

Landslide Detection and Warning System

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Abstract

Landslide Detection and Warning System is a system for monitoring various soil parameters such as soil moisture, yaw, pitch, roll, pressure. The proposed system uses soil moisture sensor which has corrosion resistant probe with two plates to measure the water content in the soil. The accelerometer used is 6-Axis accelerometer sensor that provides analog voltage at the output measuring land displacement and tilt angle i.e. yaw, roll and pitch. The temperature and pressure are measured using BMP 180 sensor. All collected data from the sensors are given to the microcontroller (Arduino) that compares and checks with the threshold value and the whole data is received by monitoring system through NodeMCU. GPS and GSM module are used to give the location details and to send message to registered phone number respectively. Lighting and buzzer comprises the warning system that is used to alert the residents along with the alert message received in the registered phone. Monitoring system continually monitor data from corresponding section. Message is sent to fire force, nearby police station and concerned authorities. The whole system is being having two hubs of sensors and a central monitoring system to give necessary alerts and warnings. So we could clearly understand how more than one region is being monitored. The project comprises of Webpage that is provided with a administrative login ID and password that gives the administrator access to the page. The webpage shows google map image of the place where the system is placed and also indicate about the status of the targeted area.

Keywords: landslide, monitoring, warning, prediction, soil movement, tilt angle and soil pressure.

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I. INTRODUCTION

A landslide is the downslope movement of soil, rock, and organic materials under the effects of gravity and also the landform that results from such movement. Landslides are known also as landslips, slumps or slope failure. Slope movement occurs when forces acting down-slope (mainly due to gravity) exceed the strength of the earth materials that compose the slope. Causes include factors that increase the effects of down-slope forces and factors that contribute to low or reduced strength. It is a real-time truth that we can't predict a landslide and stop it. But we could take necessary precautions before the occurrence by giving alert to the nearby localities and concerned authorities to take preventive measures.

The proposed system consists of mainly three sensors that we use in the project are accelerometer sensor, soil moisture sensor and temperature and pressure sensor. The accelerometer sensor that we used is 6-axis accelerometer sensor which provide analog output that measure land displacement and tilt angle. Then for temperature and pressure measurement we use BMP180 sensor. Corrosion resistant Soil Moisture sensor to measure the accurate value of moisture content in the soil. A lighting and buzzer system is provided to give alert about landslide along with the message received to the register phone numbers. The whole system consists of two hubs; each hub covers a certain area of surrounding. The main purpose of more than one hub is to show how monitoring system works with more than one system and receives and sends necessary information. The monitoring system also consists of a webpage that is provided with a administrative login ID and password that gives the administrator access to the page. The webpage shows google map image of the place where the system is placed and also indicate about the status of the targeted area.

Kamal K. Chapagai et al.[1] presents sensor Network Based Testbench Implementation of Landslide Early Warning System, an implementation of prototype based Early Warning System (EWS) to detect and provide early warning of Landslide activities. The main aim of this work is to implement the prototype with low cost sensor network.

Pathania, A. et al.[2] discussed about a lowcost, sub-surface iot framework for landslide monitoring, warning, and prediction. The primary objective of the project is to detail the development, deployment, and evaluation of a new low-cost IoT-based landslide monitoring, warning, and prediction system. In this research, we developed and deployed a new system sub-surface, which is capable of generating real-time warnings via SMS in case of significant sub-surface movements.

Ngawang Galley et al.[3] proposed a wireless sensor network based landslide detection and early warning system. This research includes the construction of a wireless data connection network using sensors, ZigBee and microcontroller. Three sensors i.e. temperature, soil moisture and angle sensor, are connected to the Arduino UNO processor for collection of data. The data collected by Arduino is then sent through ZigBee. The information received in the base station is displayed through LCD, for real time monitoring.

Dongxin Bai et al.[4] described the design and application of landslide monitoring and early warning system based on micro service architecture. In this study, an intelligent monitoring and early warning system and its application were developed based on micro service architecture.

