MAJOR
PROJECT REPORT

IOT BASED
LANDSLIDE DETECTOR

A Major Project

Submitted in partial fulfilment of the requirement for the award of the degree of

Bachelor of Technology

In

COMPUTER SCIENCE AND ENGINEERING

By

Prateek (10316210092) **Manoj (10316210067)** **Krishna Bir (10316210059)**

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

FACULTY OF ENGINEERING

SRM UNIVERSITY DELHI-NCR

Plot No.39, Rajiv Gandhi Education City, P.S.Rai, Sonepat, Haryana – 131029

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CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the project entitled "**IOT BASED LANDSLIDE DETECTOR**" in partial fulfilment of the requirement for the award of the degree of Bachelor of Technology in Computer Science & Engineering and submitted in the Department of Computer Science & Engineering of SRM University, Delhi-NCR, Sonepat, Haryana, (India) is an authentic record of my own work carried out under the supervision of **Dr. Surjeet Dalal**. The matter presented in this project has not been submitted for the award of any other degree of this or any other Institute / University.

(Signature of the candidate)
Prateek
(10316210092)

This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

Dr. Surjeet Dalal
Associate Professor

The B. Tech. project viva-voce examination of **Prateek, Manoj & Krishna Bir** has been held on

---

Internal Examiner **External Examiner**

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CERTIFICATE

This is to certify that the project entitled "**IOT BASED LANDSLIDE DETECTOR**" submitted by **Prateek, Reg. No. 10316210092, Manoj, Reg. No. 10316210067, Krishna Bir, Reg. No. 10316210059**, to the Department of Computer Science & Engineering of SRM University Delhi-NCR, Sonepat, Haryana, (India) in partial fulfilment of the requirements for the award of the degree of Bachelor in Technology in Computer Science & Engineering under the Faculty of Engineering is an authentic record of the work carried out by her under my supervision. In my opinion, this work fulfils the requirement for which it has been submitted. This project has not been submitted to any other University or Institution for any other degree.

Dr. Surjeet Dalal
Associate Professor

Dr. Ajay Sharma
HOD CSE DEPARTMENT

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CHAPTER 1

PROJECT SUMMARY

A landslide, also known as a landslip, is a geological phenomenon that includes a wide range of ground movements. Monitoring is essential to predicting the behavior of landslides and forecasting which storms can trigger large numbers of landslides. This can help saving number of lives and prevent loss of life and property as people will be aware of the upcoming danger and can take necessary steps for safety. Network of IoT is used in the project that helps updating the information about landslides on the internet. Soil moisture sensor, Rain sensor, Accelerometer Sensor, are employed that detects landslides as some critical value will be set for these sensors, if value exceeds these critical values the people will be notified about the fore coming landslides and huge loss can be prevented. Microcontroller takes the information and updates the information on the webpageusing a GPRS module connected to it. This telemetry project helps notify the residents about the fore coming disaster and can help tackle the situation better.

A landslide is the movement of rock, earth, or debris down a sloped section of land. Landslides are caused by rain, earthquakes, volcanoes, or other factors that make the slope unstable.

Geologists, scientists who study the physical formations of the Earth, sometimes describe landslides as one type of mass wasting. A mass wasting is any downward movement in which the Earth's surface is worn away. Other types of mass wasting include rockfalls and the flow of shore deposits called alluvium.

Near populated areas, landslides present major hazards to people and property. Landslides cause an estimated 25 to 50 deaths and $3.5 billion in damage each year in the United States.

What Causes Landslides?

Landslides have three major causes: geology, morphology, and human activity.

Geology refers to characteristics of the material itself. The earth or rock might be weak or fractured, or different layers may have different strengths and stiffness.

CHAPTER 2

LANDSLIDES

2.1 WHAT IS LANDSLIDE?

Landslides in mountainous terrain often occur during or after heavy rainfall, resulting in the loss of life and damage to the natural and /or built environment **[1]**. A landslide is a common natural hazard that results in loss of human lives and causes widespread damage to property and infrastructure. Landslides, in general, include all downward or sudden movement of surface material like clays, sand, gravel and rock. Earthquakes, heavy rainfall, volcanic eruptions, etc. may act as triggering mechanisms to initiate a landslide **[2]**. The downward movement of surface material takes place under the influence of gravity, and the mobility of such movement is enhanced by water content in the sediment. Landslides constitute one of the major damaging natural hazards in mountainous regions, activated mainly under the influence of earthquakes and rainfall. These natural disasters have occurred in all part of Himachal Pradesh as well in highly hilly area. Interaction between local geology and the long-term climatic conditions result in significantly different landforms with varying degree of susceptibility to land sliding. Although landslides are local phenomenon, but the total loss of life and property due to landslides is far greater than any other hazard. Occurrence of landslides is particularly common in geodynamic sensitive belts i.e. zones and areas repeatedly

rocked by earthquakes and affected by other non-tectonic activities.

Figure 1.1: Landslide

Landslides can vary in size but usually they always involve a large ground movement. This can be things such as debris and rock failing. A landslide can occur on shore or off shore and usually at coastal lines but it is the gravity that forces the debris and rocks to fall and for a total landslide to occur. If an area has some pre conditional factors, it could help to build up a lot of problems, sub surface problems and conditions from arising. The conditions could make the slope to continuously product landslides. When the stability of a slope decreases or changes, even just slightly, it can make the slope unstable. This means that with a large or even a small change, can cause a landslide.

2.2 WHAT HAPPENS DURING A LANDSLIDE?

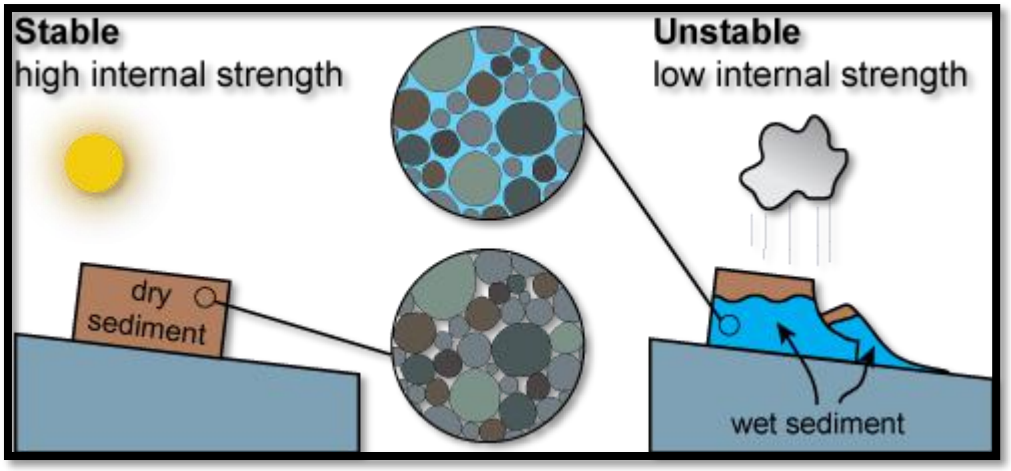


Figure 3.2: During a landslide.

When the cliff or slope's soil has become saturated with water, it will mean there is a potential for a landslide to occur. This can create debris or even a full on mud slide; but this can be very dangerous because it can product a surge or rock and mud. This can cause houses, cars, trees and everything else in its path can be moved along within the landslide. Some landslides can block bridges and create a flood at the same time. However, there are times when the debris can be thought of as a flash flood. Mud and debris combined landslides can cause a lot of damage to properties as well as human life. With landslides, it could cause blockage of water flowing through normally. Sometimes, there can be the domino effect with a landslide because if a small part of the slope breaks away, more and more creating the domino effect. When a landslide has a mass volume ready to fall through to it being unstable, it does create the domino effect and can cause total devastation also. A landslide can strike in an instant, true. But in reality, forces have quietly been at work on that section of land for a long time.

2.3 WHAT IS WEATHERING?

Weathering includes all the processes of chemical alteration and physical breakdown of rock masses at, or near, the Earth's surface. Intense and/or continuous weathering processes may result in thick sequences of complex and heterogeneous materials characterized by physical and geotechnical properties which have been strongly altered by the action of weathering. As a consequence, they may be prone to slope failures, erosion and landslides. In addition, availability of large amounts of weathered materials and loose debris in catchment basins may represent a serious hazard during, or following, intense rainfall, contributing significantly to the transport of sediment and debris during floods.

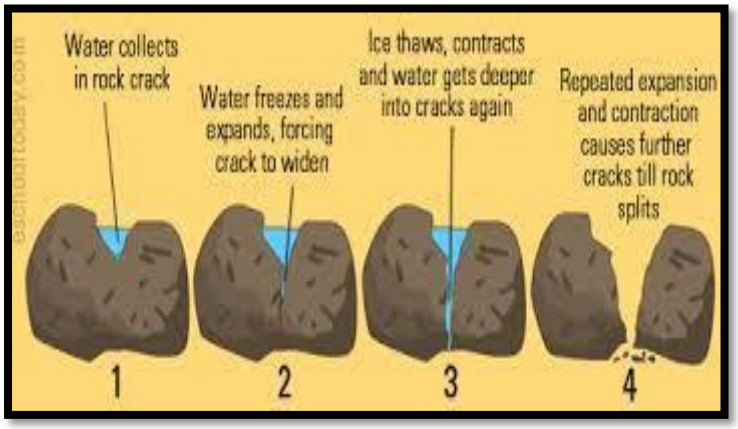


Figure 3.3: Weathering

2.3.1 Types of weathering

- Mechanical weathering- is the physical breakdown of an object into smaller components without changing its chemical composition. Changes in temperature, the freezing and thawing of water and plant growth are forces of mechanical weathering.

Figure 3.4: Mechanical weathering

- Chemical weathering- refers to the breakdown of an object into particles with a different mineral composition than the original object. Water is perhaps the most powerful agent of chemical weathering: Over time, it can dissolve many kinds of rocks into a solution that has a different chemical makeup than the original substance. Other types of chemical weathering involve more complicated chemical reactions with oxygen, carbon dioxide, water or other compounds.

Figure 3.5: Chemical Weathering

2.4 CAUSES OF LANDSLIDE

Almost every landslide has multiple causes. Slope movement occurs when forces acting downslope (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. Landslides can be initiated in slopes already on the verge of movement by rainfall, snowmelt, changes in water level, stream erosion, and changes in ground water, earthquakes, volcanic activity, disturbance by human activities, or any combination of these factors. Earthquake shaking and other factors can also induce landslides underwater. These landslides are called submarine landslides. Submarine landslides sometimes cause tsunamis that damage coastal areas.

Landslides can move slowly, (millimeters per year) or can move quickly and disastrously, as is the case with debris flows. Debris flows can travel down a hillside at speeds up to 200 miles per hour (more commonly, 30 - 50 miles per hour), depending on the slope angle, water content, volume of debris, and type of earth and debris in the flow. These flows are initiated by heavy, usually sustained, periods of rainfall, but sometimes can happen as a result of short bursts of concentrated rainfall or other factors in susceptible areas. Burned areas charred by wildfires are particularly susceptible to debris flows, given certain soil characteristics and slope conditions.

In general, the factors which influence whether a landslide will occur typically include slope angle, climate, weathering, water content, vegetation, and overloading, geology, and slope stability. How these factors interrelate is important in understanding what causes landslides along

with an understanding of the impact humans have on these factors by altering natural processes. Typically, a number of elements will contribute to a landslide, but often there is one which triggers the movement of material.

2.4.1 Natural Causes:

- Elevation of pore water pressure by saturation of slope material from either intense or prolonged rainfall and seepage
- Vibrations caused by earthquakes
- Undercutting of cliffs and banks by waves or river erosion Volcanic eruptions.

2.4.2 Human causes:

- Interference with, or changes to, natural drainage
- Leaking pipes such as water and sewer reticulation
- Modification of slopes by construction of roads, railways, buildings, etc.
- Overloading slopes
- Mining and quarrying activities
- Vibrations from heavy traffic, blasting, etc.
- Excavation or displacement of rocks.

2.4.3 Geological causes

- Weak materials
- Sensitive materials
- Weathered materials
- Sheared materials
- Jointed or fissured materials
- Adversely orientated discontinuities
- Permeability contrasts
- Material contrasts
- Rainfall and snow fall

2.4.4 Morphological (or structural) causes:

- Slope angle
- Uplift Rebound
- Fluvial erosion
- Wave erosion
- Glacial erosion
- Erosion of lateral margins
- Subterranean erosion
- Slope loading
- Vegetation change

2.5 ANATOMY OF LANDSLIDE

The term "landslide" describes a wide variety of processes that result in the downward and outward movement of slope-forming materials including rock, soil, artificial fill, or a combination of these. The materials may move by falling, toppling, sliding, spreading, or flowing. The drawing below is a graphic illustration of a landslide, with the commonly accepted terminology describing its features.

