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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 soilmoisture,yaw,pitch,roll,pressure.The proposed system uses soil moisture sensor which has corrosion resistantprobe with two plates to measure the water content in the soil. The accelerometer used is 6-Axis accelerometersensor that provides analog voltage at the output measuring land displacement and tilt angle i.e.yaw, roll andpitch. The temperature and pressure are measured using BMP 180 sensor. All collected data from the sensorsaregiventothemicrocontroller(Arduino)thatcomparesandcheckswiththethresholdvalueandthewholedata is received by monitoring system through NodeMCU. GPS and GSM module are used to give the locationdetails andto sendmessage toregisteredphone number respectively.Lightingand buzzer comprises thewarning 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, nearbypolice station and concerned authorities. The whole system is being having two hubs of sensors and a centralmonitoring system to give necessary alerts and warnings.So we could clearly understand how more than oneregion is beingmonitored. The project comprises of Webpage that is provided with a administrative login ID andpassword that gives the administrator access to the page. The webpage shows google map image of the placewherethe system isplacedandalso indicateaboutthe statusofthe targeted area.
Keywords:landslide,monitoring,warning,prediction,soilmovement,tiltangleandsoilpressure.

I. INTRODUCTION

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

The proposed system consists of mainly three sensors that we use in the project are accelerometersensor, 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 fortemperature and pressure measurement we use BMP180 sensor. Corrosion resistant Soil Moisture sensor tomeasure the accurate value of moisture content in the soil. A lighting and buzzer system is provided to give alertabout landslide along with the message received to the register phone numbers. The whole system consists oftwohubs; each hub covers acertain area of surrounding.The main purpose of more than onehub is to showhow monitoring system works with more than one system and receives and sends necessaryinformation . Themonitoring system also consists of a webpage that is provided with a administrative login ID and password thatgives the administrator access to the page. The webpage shows google map image of the place where the systemisplacedandalso indicateaboutthestatusofthetargetedarea.

Kamal K. Chapagai et al.[1] presents sensor Network Based Testbench Implementation of LandslideEarly Warning System, an implementation of prototype based Early Warning System (EWS) to detect andprovide early warning of Landslide activities. The main aim of this work is to implement the prototype with lowcostsensor 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, andevaluation 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 viaSMSincase ofsignificantsub-surfacemovements.

Ngawang Galley et al.[3] proposed a wireless sensor network based landslide detection and earlywarning 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 theArduino UNO processor for collection of data. The data collected by Arduino is then sent through ZigBee. Theinformationreceived inthe basestationisdisplayed through LCD,forrealtimemonitoring.

DongxinBai et al.[4] described the design and application of landslide monitoring and early warningsystem based on micro service architecture.In this study, an intelligentmonitoring and early warning system anditsapplicationwere developedbased onmicroservicearchitecture.

B.A.Hadi el at.[5] proposes ContinuousLandslide Early Warning SignalCapturing using IoTbasedSoil Pressure Monitoring Device. The soil pressure monitoringwith the new improved data communication asto detect any landslide early warning signal continuously without required human intervention for collecting thedata. The main objective is to design, develop and test the soil pressure monitoring system using the latestInternetofThings(IoT) technologyforsolvingthe existing issuesincludingtimelyand latesensing.

II. METHEDOLOGY

The block diagram of Landslide Detection and Warning, our system prototype model of LandslideDetection and Warning System. Mainly the system consists of two hubs. These hubs represents certain landslideprone area. Each of the landslide prone area which the hub is been created. The hub consist of mainly threesensors which could measures various parameters for the detection of Landslide. First of all the temperature andpressure sensorwhich has been used is of BMP 180.It senses and detect the variation in temperature andpressure ofthe soil moisture content. Then we uses an 6-axis Accelerometer , it clearly gives the each tilt angleand displacement value by sensing. Thethe last not the least sensor that is Soil moisture sensor, it's there tomeasure the moisture content present in the soil .If certain level of moisture content in the soil increases whichmakesaduecauseofLandslideitcanbeclearlyunderstoodbycontinuousmonitoringthethresholdvalue. These three sensors are connected to aArduino UNO. The Arduino UNO is further connected to LCD displayandLEDBuzzer.ThenfromArduinoUNOthecconnectionisdirectlygiventoNodeMCU.ThenfromNODEMCU towards GPS and GSM module. This overall connection is of one hub. Such two hubs is been therein our system. These two systems are then connected towards Monitoring System .In the monitoring system wehavecreatedawebpagewere itclearlyshowseachandeverythreshold values.