B.A.Hadi el at.[5] proposes Continuous Landslide Early Warning Signal Capturing using IoT based Soil Pressure Monitoring Device. The soil pressure monitoring with the new improved data communication as to detect any landslide early warning signal continuously without required human intervention for collecting the data. The main objective is to design, develop and test the soil pressure monitoring system using the latest Internet of Things (IoT) technology for solving the existing issues including timely and late sensing.

II. METHODOLOGY

The block diagram of Landslide Detection and Warning, our system prototype model of Landslide Detection and Warning System. Mainly the system consists of two hubs. These hubs represents certain landslide prone area. Each of the landslide prone area which the hub is been created. The hub consist of mainly three sensors which could measures various parameters for the detection of Landslide. First of all the temperature and pressure sensor which has been used is of BMP 180. It senses and detect the variation in temperature and pressure of the soil moisture content. Then we uses an 6-axis Accelerometer , it clearly gives the each tilt angle and displacement value by sensing. The the last not the least sensor that is Soil moisture sensor, it's there to measure the moisture content present in the soil .If certain level of moisture content in the soil increases which makes a due cause of Landslide it can be clearly understood by continuous monitoring the threshold value. These three sensors are connected to a Arduino UNO. The Arduino UNO is further connected to LCD display and LED Buzzer. Then from Arduino UNO the connection is directly given to NodeMCU. Then from NODEMCU towards GPS and GSM module. This overall connection is of one hub. Such two hubs is been there in our system. These two systems are then connected towards Monitoring System .In the monitoring system we have created a webpage were it clearly shows each and every threshold values.

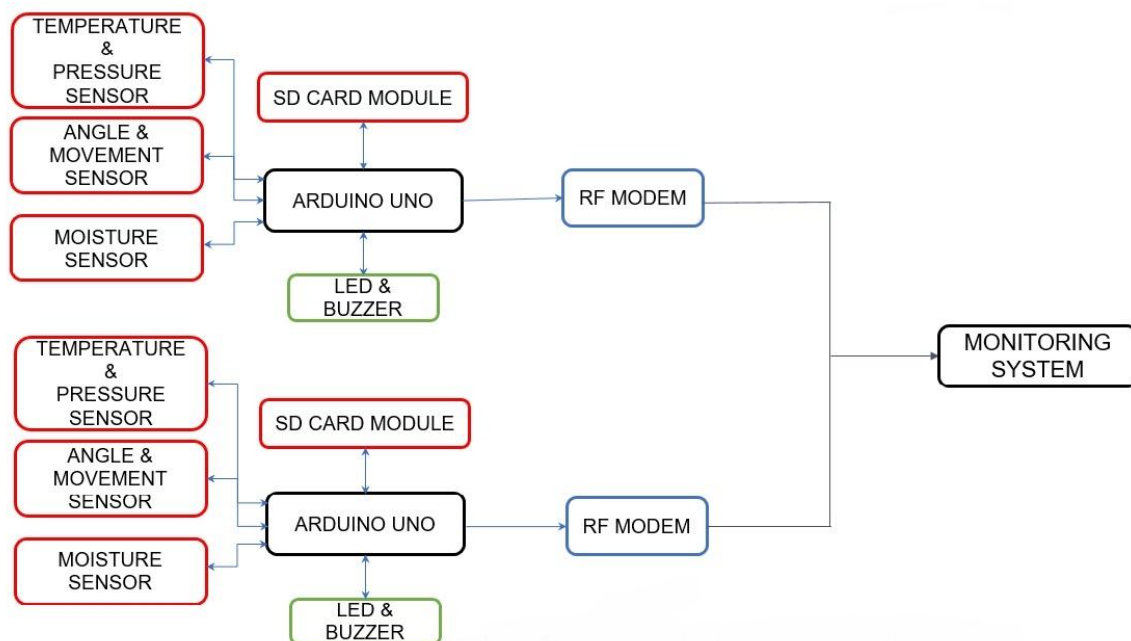


Figure 1: Block diagram of Landslide detection and warning system

The schematic diagram on Landslide detection and warning system. Here , it shows that the three sensors 6-Axis accelerometer, BMP 180 Sensor and Soil moisture sensor has been connected to Arduino UNO. Then from the Arduino UNO connection has been gone to LCD display , buzzer and LED. Then a NODEMCU is also been connected to Arduino UNO along with that a GSM module is also connected. A GPS system is been connected to NODEMCU. The Arduino UNO can directly connect the board to the computer via