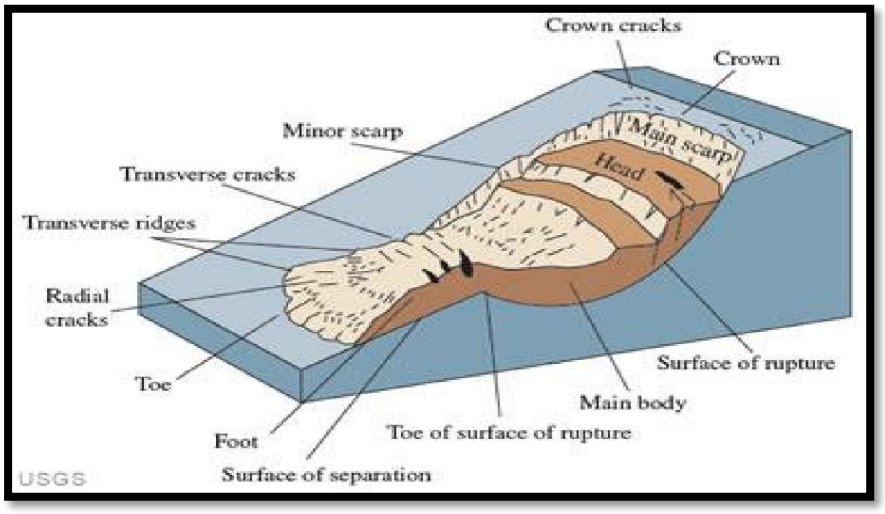


Figure 3.6: Image illustrates commonly used labels for the parts of a landslide **[3]**.

2.5.1 Main Scarp

A steep surface on the undisturbed ground around the periphery of the slide, caused by the movement of slide material away from the undisturbed ground. The projection of the scarp surface under the displaced material becomes the surface of rupture.

2.5.2 Crown

The material that is still in place, practically undisturbed and adjacent to the highest parts of the main scarp is termed as Crown.

2.5.3 Toe

The margin of displaced material most distant from the main scarp is known as Toe.

2.5.4 Flank

The side of the landslide is Flank.

2.5.5 Head

The upper parts of the slide material along the contact between the displaced material and the main scarp.

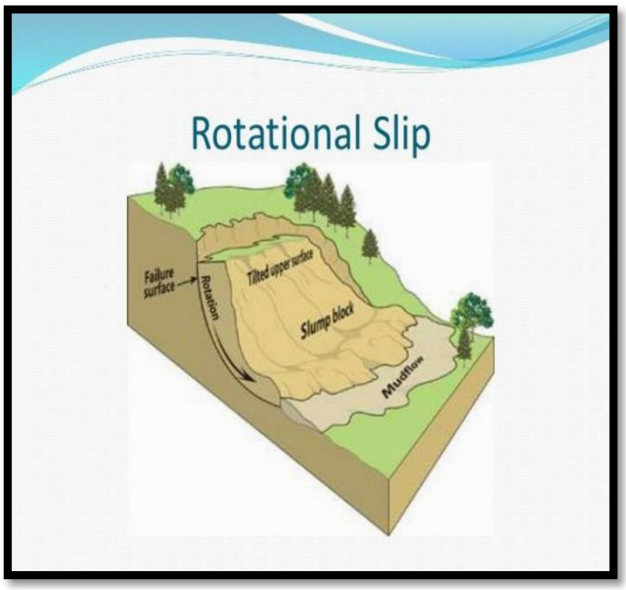
2.5.6 Foot

That Portion of the displaced material that lies down slope from the toe of the surface of rupture.

2.6 TYPES OF LANDSLIDES

Although landslides are primarily associated with mountainous regions, they can also occur in areas of generally low relief. In low-relief areas, landslides occur as cut-and fill failures (roadway and building excavations), river bluff failures, lateral spreading landslides, collapse of mine-waste piles (especially coal), and a wide variety of slope failures associated with quarries and open-pit mines. Standard classification of landslides is based on the mechanism of the soil

contour of the slope.



movement and on the type of displaced material: fall, topple, and lateral spreading, slide, flows, and creeps **[4]-[8].**

2.6.1 Rotational landslide

A rotational slide is one in which the surface of rupture is curved concavely upward (spoon shaped) and the slide movement is more or less rotational about an axis that is parallel to the

Figure 3.7: Rotational Landslide

2.6.2 Translational Slide

In a translational slide, the mass moves out, or down and outward along a relatively planar surface and has little rotational movement or backward tilting. The mass commonly slides out on top of the original ground surface.

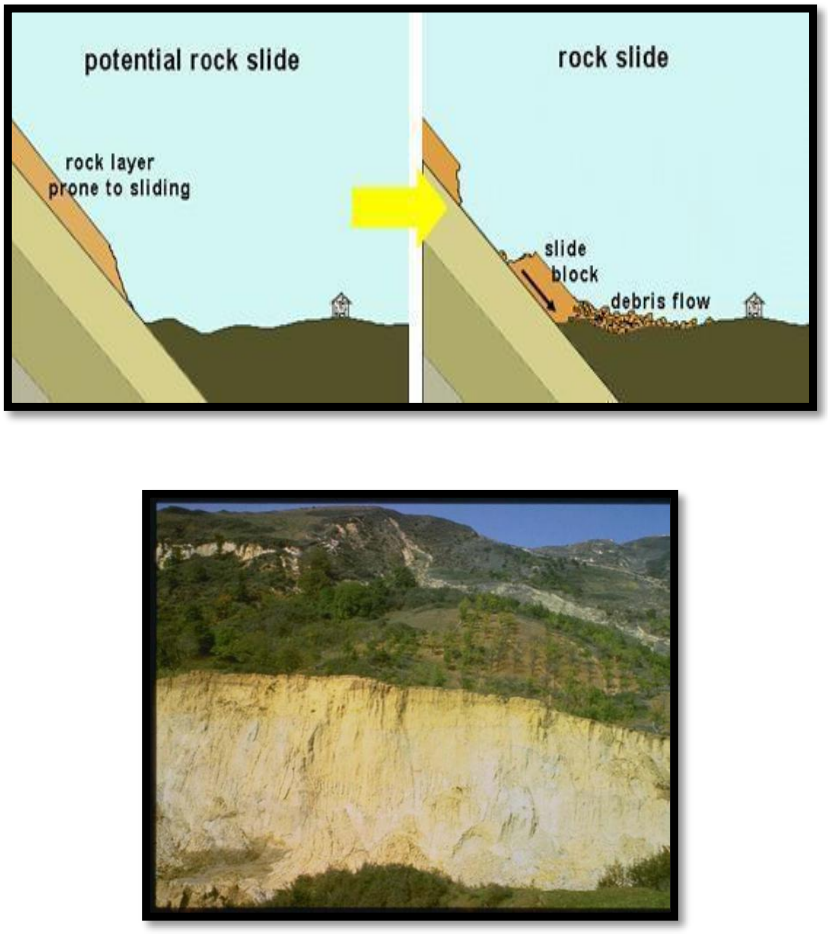


Figure 3.8: Translational Landslide

2.6.3 Block slide

It is a translational slide in which the moving mass consists of a single unit or a few closely related units that move downslope as a relatively coherent mass.

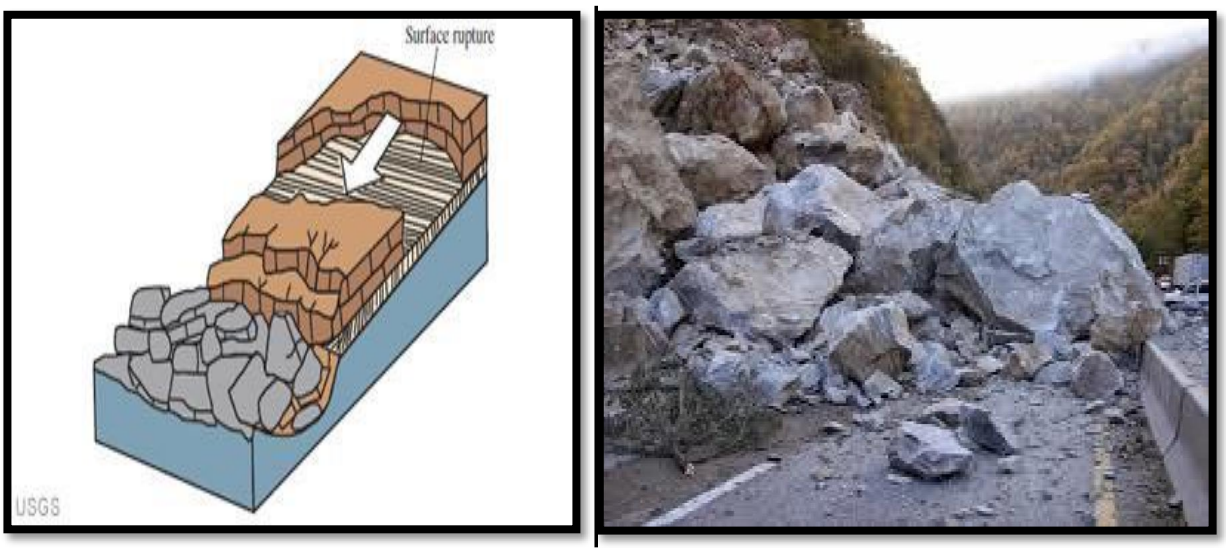


Figure 3.9: Block Slide

2.6.4 Fall

Falls are abrupt movements of masses of geologic materials that become detached from steep slopes or cliffs. Movement occurs by free-fall, bouncing, and rolling. Depending on the type of earth materials involved, the result is a rock fall, soil fall, debris fall, earth fall, boulder fall, and so on. All types of falls are promoted by undercutting, differential weathering, excavation, or stream erosion.

Figure 3.10: Fall Landslide

2.6.5 Topple

A topple is a block of rock that tilts or rotates forward on a pivot or hinge point and then separates from the main mass, falling to the slope below, and subsequently bouncing or rolling down the slope.

Figure 3.11: Topple Landslide

2.6.6 Debris Flow

A debris flow is a form of rapid mass movement in which a combination of loose soil, rock, organic matter, air, and water mobilize as slurry that flow down slope. Debris flows include less than 50% fines. Debris flows are commonly caused by intense surface-water flow, due to heavy precipitation or rapid snowmelt that erodes and mobilizes loose soil or rock on steep slopes. Debris flows also commonly mobilize from other types of landslides that occur on steep slopes, are nearly saturated, and consist of a large proportion of silt- and sand-sized material. Debrisflow source areas are often associated with steep gullies, and debris-flow deposits are usually indicated by the presence of debris fans at the mouths of gullies. Fires that denude slopes of vegetation intensify the susceptibility of slopes to debris flows.

Figure 3.12: Debris Flow

2.6.7 Debris avalanche

A debris avalanche is a type of slide characterized by the chaotic movement of rocks, soil and debris mixed with water or ice (or both). They are usually triggered by the saturation of thickly vegetated slopes which result in an incoherent mixture of broken timber, smaller vegetation and other debris. Debris avalanches differ from debris slides because their movement is much more rapid. This is usually a cause of lower cohesion or higher water content and commonly steeper slope movement. Debris slides generally begin with large blocks that slump at the head of the slide and then break apart as they move towards the toe. This process is much slower than that of a debris avalanche. In a debris avalanche this progressive failure is very rapid and the entire mass seems to somewhat liquefy as it moves down the slope. This is caused by the combination of the excessive saturation of the material, and very steep slopes.

Figure 3.13: Debris Avalanche

2.6.8 Earth flow

Earthflows have a characteristic "hourglass" shape. The slope material liquefies and runs out, forming a bowl or depression at the head. The flow itself is elongate and usually occurs in finegrained materials or clay-bearing rocks on moderate slopes and under saturated conditions.

However, dry flows of granular material are also possible.

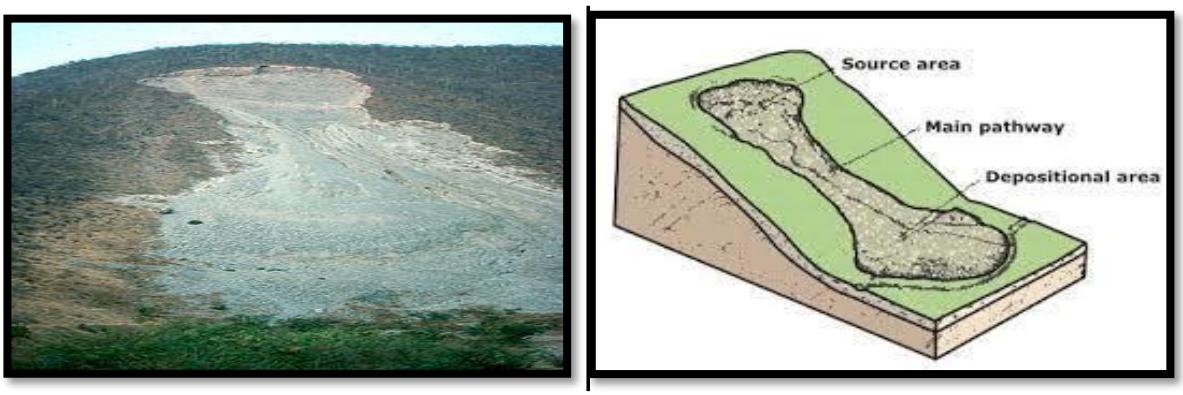


Figure 3.14: Earth flow

2.6.9 Creep

Creep is the imperceptibly slow, steady, downward movement of slope-forming soil or rock. Movement is caused by shear stress sufficient to produce permanent deformation, but too small to produce shear failure. There are generally three types of creep:

(1) Seasonal, where movement is within the depth of soil affected by seasonal changes in soil moisture and soil temperature;

(2) Continuous, where shear stress continuously exceeds the strength of the material; and

(3) Progressive, where slopes are reaching the point of failure.