Figure1:BlockdiagramofLandslidedetectionandwarningsystem

The schematic diagram on Landslide detection and warning system.Here , it shows that

the threesensors6-Axisaccelerometer,BMP180SensorandSoilmoisture sensorhasbeenconnectedtoArduinoUNO.Then from the Arduino UNO connection has been gone toLCD display , buzzer andLED.Then aNODEMCU is also been connected to Arduino UNO along with that a GSM module is also connected.A GPSsystemisbeen connectedtoNODEMCU.TheArduinoUNOcan directlyconnecttheboardtothecomputerviaa USB Cable which performs the function of supplying the power as well as acting as a serial port. The 6-axisaccelerometer,VCC is connected to input,the pins SCL and SDA are connected to pins of Arduino UNO pins A4and A5.Along with this connection BME680 has also been connected along with this.Then from soil moisturesensor, a connection from pin A0 is given to A0 pin of ArduinoUNO.The POT (potentiometer) has beenconnected to the LCD display to pins VSS,VDD and VEE.Then next the remaining connecions from LCD isgiven 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)and13(PB5/SCK)ofArduioUNO. Thenfrompin3(PD3/INT/OC2B) connection has been given to LED as well as pin 2(PD2/INT0) is been connected to BuzzerSystem.Pin 4(PD4/TO/XCK) is connected to pin D6 of NODEMCU from ArduinoUNO.From Pin 1(PD1/TXD)ofArduioUNO,itsconnectedtoGSMModule(RXDpin).FromRXpin19ofNODEMCUtoaGPSsystemalsothe connectionhasbeengone.