a USB Cable which performs the function of supplying the power as well as acting as a serial port. The 6-axis accelerometer, VCC is connected to input, the pins SCL and SDA are connected to pins of Arduino UNO pins A4 and A5. Along with this connection BME680 has also been connected along with this. Then from soil moisture sensor, a connection from pin A0 is given to A0 pin of Arduino UNO. The POT (potentiometer) has been connected to the LCD display to pins VSS, VDD and VEE. Then next the remaining connections from LCD is given to Arduino UNO from pins RS, E, D4, D5, D6 and D7 towards pins 8 (PB0/ICP1/CLKO), 9 (PB1/OC1A), 10 (PB2/OC1B), 11 (PB3/MOSI/OC2A), 12 (PB4/MISO) and 13 (PB5/SCK) of Arduino UNO. Then from pin 3 (PD3/INT/OC2B) connection has been given to LED as well as pin 2 (PD2/INT0) is been connected to Buzzer System. Pin 4 (PD4/TO/XCK) is connected to pin D6 of NODEMCU from Arduino UNO. From Pin 1 (PD1/TXD) of Arduino UNO, its connected to GSM Module (RXD pin). From RX pin 19 of NODEMCU to a GPS system also the connection has been gone.

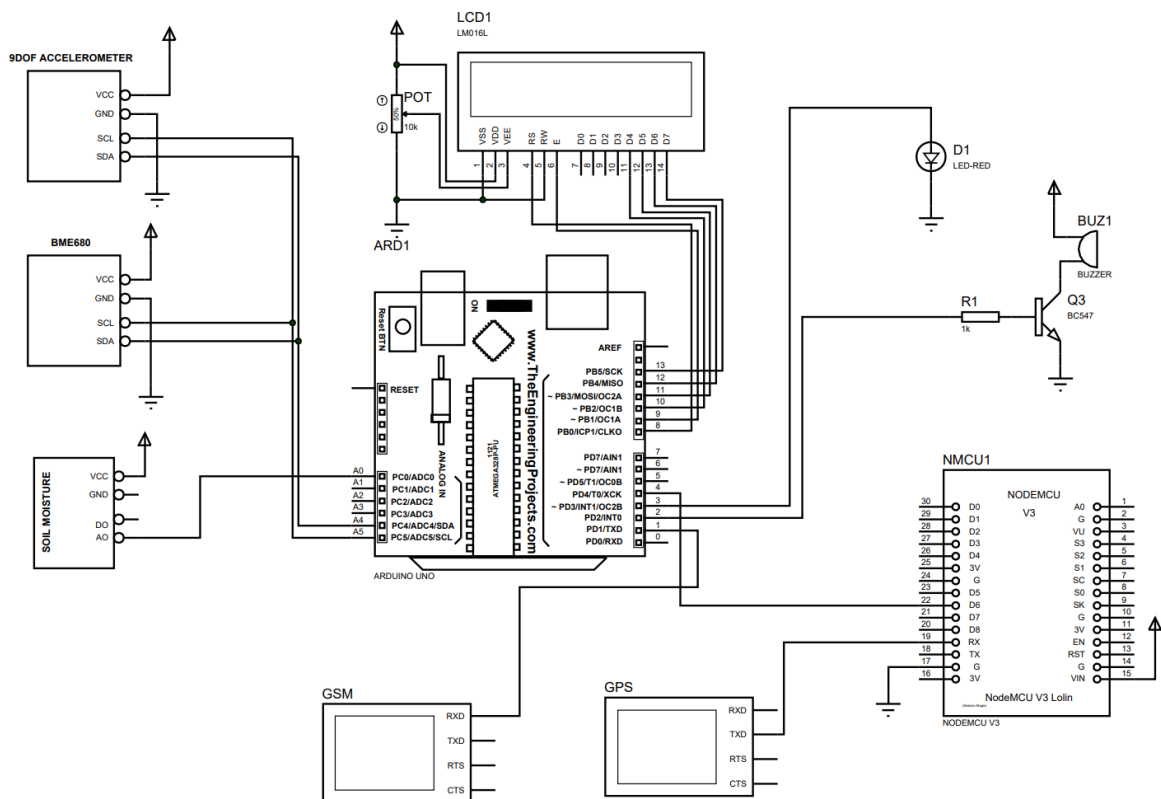


Figure 2: Schematic Diagram