Figure 3.15: Creep

2.7 LANDSLIDE IN INDIA

Landslides are among the major hydro-geological hazards that affect large parts of India. The major affected areas are:

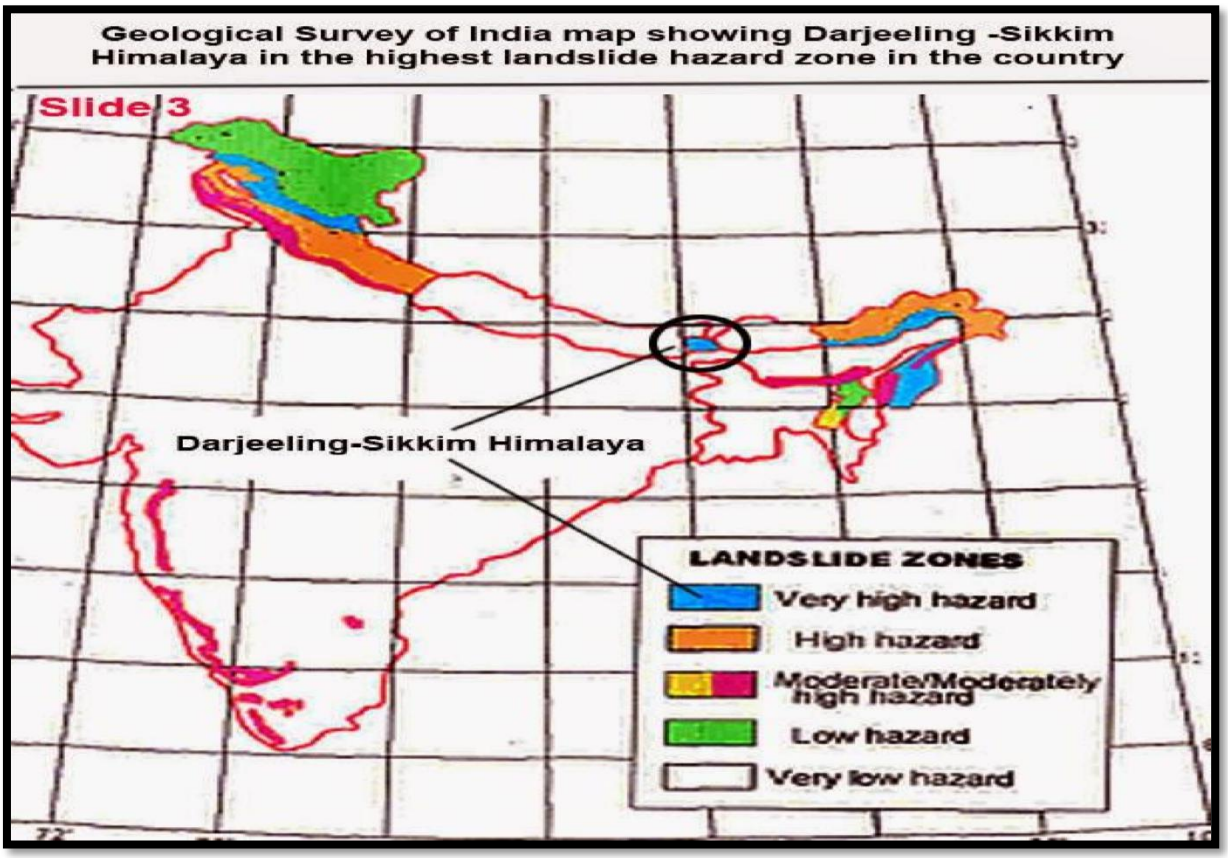


Figure 3.16: GSI map showing highest landslide zone in the country

- The Himalayas
- The North eastern hill ranges
- The Western Ghats
- The Nilgiris
- The Eastern Ghats
- The Vindhayas

In the Himalayas alone, one could find landslide of every frame, name and description- big and small, quick and creeping, ancient and new. Similarly most of the north-eastern region is bristling with landslide of a bewildering variety. Then, there are landslides in the Western Ghats in the

south, along the steep slopes overlooking the Konkan coast. Landslides are also very common in the Nilgiris, characterized by a lateritic cap, which is very sensitive to mass movement. The landslides are natural disasters and cause significant damage to civil infrastructure, disrupting railroad and highway service throughout the country. Since there are many dangerous places where landslides are occurring frequently, the monitoring system to monitor a long-term minute ground movement is considered necessary for disaster prevention. In these days, those systems to measure the three dimensional positioning in millimeter scale has been introduced to some applications, which is being recognized as an effective measure for landslide detection. The monitoring system is required to be simple for installation, because the system is to be installed at a site in mountain region. However, the conventional system consuming large amount of power, needs big batteries, causing the difficulties of the installation to a landslide site. The system should be placed in an appropriate site for landslide site. The system should be placed in an appropriate site for landslide monitoring. However, the conventional system properly operates only at the site of good visibility. And further, data transmission is required for communications from the observation station to the remote monitoring station.

2.8 PREVENTION AND REMEDIATION OF LANDSLIDES

Many methods are used to remedy landslide problems. The best solution, of course, is to avoid landslide-prone areas altogether. Before purchasing land or an existing structure or building a new structure, the buyer should consult an engineering geologist or a geotechnical engineer to evaluate the potential for landslides and other geology-related problems.

Listed below are some common remedial methods used when landslide-prone slopes cannot be avoided.

- Improving surface and subsurface drainage: Because water is a main factor in landslides, improving surface and subsurface drainage at the site can increase the stability of a landslide-prone slope. Surface water should be diverted away from the landslide-prone region by channelling water in a lined drainage ditch or sewer pipe to the base of the slope. The water should be diverted in such a way as to avoid triggering a landslide adjacent to the site. Surface water should not be allowed to pond on the landslide-prone slope.

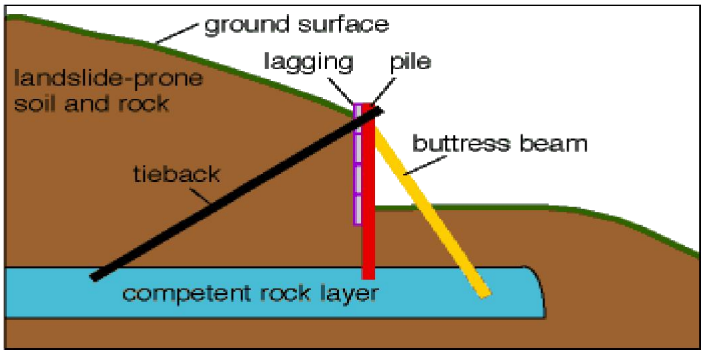


Figure 3.17. Diagram of a retaining wall with tiebacks and buttress beams.

- Removal and replacement: Landslide-prone soil and rock can be removed and replaced with stronger materials, such as silty or sandy soils. Because weathering of shale's can form landslide-prone soils, the removal and replacement procedure must include measures to prevent continued weathering of the remaining rock. Landslide material should never be pushed back up the slope. This will simply lead to continued motion of the landslide.
- Preserving vegetation: Trees, grasses, and vegetation can minimize the amount of water infiltrating into the soil, slow the erosion caused by surface-water flow, and remove water from the soil. Although vegetation alone cannot prevent or stop a landslide, removal of vegetation from a landslide-prone slope may initiate a landslide**.**
- Rock fall protection: Rock falls are contained by (1) ditches at the base of the rock exposure, (2) heavy-duty fences, and (3) concrete catch walls that slow errant boulders that have broken free from the rock outcrop. In some cases, loose blocks of rock are attached to bedrock with rock bolts, long metal rods that are anchored in competent bedrock and are threaded on the outside for large nuts. A metal plate with a centre hole, like a very large washer, is placed over the end of the rod where it extends from the loose block, and the nut is then added and tightened. Once constructed, remedial measures must be inspected and maintained. Lack of maintenance can cause renewed landslide movement.

CHAPTER 3

IOT BASED LANDSLIDE DETECTION

3.1 EARLY WARNING SYSTEM FOR LANDSLIDES

Early warning systems (EWSs) are a cost-effective means to reduce the risk with a low environmental and economic impact. In some cases, for instance when a landslide is so large that it cannot possibly be stabilized, they can even be the only solution.

[9] Define them as "monitoring devices designed to avoid, or at least to minimize the impact imposed by a threat on humans, damage to property, the environment, or/and to more basic elements like livelihoods."

According to United Nations International Strategy for Disaster Reduction (UNISDR, 2009) they are "the set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss." EWS is not just a cluster of monitoring systems or the forecast of failure, but it also involves other aspects such as the identification of risk scenarios, emergency plans, societal considerations, public awareness, etc. Each one of these components is necessary; if any element fails; the whole chain would collapse and would render the system useless.

An efficient EWS should comprise the following activities **[10]:**

- monitoring, including data acquisition, transmission and maintenance of the instruments
- analysis and forecasting, which can be done by using thresholds, expert judgment, forecasting methods and so on
- warning, i.e. the dissemination of understandable messages alerting for the impending threat
- Response, concerning if people are able to understand and how they react to the warning.

A EWS must take into account factors such as the elements at risk, the hazards, the vulnerabilities, the lead time, the residual risk and many other precious information that can only come from in depth studies and risk assessments. Finally it is worth remembering that at present there is no EWS valid for all cases; in fact every EWS must be designed purposely for a specific site. For instance the precursors and monitored parameters may largely vary depending on the type of landslide **[11]**.

3.2 LITERATURE REVIEW

An early warning system has been proposed and developed in **[12].** It uses an 89c52 microcontroller to construct node. Each node contains four sensors and zigbee are used to connect multiple nodes. Zigbee was used to transmit all reading to the receiver side through monitoring host. The system is completely useful according to result. At the platform, power supply depends on the lead acid battery and solar panel, the solar panel is used to charge the battery at day time **[12]**.

[13] This paper describes the evolution of a wireless sensor network system for landslide detection in the Idukki district of the southern state of Kerala, India, a region known for its heavy rainfall, steep slopes, and frequent landslides. This paper describes about an actual field deployment of a wireless sensor network for landslide detection. This system uses a heterogeneous network composed of wireless sensor nodes, Wi-Fi, and satellite terminals for efficient delivery of real time data to the data management center. The data management center is equipped with software's and hardware's needed for sophisticated analysis of the data.The pilot deployment of this system is already in place at Anthoniar Colony, Munnar, Idukki Kerala, India.

Reference **[14]** discusses the topic of slip surface localization in wireless sensor networks, which can be used for landslide prediction.

The Drought Forecast and Alert System (DFAS) has been proposed and developed in **[15];** it uses mobile communication to alert the users, whereas the deployed system uses real time data collection and transmission using the wireless sensor nodes, WiFi, satellite network and also

through internet. The real streaming of data through broadband connectivity provides connectivity to wider audience.

A new approach for earthquake early warning systems, they have used wireless, self-organizing mesh sensor networks model. They have followed a model-driven system development paradigm. The paper has coupled in specific geographic regions with the wave signal analysing algorithms, alarming system, convenient visualizations and earthquake data bases. This paper is solely based on the Self-Organizing Seismic Early Warning Information Networks (SOSEWIN) **[16].**

3.3 SYSTEM DESIGNING

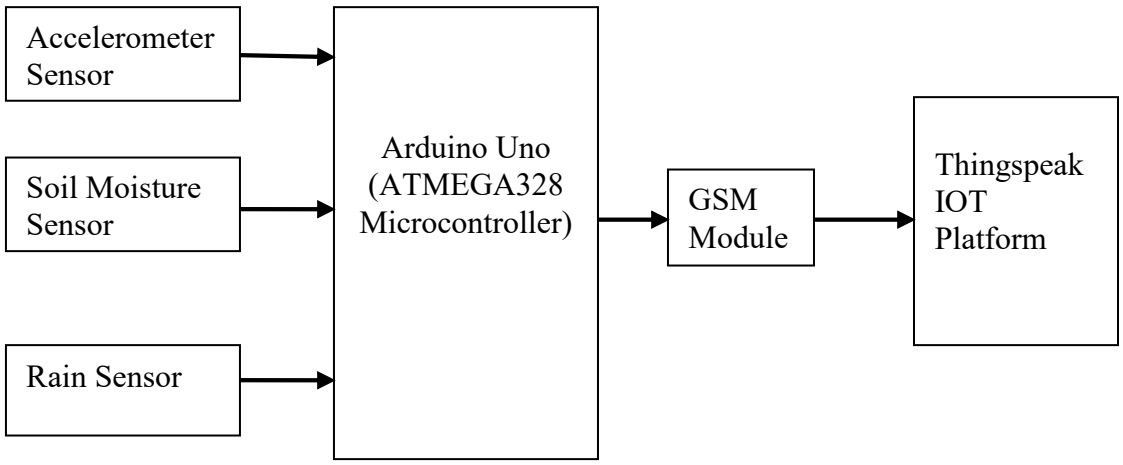


Figure 4.1: Block Diagram of System

3.4 SENSORS NEEDED FOR SYSTEM

Under heavy rainfall conditions, rain infiltration on the slope causes instability, a reduction in the factor of safety; transient pore pressure responses, changes in water table height, a reduction in shear strength which holds the soil or rock, an increase in soil weight and a reduction in the angle of repose. When the rainfall intensity is larger than the slope saturated hydraulic conductivity, runoff occurs.

Three distinct physical events occur during a landslide:

_ the initial slope failure,

_ the subsequent transport, and

_ the final deposition of the slide materials.