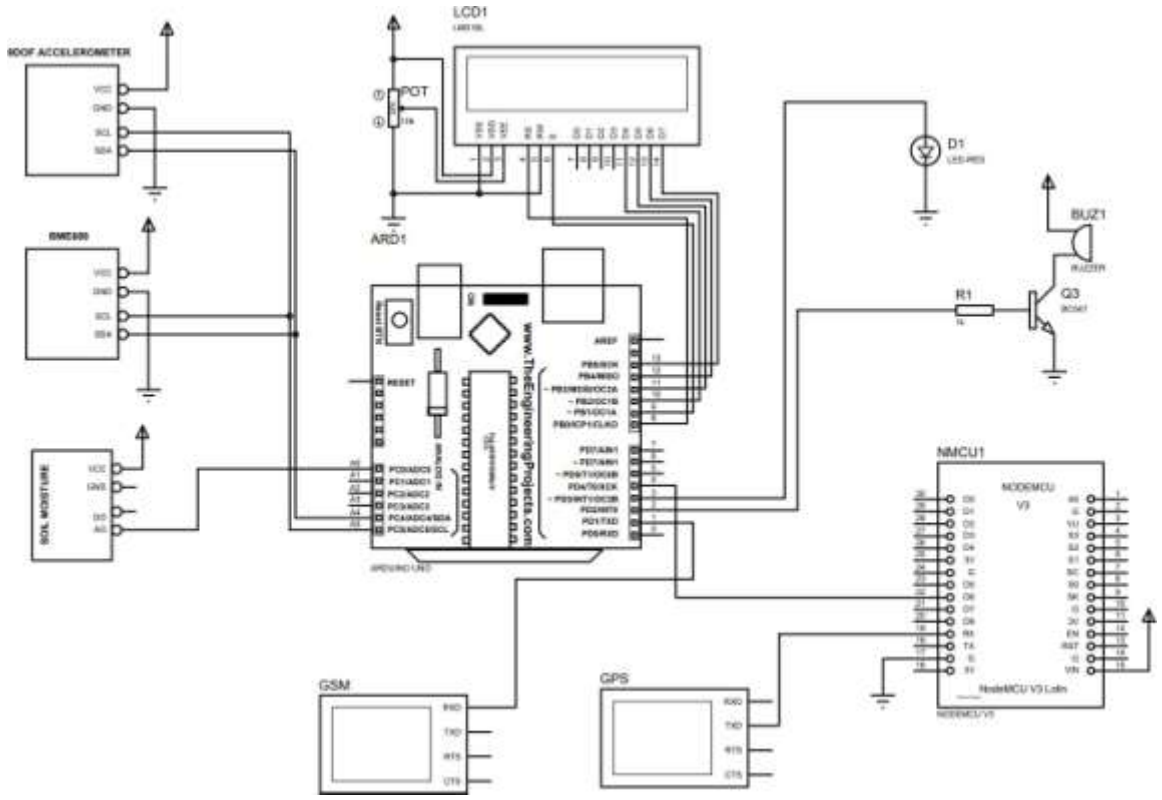

Figure2:SchematicDiagram

III. THESIMULATION

The Proteus software has been used to simulate landslide detection and warning system. An ArduinoUNO board has been used for the simulation as the central microcontroller. The objective of the simulationdesign was to ensure that the methodolgy developed for early warning system of landslide is efficient andaccurate. The choice of Arduino UNO as the micrcontroller made it a better choice for simulation purpose ascode was developed in Arduino IDE itself. In the simulation we are showing the monitoring and alerting sectionwith led and message sent via GSM.The sensors are shown as the POT as the basic principle as change inresistance.A testing value is set as threshold value and when the sensors crossesthesatandard value LED andmessageissentie, shownthrough virtualmonitor.

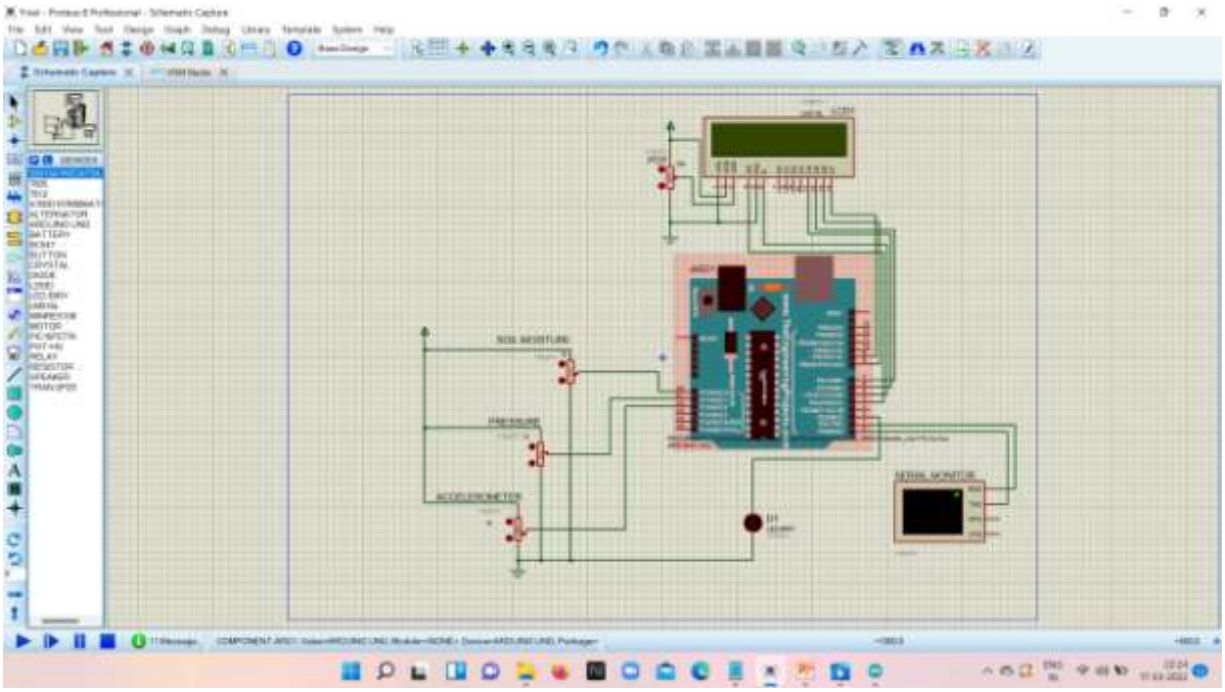

Figure3:Simulationsetup

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 signalto display/outputdevices.