III. THE SIMULATION

The Proteus software has been used to simulate landslide detection and warning system. An Arduino UNO board has been used for the simulation as the central microcontroller. The objective of the simulation design was to ensure that the methodology developed for early warning system of landslide is efficient and accurate. The choice of Arduino UNO as the microcontroller made it a better choice for simulation purpose as code was developed in Arduino IDE itself. In the simulation we are showing the monitoring and alerting section with led and message sent via GSM. The sensors are shown as the POT as the basic principle as change in resistance. A testing value is set as threshold value and when the sensors cross the standard value LED and message is sent i.e., shown through virtual monitor.

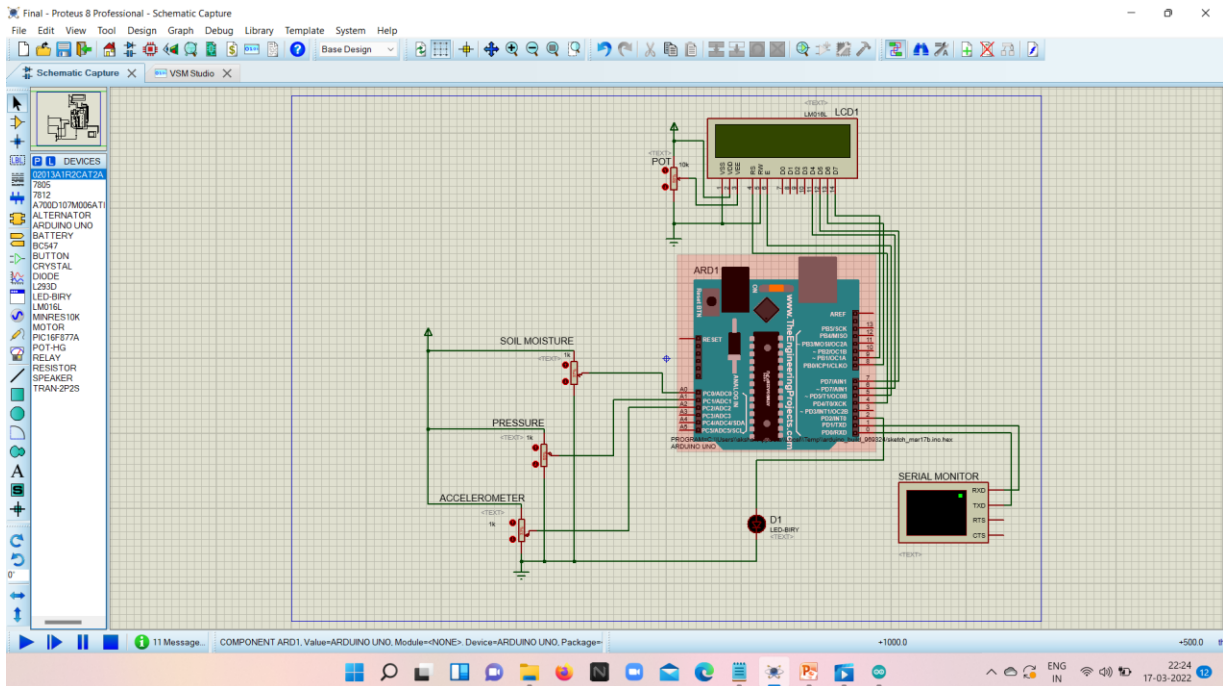


Figure 3:Simulation setup

IV. SIMULATION RESULTS

The results of the simulation are in the form of measurement of data from the sensing elements, comparison of the data with the thresholds already assigned in the controller and transmitting the control signal to display/output devices.