The initial slope failure can occur due to the increase in pore pressure and soil moisture content, under heavy rainfall, which necessitates the inclusion of geophysical sensors like soil moisture sensor and Rainfall Sensor for capturing the in-situ measurements.

After the slope failure the subsequent transport of the material happens that will generate slope gradient change, vibration etc., which has to be measured and monitored for effective issue of warning. So the warning system includes ADXL335 accelerometer that can be used for measuring in-situ slope gradient changes.

3.4.1 Soil Moisture Sensor

Soil moisture sensors measure the volumetric water content in soil. Since the direct gravimetric measurement of free soil moisture requires removing, drying, and weighting of a sample. Soil moisture sensors measure the volumetric water content indirectly by using some other property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the moisture content.

The relationship between the measured property and soil moisture must be calibrated and may vary depending on environmental factors such as soil type, temperature or electric conductivity.

Pins:

A0..... Analog output

D0..... Digital output

GND..... Ground

VCC..... Positive voltage (input: 5v for analog 3.3v for Digital).

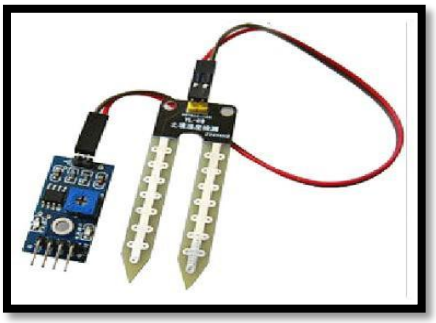


Figure 4.2: Soil Moisture Sensor

How the Soil Moisture Sensor Works:

This soil moisture sensor has two probes through which current in soil, then read the resistance of soil for reading moisture level .we know that water make the soil more prone to electric conductivity resulting less resistance in soil. Other head dry soil has poor conductivity thus more

resistance in soil using these properties of electricity the sensor is designed inside the sensor there are circuitry for measuring the resistance and converting it into voltage as output.

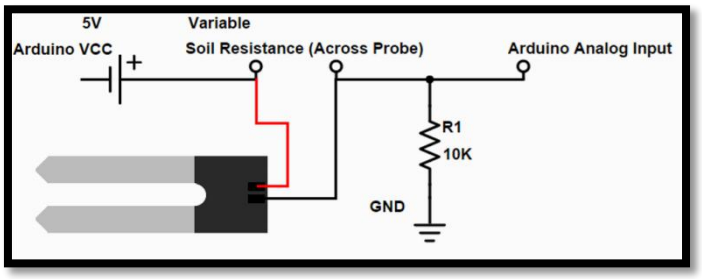


Figure 4.3: Working of Soil Moisture Sensor

Application:

- Agriculture.
- Landscape irrigation.
- Research.
- Simple sensor for gardeners

Features:

- Supply voltage 3.3v-5v
- Current -35mA

3.4.2 Rain Sensor

A rain sensor or rain switch is a switching device activated by rainfall. Rain sensors are used in the detection of water beyond what a humidity sensor can detect.

Pins:
A0..... Analog output
D0..... Digital output
GND..... Ground

VCC..... Positive voltage (input: 5v for analog 3.3v for Digital.)

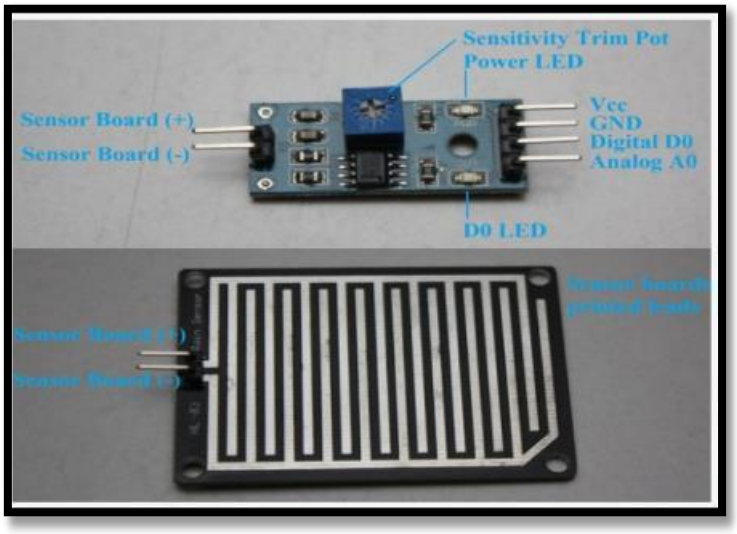


Figure 4.4: Rain Sensor

How it works:

The rain sensor detects water that completes the circuits on its sensor boards' printed leads. The sensor board acts as a variable resistor that will change from 100k ohms when wet to 2M ohms when dry. In short, the wetter the board the more current that will be conducted.

Connection with Arduino:

To test the Rain Sensor and ensure that it is working correctly connects the VCC to a 5v power source and GND. Try placing a fe w droplets of water on the Rain sensor detection board and the D0-LED should light up.

Rain Sensor..... Arduino
VCC..... 5v
GND..... GND
A0..... Analog in 0

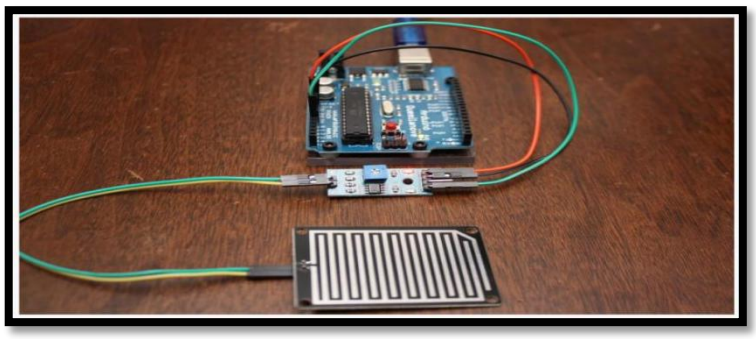


Figure 4.5: Rain Sensor Connection with Arduino

3.4.3 Accelerometer Sensor (ADXL-335)

The ADXL335 is a small thin, low power complete 3-axis accelerometer with single conditioned scale range of -+3g. It can measure the static acceleration of gravity tilt sensing applications, as well as dynamic acceleration resulting from motion shock or vibration.

It contains a polysilicon surface micromachined sensor and signal conditioning circuitry to implement an open loop acceleration measurement architecture.

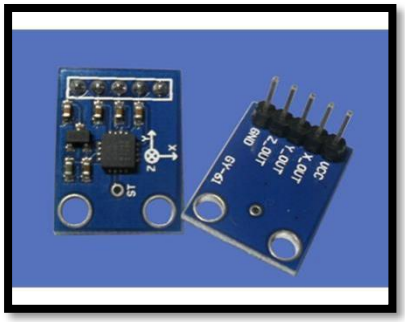


Figure 4.6:ADXL335 Sensor

Pins:
X..... Analog output

Y.....Analog output

Z.....Analog output

GND..... Ground

VCC..... Positive voltage (input: 5v for analog 3.3v for Digital.)

ADXL335 measured two kinds of motion

- First kind of motion that it measures is the static acceleration of gravity when the acceleration of gravity .when the accelerometer is tilted .so during the diamond polishing phase if the arm tilts it will send a signal.
- The second kind of acceleration it measures is the dynamic acceleration which will help to detect the change is vibration that may occur when the diamond polishing machine is at work.

Applications:

- Cost-sensitive, low power, motion- and tilt-sensing applications
- Mobile devices
- Gaming systems
- Disk drive protection
- Image stabilization
- Sports and health devices

Features

- 3-axis sensing
- Small, low profile package
- 4 mm × 4 mm × 1.45 mm LFCSP
- Low power: 350 μA typical
- Single-supply operation: 1.8 V to 3.6 V
- 10,000 g shock survival
- Excellent temperature stability
- Bandwidth adjustment with a single capacitor per axis
- RoHS/WEEE lead-free compliant

Specifications

- Output Type: Analog
- Typical Bandwidth (kHz): 1.6kHz
- Voltage Supply (V): 1.8 to 3.6
- Range: +/- 3g
- Sensitivity: 300 mV/g
- # of Axes: 3
- Sensitivity Accuracy (%): ±10
- Temp Range (°C): -40 to 85°C
- Package: 4mm x 4mm LFCSP Supply Current : 350µA
- Noise Density (µg/√Hz): 300

Functional Block Diagram

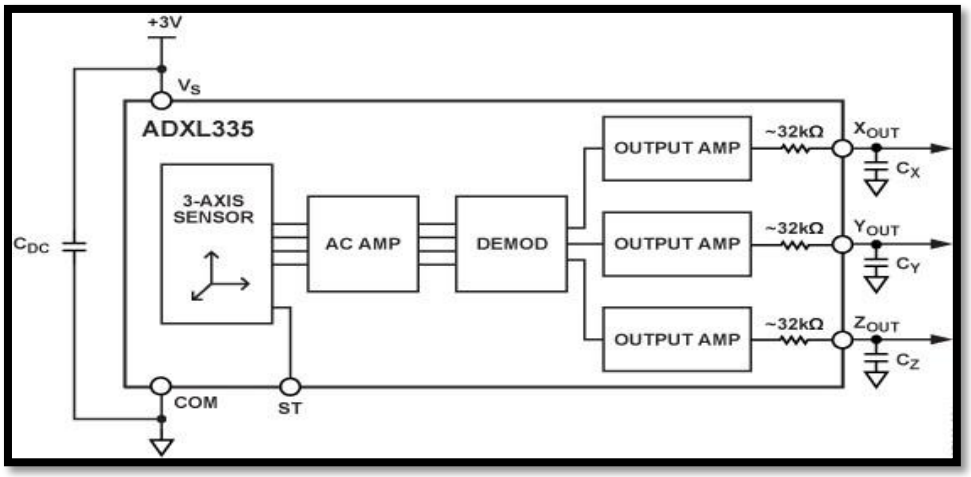


Figure 4.7: Functional Block Diagram Accelerometer Sensor (ADXL-335)

How it works:

The soil moisture sensor is pretty straight forward to use. The two large exposed pads function as probes for the sensor, together acting as a variable resistor. The more water that is in the soil means the better the conductivity between the pads will be and will result in a lower resistance, and a higher SIG out.

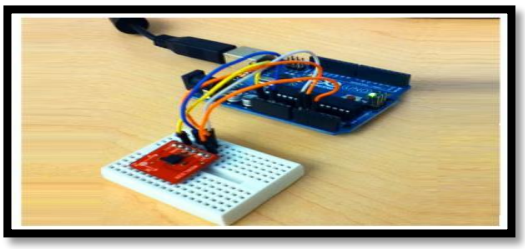


Figure 4.8: Accelerometer Connected With Arduino

Connection with Arduino:

Accelerometer Sensor..... Arduino

VCC.....5v
GND.....GND
X..... Analog in 5
Y..... Analog in 4
Z..... Analog in 3

3.4.4Buzzer (Piezo Speaker)

A Piezo is an electronic device that can be used to play beep Sound when connected with various electronics circuit. Piezo buzzers exhibit the reverse piezoelectric effect. In reverse piezoelectric effect, Piezo buzzer makes a click sound when voltage is given to it and it will start producing a continuous tone when voltage is applied in the form of square wave. Following figure shows the schematic diagram of connection of Piezo buzzer with Arduino.

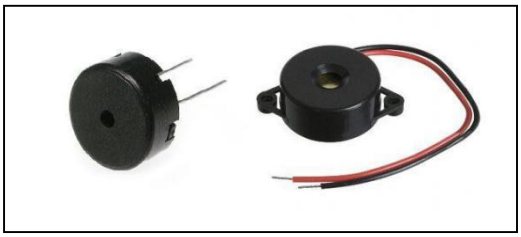


Figure 4.9 Buzzer (Piezo speaker)

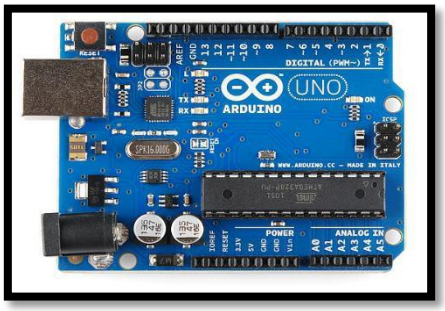


Figure 4.10: Arduino Board

Built in function of Arduino, Tone (p, f, d) is used with Piezo buzzer for generating square wave of the specified frequency on a pin. In this function, 'p' stands for the pin which to generate the tone, 'f' stands for the frequency of the tone in hertz and 'd' stands for the duration of the tone in milliseconds which is optional to mention.

3.5 MICROCONTROLLER USED (ARDUINO)

Arduinois an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece

of software,

or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board.

The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards. The Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board – you can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package.

3.5.1 What does Arduino do?

The Arduino hardware and software was designed for artists, designers, hobbyists, hackers, newbies, and anyone interested in creating interactive objects or environments. Arduino can interact with buttons, LEDs, motors, speakers, GPS units, cameras, the internet, and even your smart-phone or you're TV! This flexibility combined with the fact that the Arduino software is free, the hardware boards are pretty cheap, and both the software and hardware are easy to learn has led to a large community of users who have contributed code and released instructions for a huge variety of Arduino-based projects.