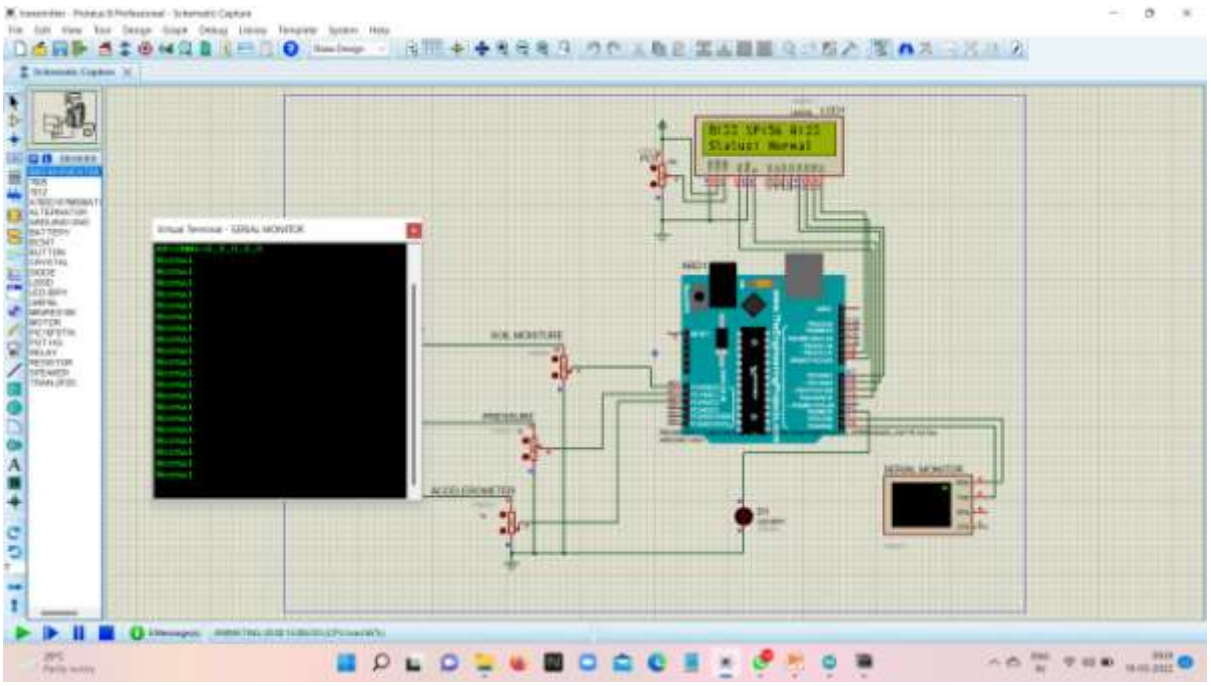

Fig.6:Simulationbeforecrossingthethresholdvalue

Thefigure 6 shows the virtual monitoring showing ”Normal” when the paramaters sensed by thesensors are below the threshold value.At this ”Normal” situation it give us a clear idea that all the landslideparameters thatwe have taken into consideration are normal aswell as the at lanslide area is at normalenvironmentcondition.Allthevaluesshowingthenormalsituationcanbeclearlyseenin theLCDdisplay.