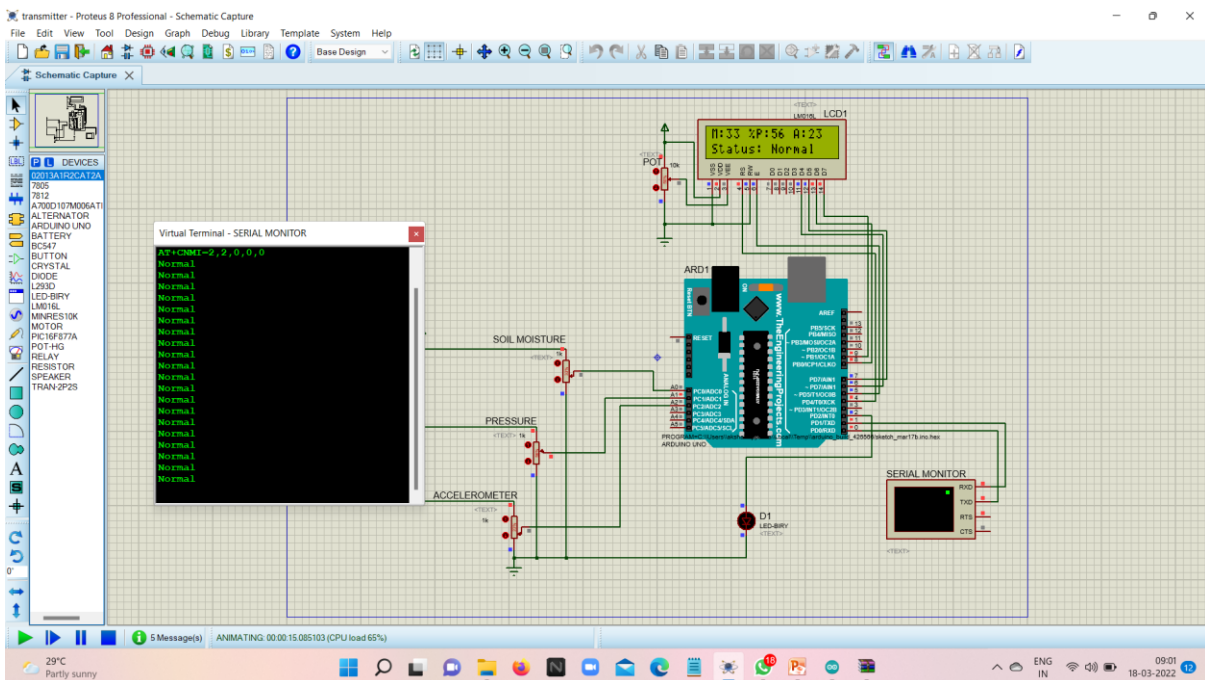


Fig.6:Simulation before crossing the threshold value

The figure 6 shows the virtual monitoring showing "Normal" when the parameters sensed by the sensors are below the threshold value. At this "Normal" situation it gives us a clear idea that all the landslide parameters that we have taken into consideration are normal as well as the landslide area is at normal environment condition. All the values showing the normal situation can be clearly seen in the LCD display.

