be implemented using IoT with a video camera based on raspberry pi. It uses a computer vision algorithm to detect the landslide. Notifies users via an Android Application. The advantages of using raspberry pi are that it is a low-cost device and demands low power. Also, it can be installed in any region.

III.   METHODOLOGY

The proposed system is an integrated system that consists of 2 modules. In fig 1. The first module consists of a group of sensor module nodes distributed and connected to the Arduino UNO. In fig 2. the second module consists of a buzzer, an LCD display, and a NodeMCU connected to the Arduino UNO. Each module contains a HC-12 for serial communication between them.

When a landslide occurs, all the sensors, i.e., soil moisture sensor, vibration sensor, and ultrasonic sensor, sense the changes and transfer them in real time to the Arduino microcontroller. This microcontroller sends real-time data to the second module through HC-12. In the second module, the microcontroller sends data to NodeMCU and the LCD display to print the status of the condition. The nodeMCU was used to send data to the Blynk application.
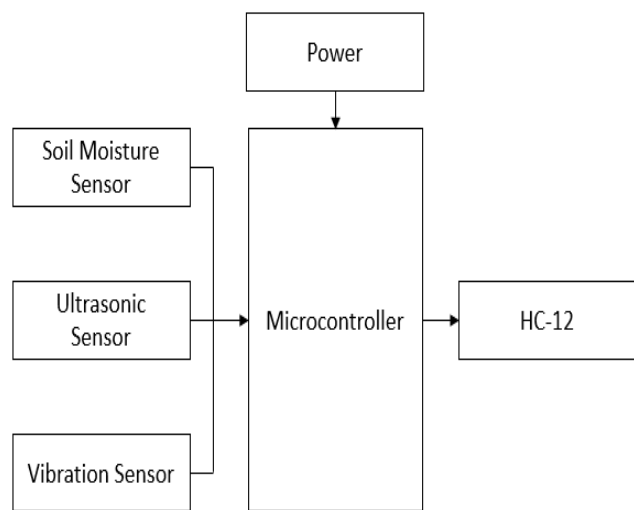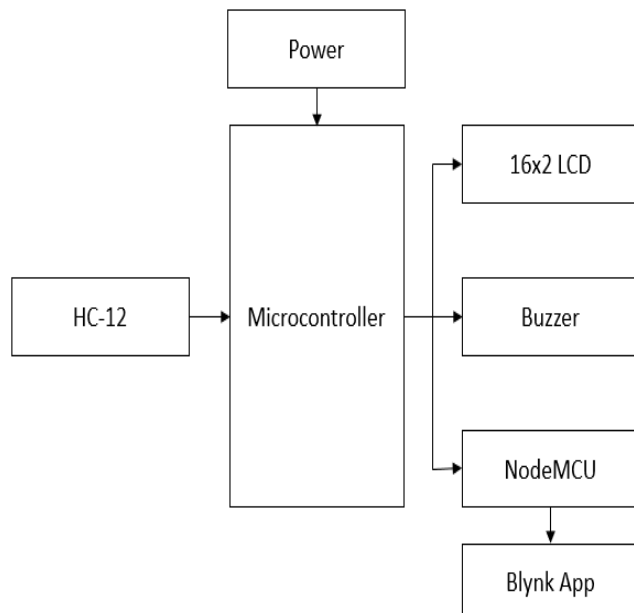

Fig 1. Module 1 Block Diagram

Fig 2. Module 2 Block Diagram

In fig 3, the system is initialized first. The extreme values of the sensors are fixed in the system and then the real-time monitoring is started. The real-time data monitoring takes place by the sensors every 1 second. Then this data is given to the heart of the system i.e., microcontroller. The microcontroller collects all real time data from the sensors, processes the data, and it is constantly checked if the monitored data crosses the threshold values. If the sensor measured values exceeds the fixed data values, the buzzer activates, an alert display appears on the LCD, and an SMS alert is sent to end users.
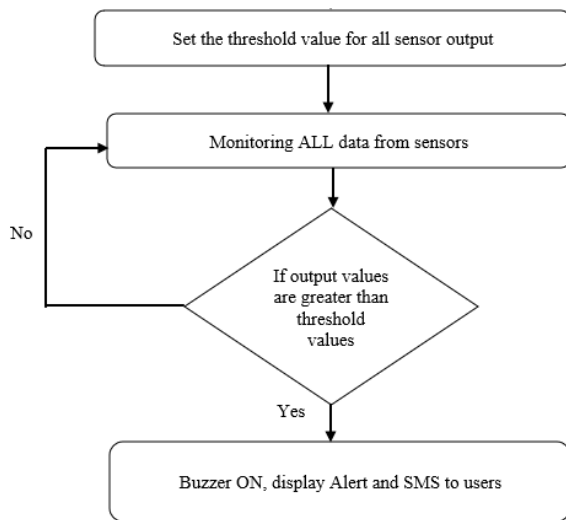

