



## IOT Based Landslide Detection

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# IOT BASED LANDSLIDE DETECTION

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**Abstract**— *Landslide is a natural disaster damaging the social life every year. It can be defined as the movement of mass of rock, debris down a slope. It occurs due to natural or manmade activities. Asia was found to be the most affected continent where 75% of landslides occurred. India also faced the loss of humans due to landslides which occurred last year during monsoon in Kerala. The main aim of the proposed system is to detect those conditions which leads to the occurrence of landslide and notify it well before time so that necessary steps can be taken to reduce or save the human loss. The proposed system uses soil moisture and accelerometer sensors. Moisture sensor readings are indicative of the moisture content in the soil whereas accelerometer checks movement of land. The readings crossing the defined thresholds give alarm to local citizens to safeguard themselves. The sensed data are also transmitted via wireless module (Antenna) to the main system used in the control room. The Arduino is interfaced with a laptop to display the SAFE, MIDDLE and DANGER zones. All the readings from sensors are also uploaded on cloud to analyse them and alert the rescue team in case of MIDDLE and DANGER zones. The system takes 10 sec time to collect data from sensor and transmit it to main system. Also, additional 20s time is required to upload data from main system to ThingSpeak cloud*

**Keywords**—*Internet of things, accelerometer, Raspberry pi, Soil moisture sensor.*

## Introduction

A landslide is movement of a mass of rock, debris, or earth down a slope. In monsoons the rain water percolates and develops hydraulic pressure which exceeds the elastic limit of the soil or rocks. Due to this the strain gets accumulated which forces the soil and rocks to loosen their adhesive strengths entailing landslides. Landslides destroy agricultural/forest lands, road transports, destroys earth's natural environment as a whole causing great loss to life. Landslides can also be said of "Mass Wasting", which refers to any down slope movement of soil and rock due to gravity. It causes property damage, injury and death. Also, it adversely affects a variety of resources such as water supplies, fisheries, sewage disposal systems, dams and roadways for years after a slide event. 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, earthquake caused liquefaction destabilizing slopes. The Manmade causes, such as, deforestation, cultivation and construction which destabilizes the already fragile slopes, vibrations from machinery or traffic. Rock avalanches, debris flows, soil movement, mud flows are the various forms of landslide. Landslides occur in rocky mountainous regions like Himalayas, konkan railways, lonavala ghats and marshy regions of Kerla in India. Landslides are hazards all over the world. Hillsides with steep slopes are prone to landslides. Landslide prediction, detection and monitoring have been done by researchers for different case studies all over the world. Landslide detection can be done by using diverse methods like visual inspection using image/video processing, satellite remote sensing, using statistical methods or using machine learning algorithms. Landslide detection can also be based on data driven approaches using wireless sensor networks (WSN). The main objective to study the landslide detection is to prevent the natural calamity by detecting its early movement. This will reduce or save the human loss caused by the landslide. Also, the objective is to find a certain way in which the sensing elements should respond quickly to rapid changes of data and send this sensed data to data analysis center. The proposed WSN/Internet of things (IoT) based landslide detection and monitoring system is a low cost, robust and delay efficient

## I. Proposed System

The system consists of sensor nodes, controller at the landslide site and raspberry pi at the monitoring station. Usually several sensor nodes are needed to cover certain area. All these sensors collect the landslide monitoring parameters such as landslide displacement, soil moisture, and tilt angle. The proposed system uses soil moisture sensor <sup>[11]</sup> operating on 3.3 to 5 V. It has two plates which measure the water content in the soil. The electric current through the plates is proportional to the amount of water content. When there is more moisture around the sensor, it draws more current which results in less output resistance and the corresponding output voltage is low. In another case, when there is low moisture around the sensor, it draws less current which results in high output resistance and the corresponding output voltage is

high. The output of soil moisture sensor used can be both analog and digital, but analog output is preferred for analog input channel of multiplexer. The accelerometer used for vibration sensing (slope displacement measurement) is ADXL335<sup>[12]</sup> which contains a polysilicon surface-micro machined sensor and signal conditioning circuitry. The basic structure of accelerometer has a fixed plate and a moving plate. The moving plate deflects due to the acceleration which in turn unbalances the differential capacitance and gives the output voltage proportional to the accelerations. ADXL335 accelerometer provides analog voltage at the output X, Y, Z pins which are proportional to the acceleration in respective directions i.e. X, Y, Z. The collected data from the sensors is given to the controller through multiplexer CD4051B<sup>[13]</sup>. This is done because the controller used here is NodeMCU (esp8266)<sup>[14]</sup> which has only one analog input pin and in-build Wi-Fi module which is required for transmission of data towards monitoring station. The multiplexer block can be eliminated if other controller having more analog input pins and suitable for interfacing of Wi-Fi module is used.