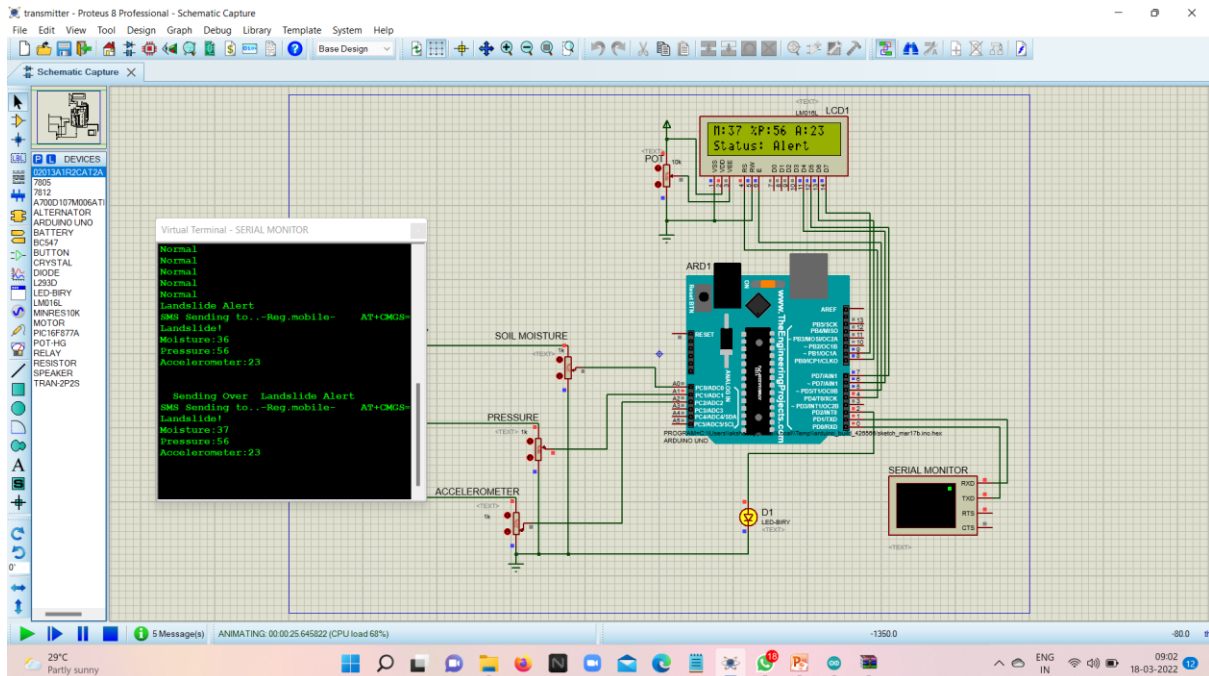


Figure 7: Simulation after crossing the threshold value

The figure 7 clearly picturizes the situation that happens when the threshold values have been crossed means a situation of landslide have been detected. The monitoring system when we observe we could see that the values at the time landslide detection have been clearly mentioned as well as to make the person who is controlling or observing the monitoring system could understand that Landslide has been detected. Because a message of "Landslide-Alert" is seen in monitoring system. Along with that each parameter which have crossed the threshold value have been clearly specially mentioned.

V. HARDWARE IMPLIMENTATION

The figure 8 shows the Hardware setup of the Landslide Detection and Monitoring System. It consists of all the 3 sensors to detect the soil parameters to predict the early landslide system. BMP180 is used for sensing the pressure, 3 axis Accelerometer is used to measure the acceleration exerted upon the soil. The accelerometer typically gives us two types of data: 1. Static force applied on the soil due to gravity (tilt or orientation) and 2. Force / Acceleration exerted upon the soil on the movement or force detection. And last not the least the soil moisture sensor to measure the moisture content in the soil. Arduino is used as the microcontroller that monitors and checks with threshold value. It collects data from all the sensor. The whole system is programmed using Arduino IDE. The alert message is sent to respective mobile numbers when the threshold of soil moisture sensor and accelerometer sensor or pressure sensor is crossed as clearly mentioning that the Landslide has been detected. Along with that each threshold values also been specifically mentioned. During alert LED and buzzer is activated along with the message sent to the registered phone number through GSM module. With the help of NodeMCU having an in-built wifi module, the landslide region location along with the status and GPS location is shown in the deigned administrative webpage.