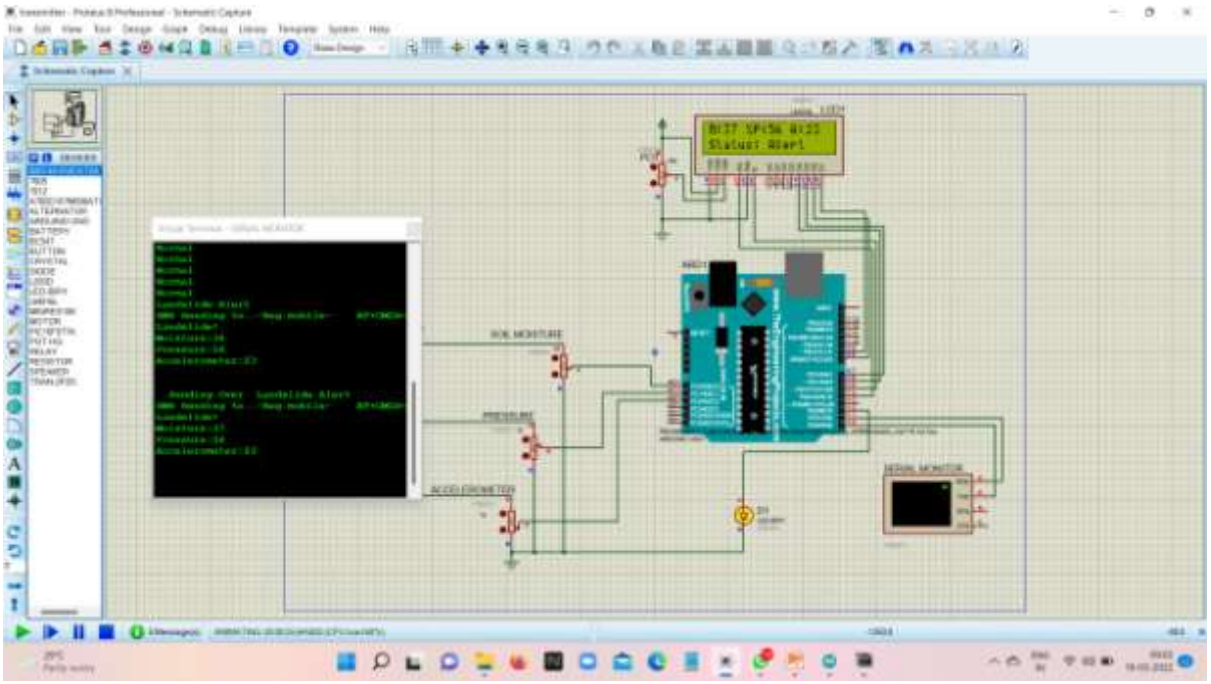

Figure7:Simulationaftercrossingthethresholdvalue

The figure 7 clearly picturizes the situation that happens when the threshold values have been crossedmeans a situation of landslide have been detected.The monitoring system when we observe we could see that thevalues at the time landslide detection have been clearly mentioned as well as to make the person who iscontrolling or observing the monitoring system could understand that Landslide has been detected.Because amessage of ”Landslide-Alert” is seen in monitoring system.Along with that each parameter which have crossedthethresholdvaluehave been clearlyspeciallymentioned.

V. HARDWAREIMPLIMENTATION

Thefigure8showstheHardwaresetupoftheLandslideDetectionandMonitoringSystem.Itconsistsoftallthe3sensorstodetectthesoilparameterstopredicttheearlylandslidesystem.BMP180isusedforsensingthepressure,3axisAccelerometerisusedtomeasuretheaccelerationexertedupontheSoil.Theaccelerometer typically gives us two types of data:1.Static force applied on the soil due to gravity(tilt ororientation)and2.Force/Accelerationexertedupontheoilonthemovementorforcedetection.Andlasttotheleastthesoilmoisturesensortomeasurethemoisturecontentinthesoil.Arduinoisusedasthemicrocontroller that monitors and checks with threshold value.It collects data from all the sensor.The wholesystem is programmed using Arduino IDE .The alert message is sent to respective mobile numbers when thethreshold of soil moisture sensor and accelerometer sensor or pressure sensor is crossed as clearly mentioningthat 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 registerd phone number throughGSM module.With the help of NodeMCU having an in-built wifimodule ,the landslide region location alongwiththe statusandGPSlocationisshowninthedeignedadministrativewebpage.