3.5.2 What's on the board?

There are many varieties of Arduino boards that can be used for different purposes. Some boards look a bit different from the one below, but most Arduino have the majority of these components in common:

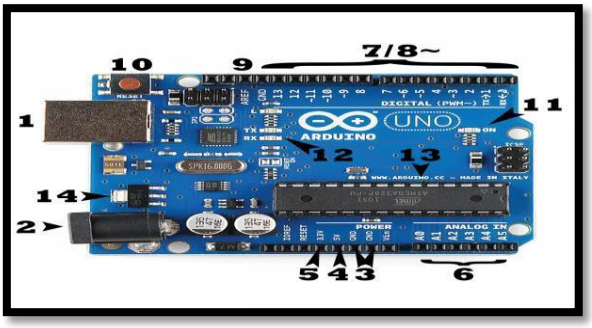


Figure: 4.10Arduino boards

Power (USB / Barrel Jack)

Every Arduino board needs a way to be connected to a power source. The Arduino UNO can be powered from a USB cable coming from your computer or a wall power supply that is terminated in a barrel jack. In the picture above the USB connection is labeled.

(1) The barrel jack is labelled (2) The USB connection is also labelled through which you will load code onto your Arduino.

Pins (5V, 3.3V, GND, Analog, Digital, PWM, AREF)

The pins on your Arduino are the places where you connect wires to construct a circuit. They usually have black plastic 'headers' that allow you to just plug a wire right into the board. The Arduino has several different kinds of pins, each of which is labelled on the board and used for different functions.

GND (3)**:** Short for 'Ground'. There are several GND pins on the Arduino, any of which can be used to ground your circuit.

5V (4) & 3.3V (5)**:** As you might guess, the 5V pin supplies 5 volts of power, and the 3.3V pin supplies 3.3 volts of power. Most of the simple components used with the Arduino run happily off of 5 or 3.3 volts.

Analog (6): The area of pins under the 'Analog In' label (A0 through A5 on the UNO) is Analog In pins. These pins can read the signal from an analog and convert it into a digital value that we can read.

Digital (7): Across from the analog pins are the digital pins (0 through 13 on the UNO). These pins can be used for both digital input (like telling if a button is pushed) and digital output (like powering an LED).

PWM (8): You may have noticed the tilde (~) next to some of the digital pins (3, 5, 6, 9, 10, and 11 on the UNO). These pins act as normal digital pins, but can also be used for something called Pulse-Width Modulation (PWM). AREF (9): Stands for Analog Reference. Most of the time you can leave this pin alone. It is sometimes used to set an external reference voltage (between 0 and 5 Volts) as the upper limit for the analog input pins.

Reset Button

Just like the original Nintendo, the Arduino has a reset button (10). Pushing it will temporarily connect the reset pin to ground and restart any code that is loaded on the Arduino. This can bevery useful if your code doesn't repeat, but you want to test it multiple times. Unlike the original Nintendo however, blowing on the Arduino doesn't usually fix any problems.

TX RX LEDs

TX is short for transmit, RX is short for receive. These markings appear quite a bit in electronics to indicate the pins responsible for serial communication. In our case, there are two places on the Arduino UNO where TX and RX appear – once by digital pins 0 and 1, and a second time next to the TX and RX indicator LEDs **(12)**. These LEDs will give us some nice visual indications whenever our Arduino is receiving or transmitting data (like when we're loading a new program onto the board).

Main IC

The black thing with all the metal legs is an IC, or Integrated Circuit **(13)**. Think of it as the brains of our Arduino. The main IC on the Arduino is slightly different from board type to board type, but is usually from the AT mega line of IC's from the ATMEL company. This can be important, as you may need to know the IC type (along with your board type) before loading up a new program from the Arduino software. This information can usually be found in writing on the top side of the IC. If you want to know more about the difference between various IC's, reading the datasheets is often a good idea.

Voltage Regulator

The voltage regulator (14) is not actually something you can (or should) interact with on the Arduino. But it is potentially useful to know that it is there and what it's for. The voltage regulator does exactly what it says – it controls the amount of voltage that is let into the Arduino board.

Think of it as a kind of gatekeeper; it will turn away an extra voltage that might harm the circuit. Of course, it has its limits, so don't hook up your Arduino to anything greater than 20 volts.

3.6 TECHNOLOGY USED FOR COMMUNICATION WITH WEB (GSM)

GSM (Global System for Mobile communication) is a digital mobile telephony system. GSM uses a variation of time division multiple access (TDMA) and is the most widely used of the three digital wireless telephony technologies (TDMA, GSM, and CDMA). GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900 MHz or 1800 MHz frequency band.

Figure 4.11: GSM (SIM 900) Pins

TX.....Analog output

Rx.....Analog output GND.....Ground

Vcc…….5v

3.6.1 How it works:

The GSM-900 has a down link frequency range of 935-960 MHz and an up link frequency of range of 895-915 MHz This frequency band is partitioned into 124 pairs of simplex channels with separation of 200KHz.A particular range of simplex channels is given to a particular network provider. The type of interface used in GSM is digital air interface. The analogue voice signals are converted to digital signals before transmission. Up to 8 MS subscribers can be handled by the GSM RF carrier at a time. The rate of transmission is 270 Kbps.

The Gaussian minimum shift keying (GMSK) is used for transmitting the digital signals. In GMSK, a phase change represents the change from a digital "1" or a "0 ", occurs over a period of time. The addition of high frequency components to the spectrum is reduced. In GSMK, the phase change is not constant and it is spread- out.

3.6.2 Connection with Arduino

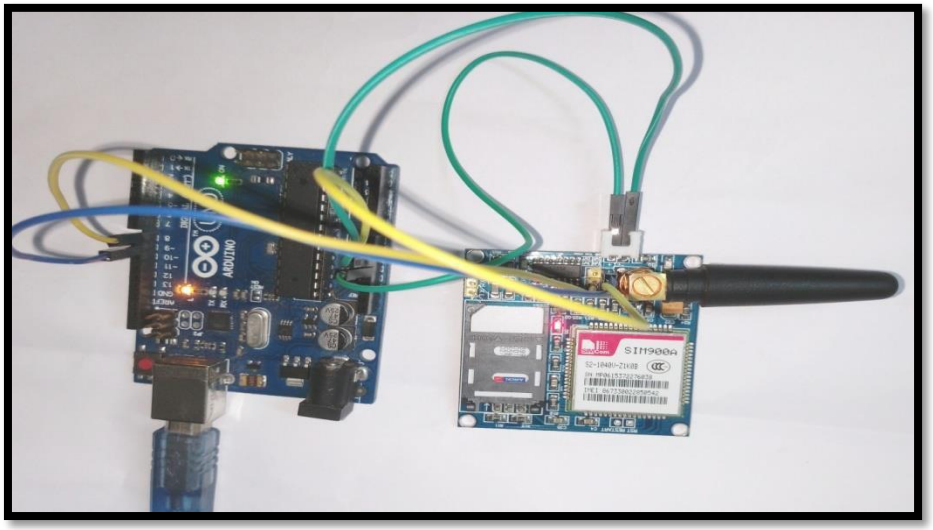


Figure 4.12: GSM Connected With Arduino

1) GSM Module is powered using 5Volts from Arduino.
2) Arduino is powered using USB cable / Adapter.
3) 8nd pin of Arduino is connected to TX pin in GSM module.
4) 9nd Pin of Arduino is connected to RX pin of GSM Module.
5) Arduino GND is connected to GSM GND.

3.7 INTERNET OF THINGS (IOT)

The IoT links smart objects to the Internet. It can enable an exchange of data never available before, and bring users information in a more secure way. IoT is simply the network of interconnected things/devices which are embedded with sensors, software, network connectivity and necessary electronics that enables them to collect and exchange data making them responsive.

More than a concept Internet of Things is essentially an architectural framework which allows integration and data exchange between the physical world and computer systems over existing

network infrastructure.

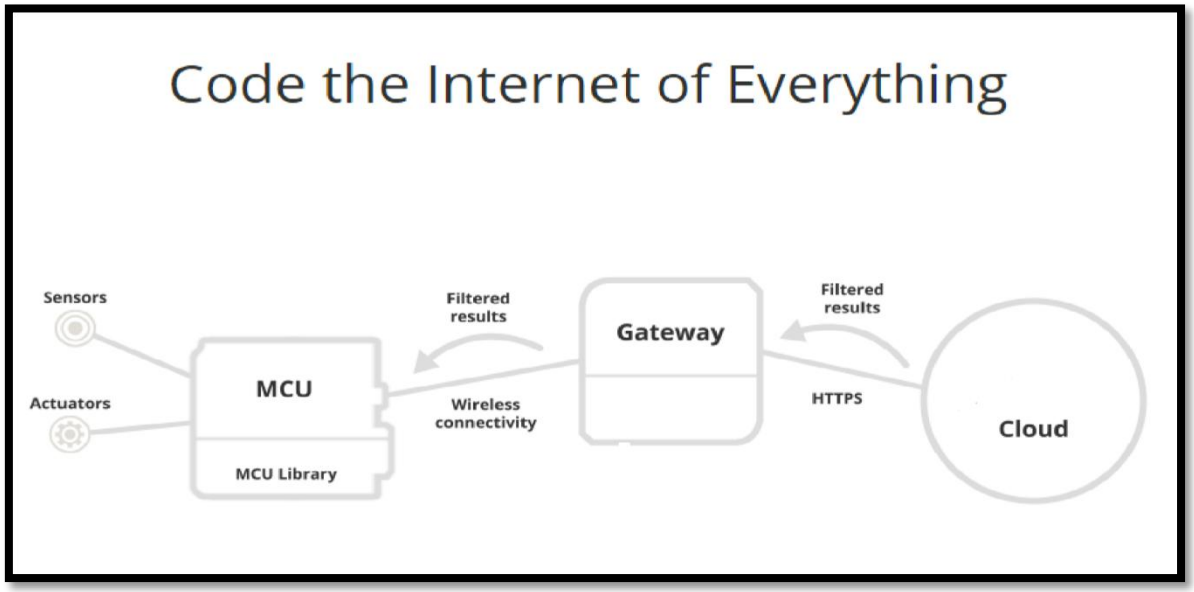


Figure 4.13: Flow Chart of IOT

The internet of things (IoT) is the network of physical devices, vehicles, buildings and other items—embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data. The IoT allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit; when IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such assmart grids,smart homes, intelligent transportation andsmart cities. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure.

3.7.1 Important Components Internet of Things

Internet of things is being enabled by the presence of other independent technologies which make fundamental components of IoT.

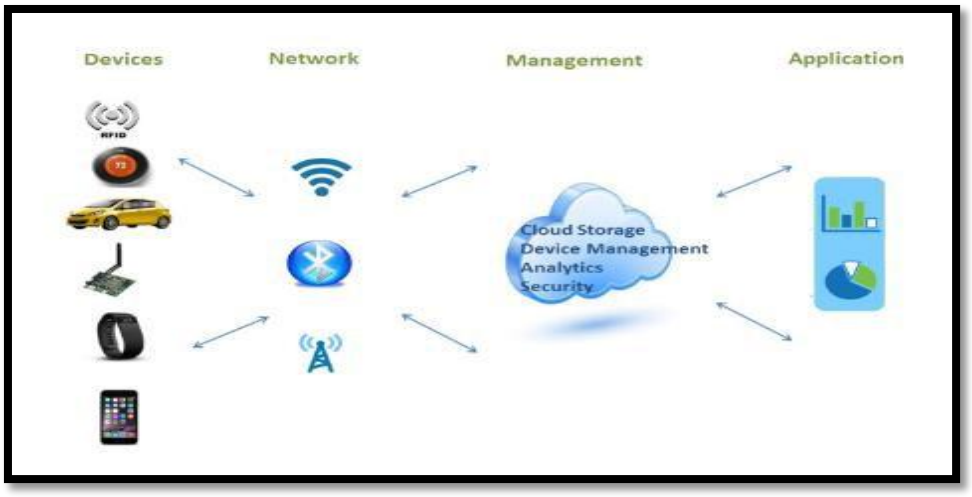


Figure 4.14: Components of IOT

The fundamental components that make internet of things a reality are:

- Hardware-Making physical objects responsive and giving them capability to retrieve data and respond to instructions
- Software-Enabling the data collection, storage, processing, manipulating and instructing
- Communication-Infrastructure-Most important of all is the communication infrastructure which consists of protocols and technologies enabling two physical objects to exchange data.