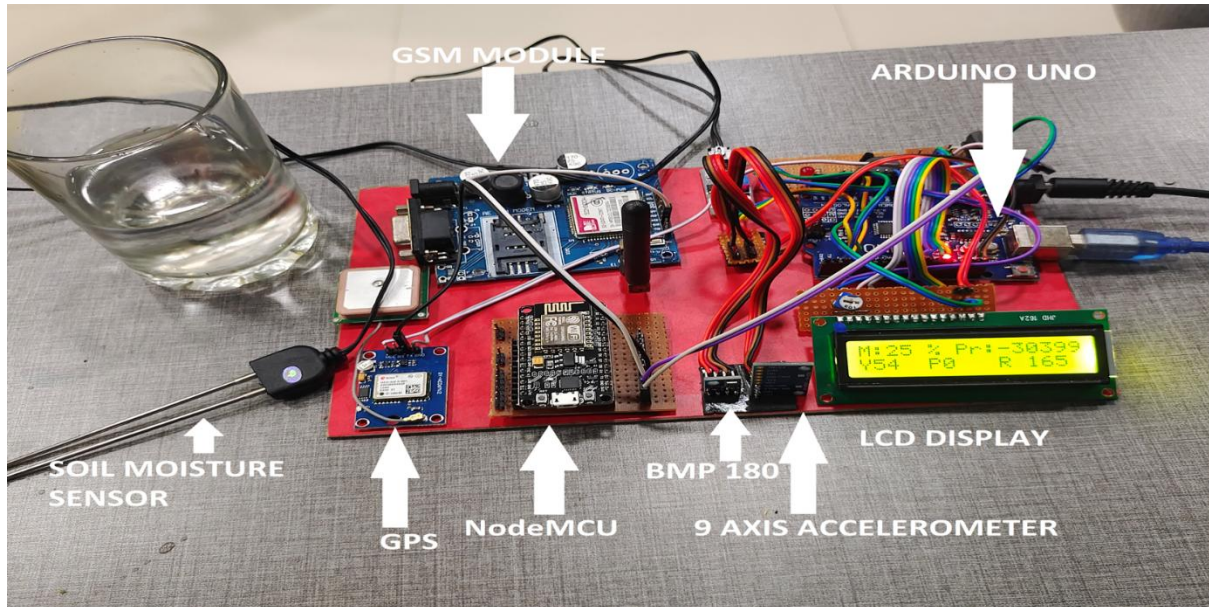


Figure 10:Hardware

The web interface for the real time monitoring. Through this web page we could clearly track the location where Landslide has been detected and it make us more beneficial to give the alert messages and Buzzer kept at respective area make alert sound. By entering the Login ID and password we could open the webpage. The directly the webpage opens to a Dashboard where it shows the data of latest updates. To check the previous data there is history option to check the data. In both Location data screen if landslide has been detected then at the lower left end it will be clearly mentioning that the situation is NORMAL or LANDSLIDE ALERTED.