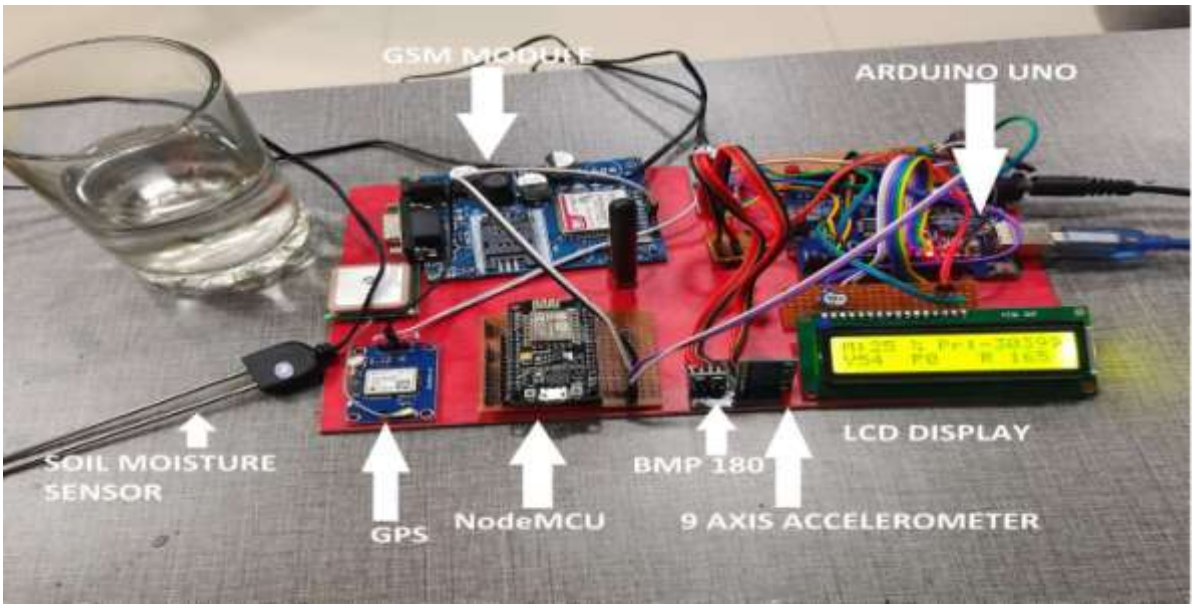

Figure10:Hardware

The web interface for the real time monitoring.Through this web page we could clearly track thelocation were Landslide has been detected and it make us more beneficial to give the alert messages and Buzzerkept 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 were it shows the data of latest updates.To check the previousdata there is history option to check the data.In both Location data screen if landslide has been detected then atthelower leftend it willbeclearlymentioningthatthesituationisNORMALorLANDSLIDEALERTED.

Figure11:Webinterfaceforreal timemonitoring

Figure12:Webinterfaceshowingthecurrentstatusandstatusofthesystem

VI. CONCLUSION

The Landslide Detection and Warning System consists of heterogeneous network of sensors that showreal time data.Proper warning and alert system is developed at a low cost implementation. This system can bescaled up for implementation in real field to provide early warning system. The system can also be improved byincorporating more number of sensor and controllers to cover a larger area.Increasing the sensors with improvedalgorithmcanalsoimprovethereliabilityofthesystem.Ourproject,LandslideDetectionandWarningSystemisasystemformonitorsvarioussoilparameterssuchassoilmoisture,yaw,pressure,tiltangleusingvarioussensors. All collected data from the sensors is given to the microcontroller(arduino) that compares and checkswith the threshold value and the whole data is received by monitoring system through NodeMCU .GPS andGSM 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 messagereceived 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 havingtwo hubs of sensors and a central monitoring system to give necessary alerts and warnings along with that exactlocation in the google map can also be seen through the webpage that have been created.So it is clearlyunderstand how more than one region is been monitored.The webpage that is provided with a administrativelogin ID and password that gives the administrator access to the page. The webpage shows google map image ofthe place where the system is placed and also indicate about the status of the targeted area.Future modificationcan bedonewith incorporation ofmachinelearning andartificialintelligencetohavemoreaccurateandefficientsystem.

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