3.7.2 Application of IOT

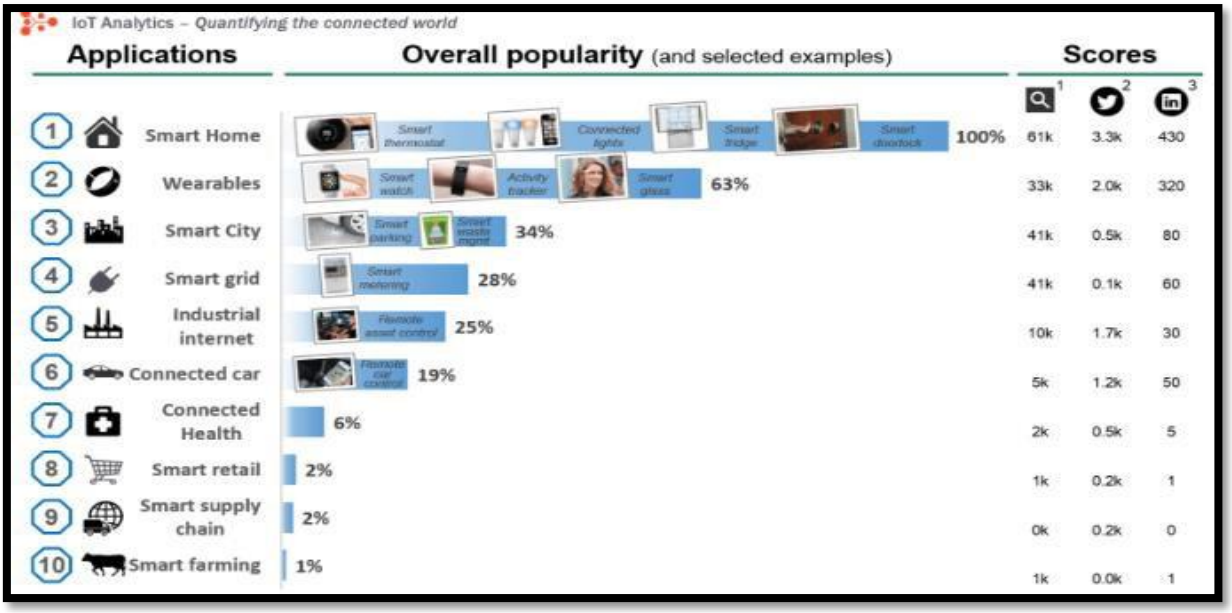


Figure 4.15: Application of IOT

List of Applications:

1. Smart home

Smart Home clearly stands out, ranking as highest Internet of Things application on all measured channels. More than 60,000 people currently search for the term “Smart Home” each month. This is not a surprise. The IoT Analytics company database for Smart Home includes 256 companies and start-ups. More companies are active in smart home than any other application in the field of IoT. The total amount of funding for Smart Home start-ups currently exceeds $2.5bn. This list includes prominent start up names such as Nest or Alert Me as well as a number of multinational corporations like Philips, Haier, or Belkin.

2. Wearable’s

Wearable’s remain a hot topic too. As consumers await the release of Apple’s new smart watch in April 2015, there are plenty of other wearable innovations to be excited about: like the Sony Smart B Trainer, the Myo gesture control, or LookSee bracelet. Of all the IoTstart-ups, wearables

maker Jawbone is probably the one with the biggest funding to date. It stands at more than half a billion dollars!

3. Smart City

Smart city spans a wide variety of use cases, from traffic management to water distribution, to waste management, urban security and environmental monitoring. Its popularity is fuelled by the fact that many Smart City solutions promise to alleviate real pains of people living in cities these days. IoT solutions in the area of Smart City solve traffic congestion problems, reduce noise and pollution and help make cities safer

4. Smart farming

Smart farming is an often overlooked business-case for the internet of Things because it does not really fit into the well-known categories such as health, mobility, or industrial. However, due to the remoteness of farming operations and the large number of livestock that could be monitored the Internet of Things could revolutionize the way farmers work. But this idea has not yet reached large-scale attention. Nevertheless, one of the Internet of Things application is that it should not be underestimated. Smart farming will become the important application field in the predominantly agricultural-product exporting countries.

3.8 IOT PLATFORM (THINGSPEAK CLOUD)

The ThingSpeak API is an open source interface which listens to incoming data, timestamps it, and outputs it for both human users (through visual graphs) and machines (through easily parseable code). We look into practical examples using the Arduino micro-controller as well as communication with graphical interface operating systems through a Python script.

3.8.1 Operating Principles

In order to connect an object to the IoT, several things are needed in the hardware and software realm. First of all, if one wishes to go beyond simply connecting data from a computer, objects to gather (sensors) or receive (actuators) data are necessary.

For example, a digital thermometer can be used to measure temperature. In this case, the data needs to be uploaded to a network of connected servers which run applications. Such a network is commonly referred to as 'the cloud'. The cloud utilizes the process of visualization, meaning that several physical servers can be connected and used in tandem, but appears to the user as one machine (despite that at the physical level, the machines function independently). This method of computing thus allows changes to be made to the 'virtual' server (such as software updates or changes in storage space) much easier than before.

In this case, an object will connect to the cloud through a (possibly wireless) Internet connection to upload or receive data. Objects to be connected are typically augmented with either sensors or actuators. A sensor is something that tells us about our environment. Think of a temperature sensor, or even the GPS receiver on your mobile phone. Actuators are something that you want to control. Things like thermostats, lights, pumps, and outlets. The IoT brings everything together and allows us to interact with our things and, even more interestingly, allows things to interact with other things. For the purpose of connecting an object to the IoT, we focus on the ThingSpeak API. The interface provides simple communication capabilities to objects within the IoT environment, as well as interesting additional applications (such as ThingTweet, which will be further discussed in a later section).

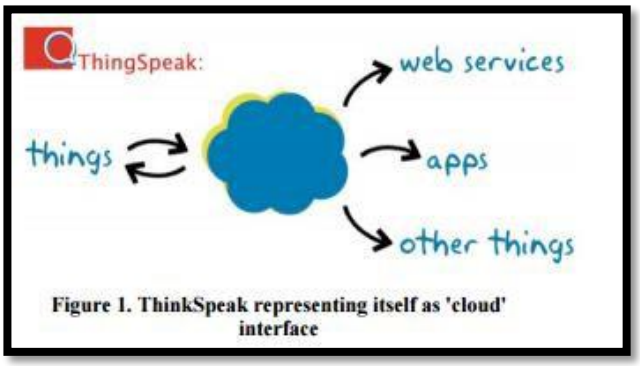


Figure 1. ThinkSpeak representing itself as 'cloud' interface

Moreover, ThingSpeak allows you to build applications around data collected by sensors. It offers near real-time data collection, data processing, and also simple visualizations for its users. Data is stored in so-called channels, which provides the user with a list of features. Each channel allows you to store up to 8 fields of data, using up to 255 alphanumeric characters each. There are also 4 dedicated fields for positional data, consisting of: Description, Latitude, Longitude, and Elevation. All incoming data is time and date stamped and receives a sequential ID. Once a channel has been

created, data can be published by accessing the ThingSpeak API with a ‘write key’, a randomly created unique alphanumeric string used for authentication. Consequently, a

‘read key’ is used to access channel data in case it is set to keep its data private (the default setting). Channels can also be made public in which case no read key is required.

CHAPTER 4

COMMUNITY BASED LOW COST EARLY WARNING SYSTEM FOR LANDSLIDES

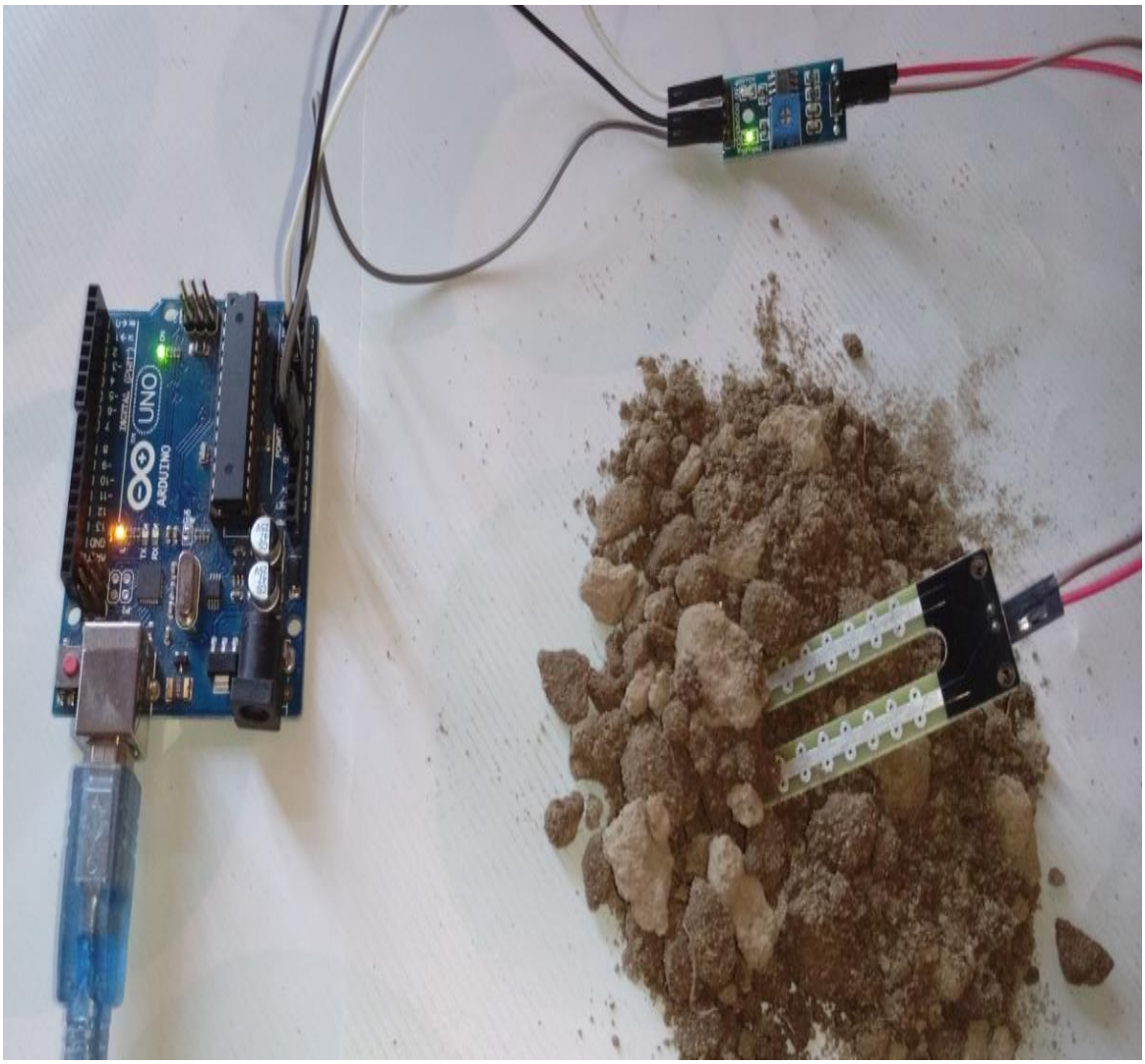
WORKING OF INDIVIDUAL SENSORS, THEIR CODE AND RESULTS:

4.1 SOIL MOISTURE SENSOR

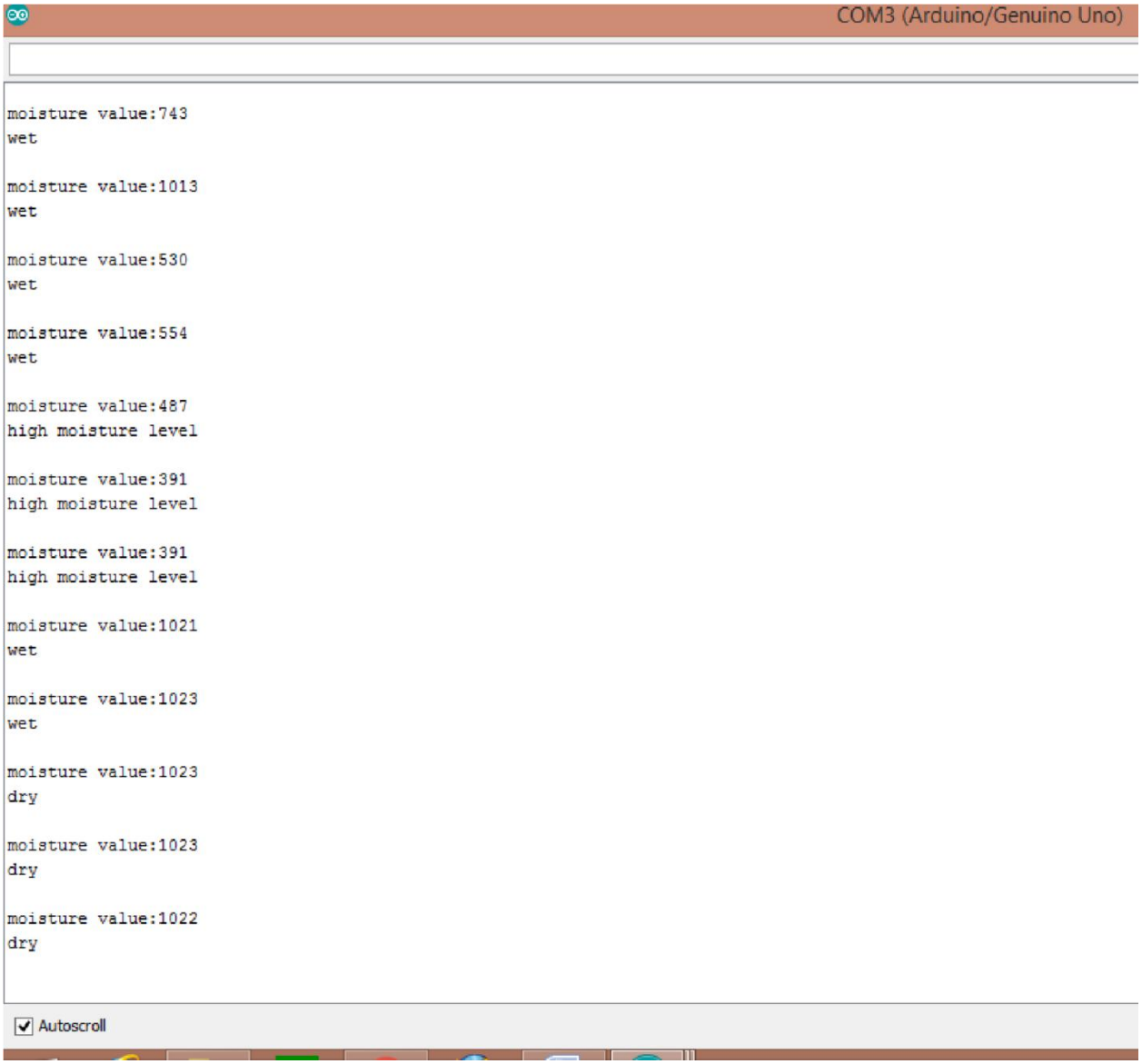
4.1.1 Soil Moisture Sensor Code:

```
void setup() {
  // put your setup code here, to run once:
Serial.begin(9600);

}

void loop() {
Serial.print("moisture value:");
Serial.println(analogRead(A0));
intval=analogRead(5); if(val>800)
Serial.println("dry"); else
if(val>500)
Serial.println("wet");
else
Serial.println("high moisture level");
Serial.println("");
delay(1000);

  // put your main code here, to run repeatedly:

}
```