The controller accepts the data from sensor nodes. If these sensed data cross threshold values, it gives an alert. The entire data range is divided in three classes; SAFE zone, MIDDLE zone and DANGER zone. Alert is given for MIDDLE and DANGER zone. Pattern of alert for both classes is different and for different purpose. First alert is thrown when sensed values lie in MIDDLE zone. This alert informs local citizen to be alert as there might be chances of landslide occurrence in future. This alert also informs citizens to keep their important belongings such as first aid kit, clothes, water bottle and eating stuff ready as these are the things people need in hazardous situations. The second and the final alert is given as the sensed values lie in DANGER zone. This alert informs citizens to leave the place immediately. Apart from giving alerts to the local citizens, controller also transmits all the sensed data towards the monitoring station. The monitoring station does the work of monitoring and analysing of data. The sensed data is communicated to monitoring station via NodeMCU using Blynk App. The data reception and transmission by raspberry pi towards cloud is done using python script. During DANGER zone, it sends alert to the rescue teams as well.

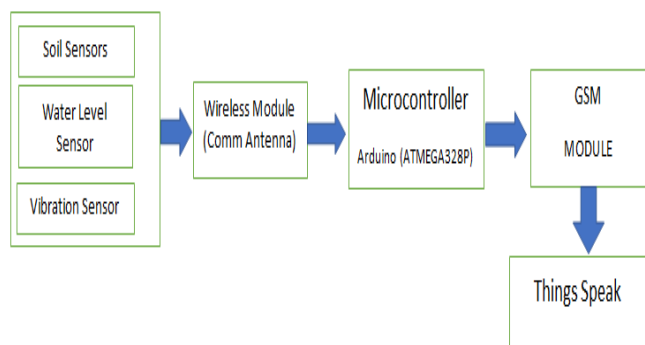


Fig. Block Diagram of proposed system

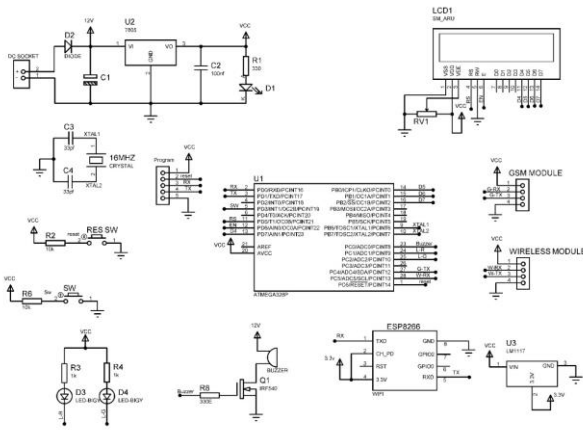
## II . Literature Review

Landslides in heavy rainfall areas are making threat to the people living in nearby area. Also, it becomes difficult to predict about it either. So, combining with partnership of professional laboratories i.e. IS Terre: earth science and LCIS: embedded electronics, telecommunication

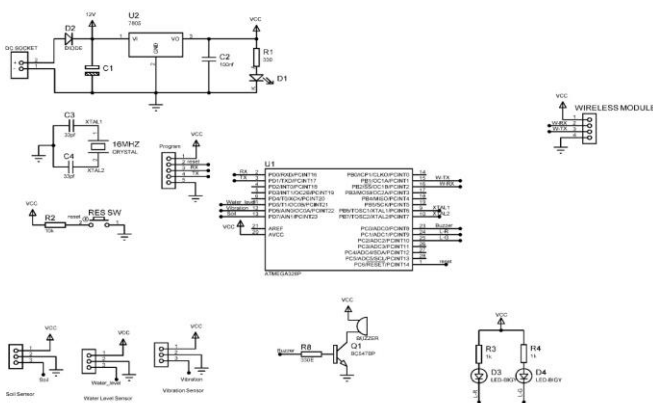
<sup>[1]</sup> is aimed to make a new predictive tool which can be used to analyse the area movement using sensors. The basic plan is that the sensors sense the field's movement with minimal cost and power consumption. The monitoring techniques uses geo location using wireless sensor networks which is based on LoRa (Long Range) transmission technology. In order to achieve geo location using a network of sensors, a common technique is used to have a set of fixed (non-mobile) nodes and anchors whose location is already known. The computation of sensor nodes location is done using various techniques. In one such particular technique one anchor is elected to the role of master as it receives information from the other anchors<sup>[1]</sup>. Another survey is based on the landslide which occurred in Guizhou area in China<sup>[2]</sup> with major human loss. The threat there increases after rainfall. It introduces ZICM2410 based WSN for monitoring landslide. In this system there are acquisition nodes, base station, monitor host and PC. Several nodes constitute together to form a WSN which collects the information of landslide parameters such as landslide displacement, soil temperature, soil moisture, tilt angle, local rainfall, etc. This system has chosen the ZICM2410 Zigbee chip to build wireless sensor network which is low-cost and can exchange and use the information. It supports multiple network topologies such as point-to-point, point-to-multipoint and mesh network. At the base station, GSM technology is used to transfer the data to the monitor from remote places. The monitor is placed indoors and receives the information from GSM network and this information is updated to the PC using RS232 interface so that people can look up to the monitoring of landslide using the software installed on the PC. PC management software includes two parts as real-time display interface and database management. The system uses VC++ tools to develop the human-computer interface and the SQL anywhere 11 Database platform to design the database<sup>[2]</sup>. For a landslide monitoring system, the WSN must be designed in such a way that it should withstand adverse effects of landslides, it should have longer battery life for longer use and high efficiency. In paper<sup>[3]</sup>, the system uses WSN to collect the data of battery life, radio link and path statistics. The sensor nodes and communication protocols are specifically designed for the network to be self-organizing, fault tolerant and adaptive.