Fig 3. Flow of the system

IV. HARDWARE SPECIFICATIONS

The Arduino UNO is the heart of the system, it is the microcontroller which is based on the ATmega328P processor. It has a total of 28 pins, out of 6 pins are analog input pins, 14 pins are digital I/O pins, reset button and a USB connection. It can run on both online and offline platforms programmed based on IDE, which stands for Integrated Development Environment. The NodeMCU is the other main part of the system. It is also a microcontroller which has an in-built Wifi module called the ESP8266. It contains 64KB SRAM, a CPU, works at 3.3V. It has a total of 30 pins. It has a total of 17 GPIO's pins out of 1 pin is analog input pin and 16 pins are digital input/output pins. The system also contains a 16x2 LCD display which displays Safe, danger and Alert status of the landslide. The LCD is in

the project to give a visual alert of the landslide that is detected to the people nearby. The HC-12 is the wireless communication module which is used to send data from one module to another module. The module has a maximum transmit power of 100mW and a communication distance of about 500 meters or less than 1 kilometer. The water level in the soil is measured using soil moisture sensor. Since moisture level increases in monsoon due to heavy rainfall. This sensor comes with a pair of probes that can be inserted in the soil. A small number of current flows through the probes and the level of resistance will vary on moisture level. The output from the sensor is an analog output and the microcontroller requires digital inputs. So, an analog-to-digital port (ADC) was connected between the moisture sensor and the microcontroller. A vibration sensor is used to detect some vibrations which happen in the soil due to landslides. It is also known as tilt sensor module-SW-520. It has 3 pins: GND, VCC and one digital pin. It works with a 3.3V dc power supply. It can work in 0 degree celsius to 80 degree celsius. An ultrasonic sensor is used to check whether a landslide happened or not. It is a proximity sensor used to detect objects. It has a transmitter and receiver. The transmitter sends the signal with ultrasonic frequency of 20k Hz and the receiver receives reflected signal from the object. It works at 5V dc power supply.

V. RESULTS AND DISCUSSIONS

In fig 4. SW-520 Tilt sensor module, soil moisture sensor and ultrasonic sensor monitors changes in environment and then microcontroller collects all data from these sensors. This data is sent to another microcontroller using HC-12 to display the current status of condition.

In fig 5. the real time data monitored by sensors excessed the systems threshold values, the system will send an alert SMS to end users mobile.
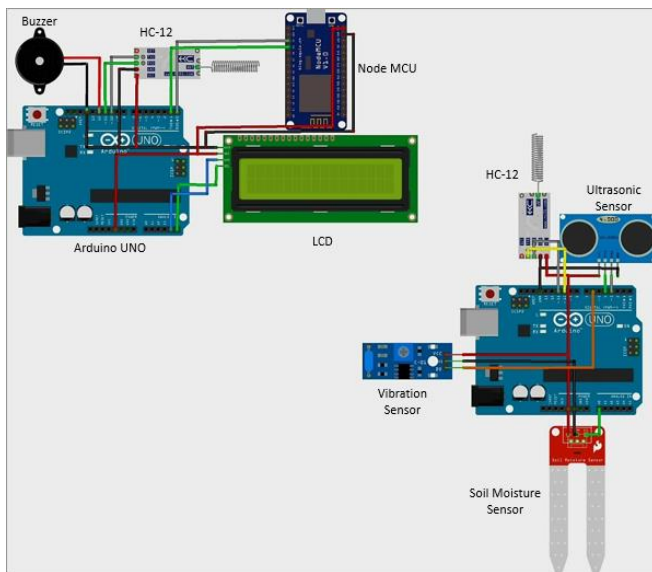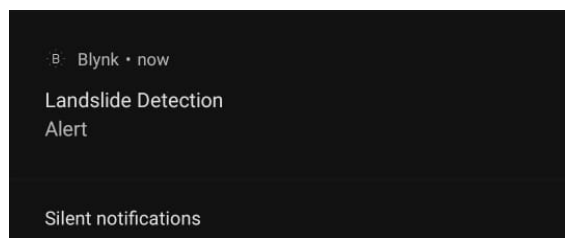
Fig 4. Tinkercad Simulation

Fig 5. Notification

VI. CONCLUSION

The proposed system aims to create a low cost and an early warning landslide detection system. The proposed system not only assists in detecting landslides, but also to communicate with those who are worried about a position of authority where other emergency messages may be sent. The system successfully monitors real time data. The threshold data values are already given to the system. If monitored values exceed the threshold values, the system will send an alert SMS to end users mobile. The early warning landslide detection system avoids damage to human beings but also other properties and animal lives.

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