4.1.2 Soil Moisture Sensor Circuit:



4.1.3 Soil Moisture Sensor Result:

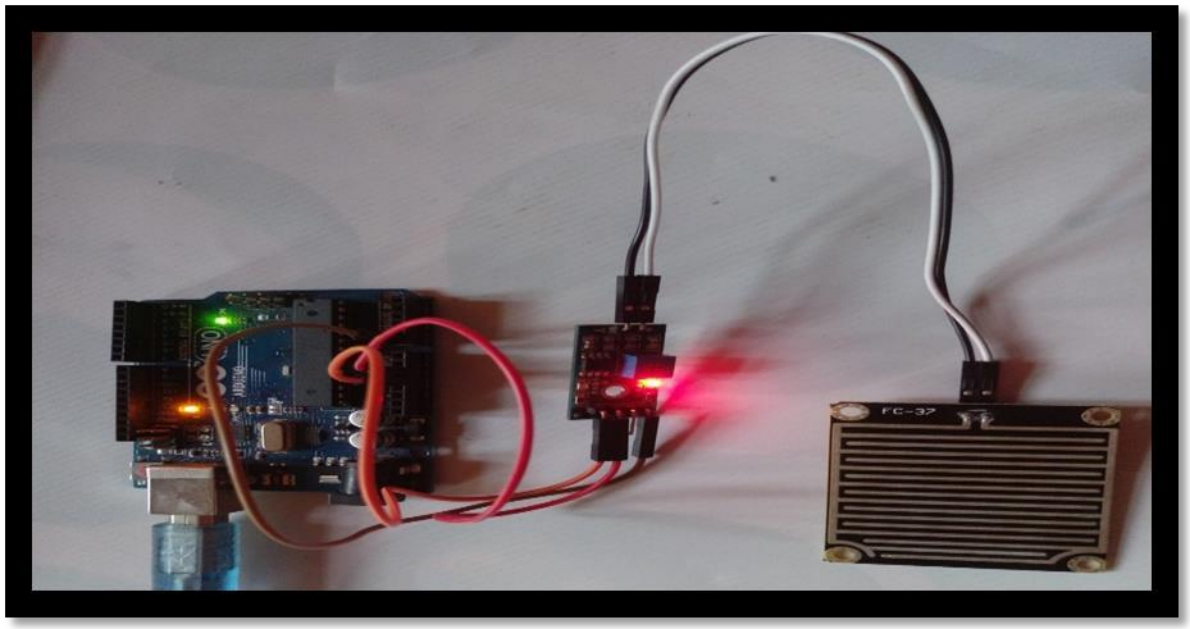


4.2 RAIN SENSOR

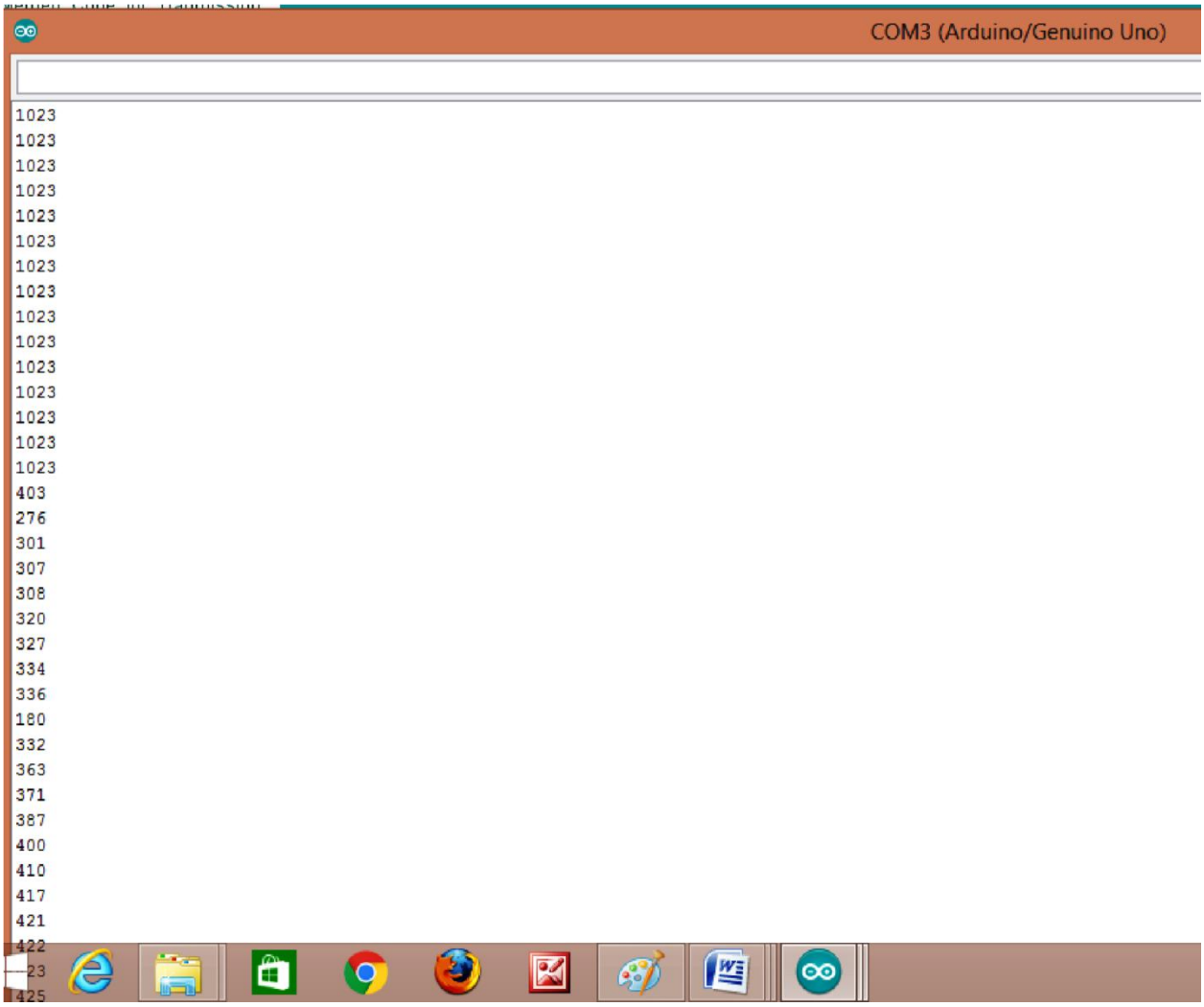
4.2.1 Rain Sensor Code:

```
void setup() {
Serial.begin(9600);
 // put your setup code here, to run once:
}  void  loop()
{

intsensorValue =analogRead(A0);
Serial.println(sensorValue);   delay(1000);

  // put your main code here, to run repeatedly:
}
```

4.2.1 Rain Sensor Circuit:



4.2.3 Rain Sensor Result:

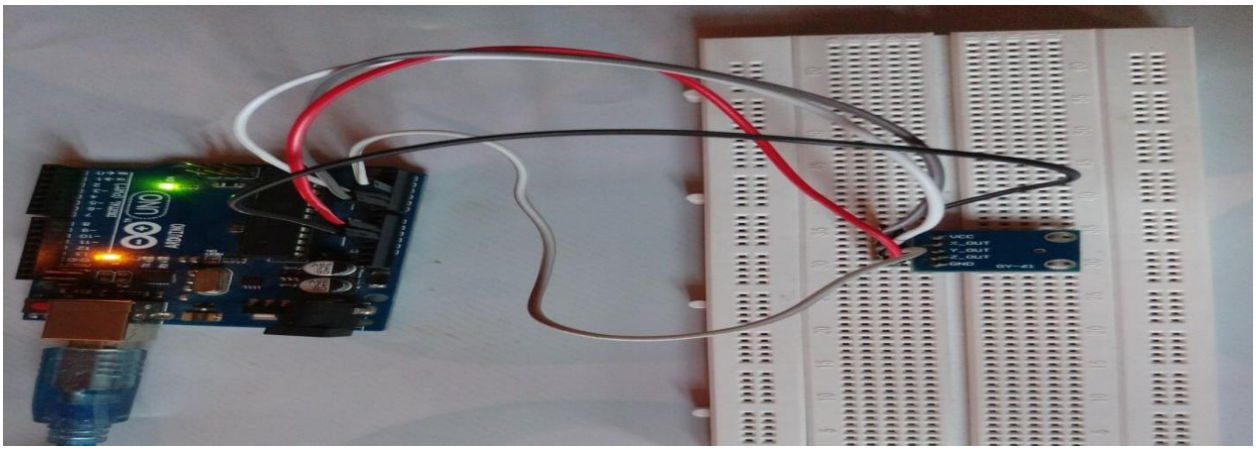


4.3 ACCELEROMETER SENSOR (ADXL-335)

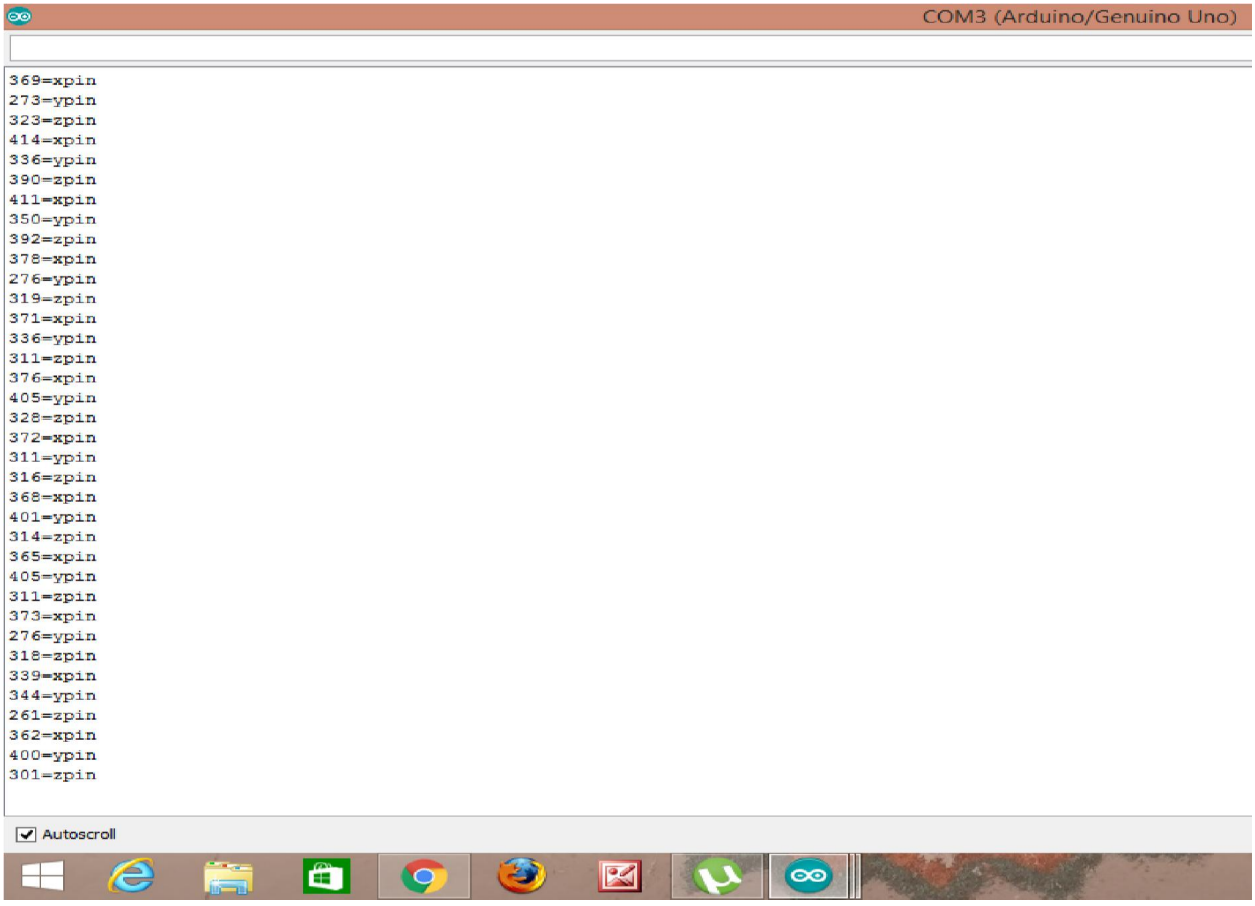
4.3.1 Accelerometer Sensor (ADXL-335) Code:

```
void setup()
{
  // initialize the serial communications:
Serial.begin(9600);

  // Provide ground and power by using the analog inputs as normal
  // digital pins.  This makes it possible to directly connect the   //
breakout board to the Arduino.  If you use the normal 5V and   //
GND pins on the Arduino, you can remove these lines.
pinMode(groundpin, OUTPUT);   pinMode(powerpin,
OUTPUT);   digitalWrite(groundpin, LOW);
digitalWrite(powerpin, HIGH);
}

void loop()
{
  // print the sensor values:
Serial.print(analogRead(xpin));   //
print a tab between values:
Serial.println("=xpin");
Serial.print(analogRead(ypin));   //
print a tab between values:
Serial.println("=ypin");
Serial.print(analogRead(zpin));
Serial.println("=zpin");   // delay
before next reading:
delay(10000);
}
```

4.3.2 Accelerometer Sensor (ADXL-335) Circuit:



4.3.3 Accelerometer Sensor (ADXL-335) Result:



4.4 SYSTEM IMPLEMENTATION

Soil Moisture sensor, Rain sensor, Accelerometer, GPS Module all these sensors are connected to the Arduino Uno board. Arduino Uno Board is connected to the pc via an USB cable and then code or program is first compiled using Arduino Ide software and then uploaded to Arduino Board. Then output is seen on Serial Monitor window of Arduino software.