transmitted over Blynk app and stored and displayed for the future use. A graph will be also made for so the data reading can be more feasible. Where the latter is receives the message and displays it on laptop screen.

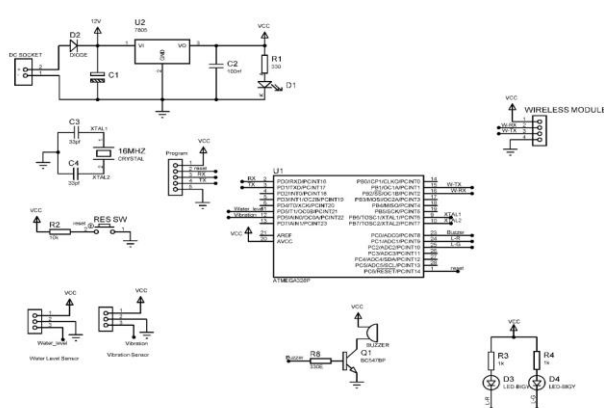
### III . Result and Survey



**Landslide detection System main**



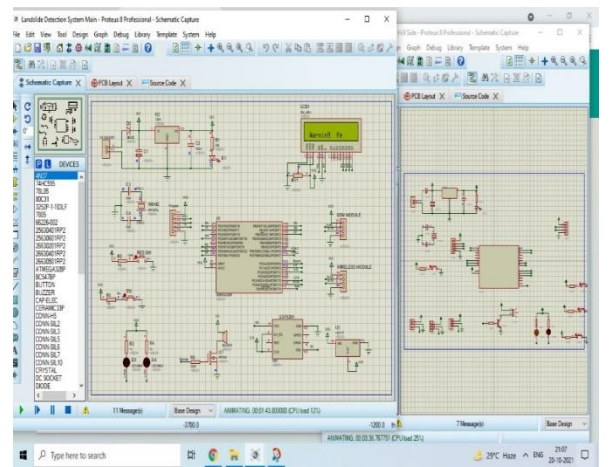
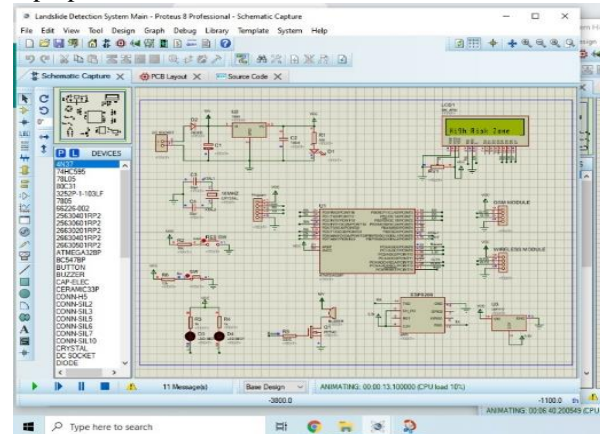
**Landslide Detection Hill slide**



**Landslide Detection River side**

### III EXPECTED RESULT AND DISCUSSION

The model of the proposed system. It has a PCB board where the sensor connection points, NodeMCU, multiplexer and on-board power supply system are mounted. The sensors are placed in the soil and the readings are collected and



### IV. CONCLUSION

This project provides a low cost IOT based landslide detection. Reading will be taken through the sensors and will be given further If the values crosses the threshold value alert message will be given. The system comprises of ThingsSpeak app or blynk app where data will be backed and stored for the future use also the graph will be displayed for easy readings.

### V. Future Scope

We intend to improve and be more precise by using different technology like machine learning and image processing for the landslide detection

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