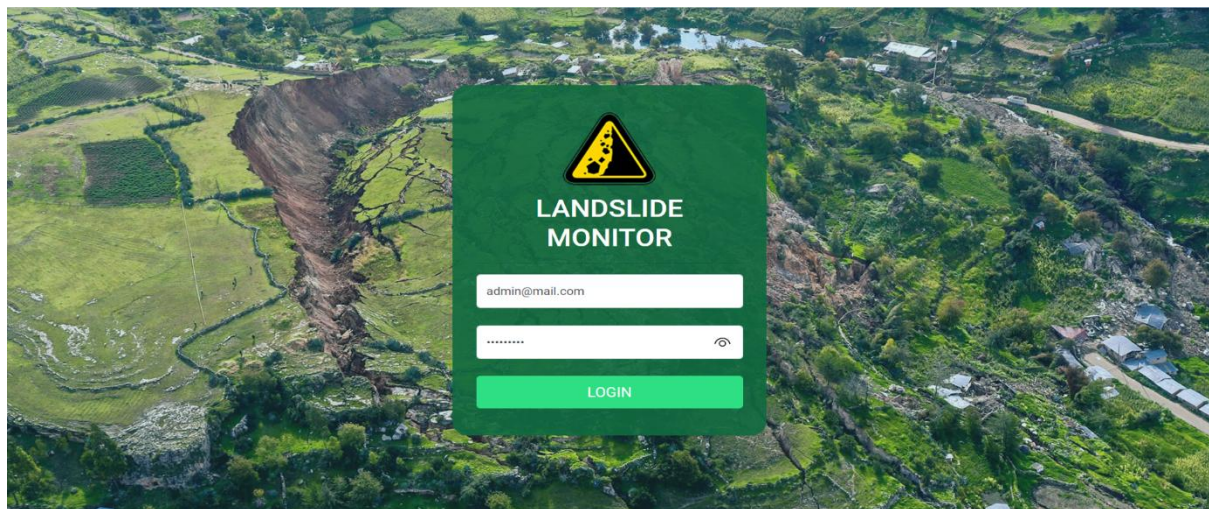


Figure 11:Web interface for real time monitoring

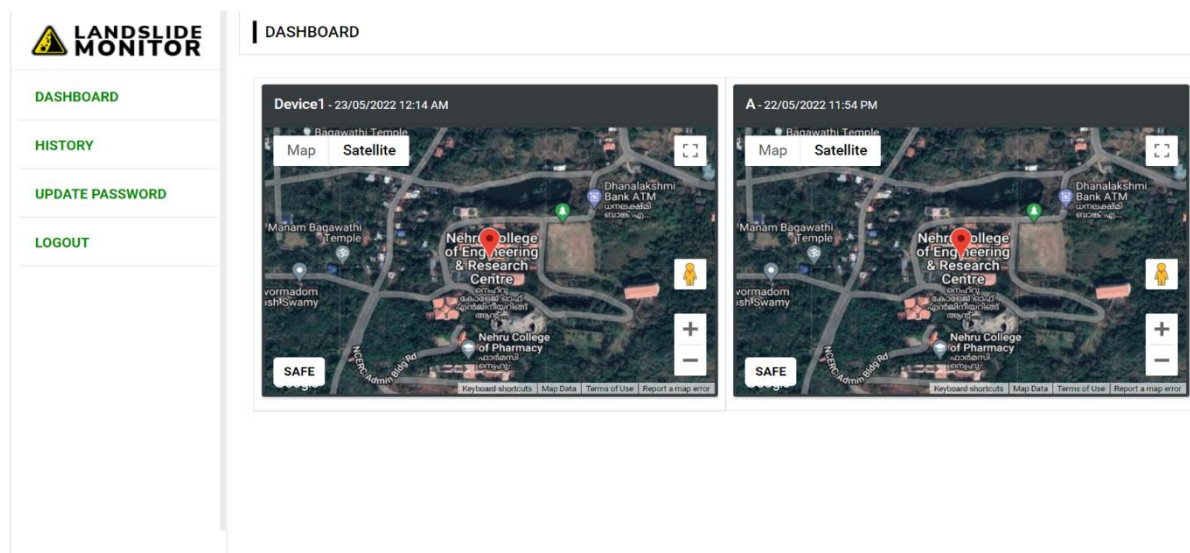


Figure 12: Web interface showing the current status and status of the system

VI. CONCLUSION

The Landslide Detection and Warning System consists of heterogeneous network of sensors that show real time data. Proper warning and alert system is developed at a low cost implementation. This system can be scaled up for implementation in real field to provide early warning system. The system can also be improved by incorporating more number of sensor and controllers to cover a larger area. Increasing the sensors with improved algorithm can also improve the reliability of the system. Our project, Landslide Detection and Warning System is a system for monitors various soil parameters such as soil moisture, yaw, pressure, tilt angle using various sensors. All collected data from the sensors is given to the microcontroller (arduino) that compares and checks with the threshold value and the whole data is received by monitoring system through NodeMCU. GPS and GSM module are used to give the location details and send message to registered phone number respectively. Lighting and buzzer comprises the warning system that is used to alert the residents along with the alert message received in the registered phone. Monitoring system continually monitor data from corresponding section. Message is sent to fire force, nearby police station and concerned authorities. The whole system is been having two hubs of sensors and a central monitoring system to give necessary alerts and warnings along with that exact location in the google map can also be seen through the webpage that have been created. So it is clearly understand how more than one region is been monitored. The webpage that is provided with a administrative login ID and password that gives the administrator access to the page. The webpage shows google map image of the place where the system is placed and also indicate about the status of the targeted area. Future modification can be done with incorporation of machine learning and artificial intelligence to have more accurate and efficient system.

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