After that GSM Module is interfaced with Arduino Board through Serial communication pins i.e. TX pin of GSM module is connected to RX pin(9) of Arduino, RX pin of GSM is connected with TX pin(8) of Arduino and GND of GSM to GND of Arduino. GSM is power supplied from outside with 5v power The data of these sensors is send to the Thingspeak channel using AT commands method of sending data with GSM to web. Some AT Commands Used are:- For Setting the connection type, APN and enabling GPRS.

```
AT+SAPBR=3,1,"Contype","GPRS"
AT+SAPBR=3,1,"APN","www"
AT+SAPBR =1,1
```

Software Serial library is included in program for communication between Arduino and GSM. A constructor of Software Serial is created with name GPRSand digital pin numbers as parameters are passed. Following line of code denotes the contructor defined in the program:SoftwareSerial GPRS (9, 8);

In the above line, pin number 9 is acting as Rx of Arduino and pin 8 as Tx of Arduino. Baud rates are set for communication between Software Serial library, GSM module and serial monitor of Arduino IDE. A function shown below is created which shows data available on GSM/GPRS on the serial monitor.

```
Void toSerial ()
   {
     While (GPRS.available ()! =0)
    {
Serial.Write (GPRS.read ());
    }
```

If the tip Count variable (number of times bucket tips) exceeds a certain set threshold then, SMS (with some information) is sent using GSM module to a specific phone number and Piezo buzzer connected with Arduino is also made to make sound using tone() function.

Bearer settings are set by giving some specific commands (which are given below) to the GSM

"AT+SAPBR=3, 1, \"CONTYPE\",\"GPRS\""""AT+SAPBR=3,
1, \"APN\",\"aircelgprs.pr\""

"AT+SAPBR=1, 1"

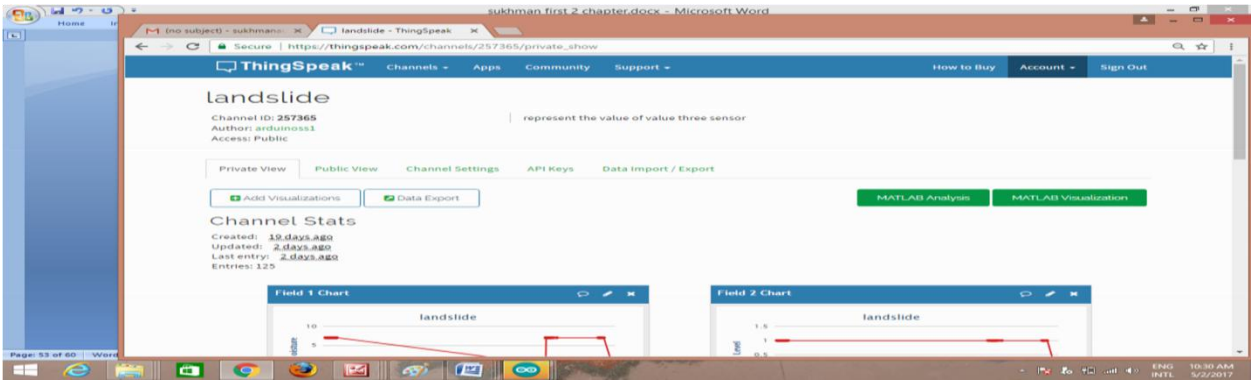
GSM Response to each command is seen on serial monitor using to Serial () function.
After that Http request is initiated (using "AT+HTTPINIT" command) and data i.e. tip Count is multiplied by 0.1(as Resolution of Rain Gauge sensor is 0.1mm) is sent to the thingspeak channel by commands
"AT+HTTPPARA=\"URL\",\"http://api.thingspeak.com/update?api_key=QWLKWB8Y90BZQCZV&field1="tipCount*0.1

"AT+HTTPACTION=0"
"AT+HTTPREAD"

"AT+HTTPTERM" is sent to the GSM for terminating the http request.

The data which is sent to the thingspeak cloud can be analyzed and an action like tweet (by linking a twitter account with thingspeak app thingtweet), SMS (by linking a web SMS service like twilio with thingspeak app thinghttp)can be triggered if specific action exceeds the certain threshold values. Rainfall data is be stored on thingspeak site with timestamp which can be downloaded in form of excel sheet or .csv file. Along this a realtime plot between rainfall (mm) and time is also shown.

And data starts updating on Thingspeak Channel which looks like this



4.5 COMPILED CODE OF THE PROJECT WORK

```
#include <SoftwareSerial.h>
#include <String.h>
// For the GSM module, refer to the link given on the page below:
// https://www.tindie.com/products/ICStation/sim900-gsm-module5253/

/*Declarations for accelerometer*/ float
value_acce_x1;
float value_acce_y1;
float value_acce_z1;

/*Declarations for Soil-moisture sensor*/ intSoilMoisturePin = 0;    // select the
analog input pin for the soil-moisture intMoistureAnalogValue = 0;  // variable to
store the value coming from the sensor float percentage_moisture;
const float MOISTURE_ANALOG_MIN = 360.0; // Value of the moisture sensor when it is
dipped in bowl of water
const float MOISTURE_ANALOG_MAX = 1023.0; // Value of the moisture sensor when it is
free of any moisture

/*Declarations for rain detector*/
/*
http://www.instructables.com/id/Arduino-Modules-Rain-Sensor/
https://www.arduino.cc/en/reference/map
```

- If the Sensor Board is completely soaked; "case 2" will be activated and " FLOOD" will be sent to the serial monitor.
- If the Sensor Board has water droplets on it; "case 1" will be activated and " WARNING" will be sent to the serial monitor.
- If the Sensor Board is dry; "case 0" will be activated and " NO RAIN " will be sent to the serial monitor.

```
*/ intRainDetectorPin = 1;    // select the analog input pin for the rain detector
intRainAnalogValue = 0;    // variable to store the value coming from the sensor
// lowest and highest sensor readings:
constint RAIN_ANALOG_MIN = 0;        // sensor minimum when dipped in water
constint RAIN_ANALOG_MAX = 1024;  // sensor maximum when dry

/*Declarations for Buzzer*/
constint buzzer = 2; //buzzer to digital pin 2

/*Declarations for GSM*/
//SIM900 TX is connected to Arduino D8
#define SIM900_TX_PIN 8

//SIM900 RX is connected to Arduino D9
#define SIM900_RX_PIN 9

//Create software serial object to communicate with SIM900
SoftwareSerialserialSIM900(SIM900_TX_PIN,SIM900_RX_PIN);

void setup() {
pinMode(buzzer, OUTPUT);
Serial.begin(9600); // the bigger number the better
//Serial.println("CLEARDATA"); //clears up any data left from previous projects
//Serial.println("LABEL,TIME, ACC_X1, ACC_Y1, ACC_Z1, MOISTURE_ANALOG,
MOISTURE_PERCENTAGE, RAIN_LEVEL, RAIN_CONDITION "); //always write LABEL,
so excel knows the next things will be the names of the columns (instead of Acolumn you could
write Time for instance)
//Serial.println("RESETTIMER"); //resets timer to 0
}

void loop() {
          /*Accelerometer 1 Values */            int
value_acce_x1 = (analogRead(A2));            int
value_acce_y1 = (analogRead(A3));            int
value_acce_z1 = (analogRead(A4));
Serial.print("Accelerations: X " + String(value_acce_x1) + " Y " +
String(value_acce_y1) + " Z " + String(value_acce_x1));
Serial.println();
delay(100);

          /*Soil-moisture values*/
          // read the sensor on analog A0.
MoistureAnalogValue = analogRead(SoilMoisturePin);                delay(100);
Serial.print("Analog value from soil-moisture sensor = " );
```

```
Serial.println(MoistureAnalogValue);
percentage_moisture=map(MoistureAnalogValue,                    MOISTURE_ANALOG_MAX,
MOISTURE_ANALOG_MIN,0,100);
percentage_moisture=constrain(percentage_moisture,0,100);
Serial.print("Moisture in percentage: " + String(percentage_moisture) + " %");
Serial.println();
delay(100);

          /*Rain Detector values*/
          // read the sensor on analog A1.
intRainAnalogValue = analogRead(RainDetectorPin);              //
map the sensor range (four options):
int level = map(RainAnalogValue, RAIN_ANALOG_MAX,
RAIN_ANALOG_MIN,0,3);
Serial.print("Rain situation: ");
char* RainConditions[]={"NO RAIN", "WARNING", "FLOOD"};
          //   level   value:
if (level == 0)
Serial.println(RainConditions[level]);             else
if (level == 1)
Serial.println(RainConditions[level]);             else
Serial.println(RainConditions[level]);
Serial.println();
delay(100);  // delay between reads

         /*Transmitting data to Thingspeak cloud via GSM Module*/
serialSIM900.println ("AT+CGATT?");            delay (100);
toSerial();

          serialSIM900.println                ("AT+SAPBR=3,1,\"CONTYPE\",\"GPRS\"");
delay(500);
toSerial ();

serialSIM900.println("AT+SAPBR=3,1,\"APN\",\"aircelgprs.pr\"");            delay
(500);
toSerial();

          serialSIM900.println          ("AT+SAPBR=1,1");
delay (500);
toSerial();

          serialSIM900.println          ("AT+SAPBR=2,1");
delay (500);
toSerial ();
```

```
        serialSIM900.println        ("AT+HTTPINIT");
delay (500);
toSerial();


serialSIM900.print("AT+HTTPPARA=\"URL\",\"http://api.thingspeak.com/update?api_key=Q
WLKWB8Y90BZQCZV&field1=");
serialSIM900.print(percentage_moisture);
serialSIM900.print("&field2=");
serialSIM900.print(level);
serialSIM900.print("&field3=");
serialSIM900.print(value_acce_x1);
serialSIM900.print("&field4=");
serialSIM900.print(value_acce_y1);
serialSIM900.print("&field5=");
serialSIM900.print(value_acce_z1);          serialSIM900.println
("\"");
delay (500);
toSerial();

        serialSIM900.println                ("AT+HTTPACTION=0");
delay(500);
toSerial();

        serialSIM900.println        ("AT+HTTPREAD");
delay (1000);
toSerial();

        serialSIM900.println ("");
        serialSIM900.println  ("AT+HTTPTERM");
toSerial();          delay (300);
        serialSIM900.println ("");
delay (500);

        /*Threshold comparison for sending alert messages on phone and buzzer sound*/
if(value_acce_x1 > 600 || value_acce_y1 > 500 || value_acce_z1 > 700 || percentage_moisture> 70
|| level == 2)
          {
tone(buzzer, 1000); // Send 1KHz sound signal
delay(1000);       // for 1 sec
noTone(buzzer);    // Stop sound
delay(1000);       // for 1sec              //Set
SMS format to ASCII
serialSIM900.begin(9600);
```

```
delay(500);
serialSIM900.write("AT+CMGF=1\r\n");                delay(500);

            //Send new SMS command and message number
serialSIM900.write("AT+CMGS=\"+919478197205\"\r\n");                delay(500);

            //Send SMS content
serialSIM900.write("Alert, Landslide is imminent!");                delay(500);

            //Send Ctrl+Z / ESC to denote SMS message is complete
serialSIM900.write((char)26);
delay(500);
            }
}

voidtoSerial ()
    {
while (serialSIM900.available ()!=0)
Serial.write(serialSIM900.read());
    }
```

CHAPTER 5

CONCLUSION

Landslide detection is one of the challenging research areas available today in the field of geophysical research. This project discusses the design and deployment of a landslide detection system for laboratory experiment. The main goal of this effort is to detect rainfall induced landslides which occur commonly in India.

The proposed work is for monitoring the hazard of landslides and by measuring the parameters related to landslides the hazard is pre-warned before it occurs. The proposed system is with wireless sensor network which collects data and transfers it wirelessly using GSM for further analysis in order to give quick response. If any possibility of occurrence of hazard is noticed the alerts are given through Wireless Sensor Network. By use of WSN any mechanical or geophysical sensor can be interfaced easily for protection of human losses as well as economic loss.

CHAPTER 6

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