Soil Creep Detection System

PROJECT REPORT

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B.Tech in Applied Electronics and instrumentation Engineering

Department of Electronics and communication

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DECLERATION

We hereby declare that the project report Soil Creep Detection System, submitted for partial fulfillment of the requirements for the award of the degree of Bachelor of Technology of the APJ Abdul Kalam Technological University, Kerala is a bonafide work done by us under the supervision of Dr Biju Longinose. This submission represents our ideas in our own words and where ideas or words of others have been included, we have adequately and accurately cited and referenced the original sources. We also declare that we have adhered to ethics of academic honesty and integrity and have not misrepresented or fabricated any data or idea or fact or source in our submission. We understand that any violation of the above will be a cause for disciplinary action by the institute and/or the University and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been obtained. This report has not been previously formed the basis for the award of any degree, diploma, or similar title of any other University.

Place: Trivandrum
Date:08/07/2020

DEPARTMENT OF ELECTRONICS AND COMMUNICATION

COLLEGE OF ENGINEERING THIRUVANANTHAPURAM - 695016

CERTIFICATE

This is to certify that the report entitled **Soil creep Detection and System** submitted by **Ajmal Rahman I**,**Akhil A B**,**Akshay P S** ,**Sharon Aneesh V** to the APJ Abdul Kalam Technological University in partial fulfilment of the requirements for the degree of B.Tech in Applied Electronics and Instrumentation Engineering is a bonafide record of the Project work carried out by them under our guidance and supervision. This report in any form has not been submitted to any other University or Institute for any purpose.

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Abstract

Here, we consider soil creep detection system which has the ability to continuously collect and provide provisions to monitor data. The system is a collection of sensors that are paired with LORA integrated microcontroller board which enables long-range wireless transmission of data, the said data will be monitored remotely and used for raise alarm while keeping a database for further study.

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Introduction

1.1 Background

Soil creep or Downhill creep is the slow, downward progression of rock and soil down a slope as a result of prolonged pressure and stress, the pressure and stress may be due to accumulated water content of the soil. Creep is the sum of numerous minute, discrete movements of slope material caused by the force of gravity.iIt is also a major contributing factor of landslides.

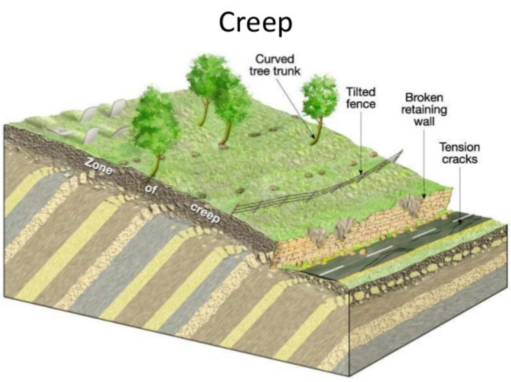


Figure (1.1): *Soil Creep*

Early detection of creep may help in averting landslides.water is a very important factor when discussing soil deformation and movement, The presence of water may help the hillside stay put and give it cohesion, but in a very wet environment or during or after a large amount of precipitation the pores between the grains can become saturated with water and cause the ground to slide along the slip plane it creates. Creep can also be caused by the expansion of materials such as clay when they are exposed to water. Clay expands when wet, then contracts after drying. The expansion portion pushes downhill, then the contraction results in consolidation at the new offset. Objects resting on top of the soil are carried by it as it descends the slope.

1.2 Objective

Soil creep can deductecd by evidences such as bent tree , displaced headstones and changes in landscape however such evidences can be visible when significant amount of mass movement have already occured.

Figure (1.2): *Visual evidence of soil creep*

This project aims at sensing soil creep before any drastic changes and provide a continous remote monitoring of geophisical data using a wireless sensor nework ,this would be helpful for plantation sites and residential areas in micro basinal slopes.

1.3 Literature Survey

Wireless sensor technology has generated enthusiasm in engineers to develop real-time deployments. One of the major areas of focus is environmental monitoring, detection, and prediction. The Drought Forecast and Alert System (DFAS) has been proposed and developed in [2]; 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 the internet. The real streaming of data through broadband connectivity provides connectivity to a wider audience. An experimental soil monitoring network using a WSN is presented in reference [3], which explores real-time measurements at temporal and spatial granularities. Paper [4] describes a state-of-the-art system that combines multiple sensor types to provide measurements to perform deformation monitoring. Reference [5] discusses the topic of slip surface localization in wireless sensor networks, which can be used for landslide prediction. A durable wireless sensor node has been developed [6], which can be employed in expandable wireless sensor networks for remote monitoring of soil conditions in areas conducive to slope stability failures. In this project we develop a system with similar characteristics such as WSN providing remote access and open source development platform for soil creep monitoring.

1.4 Overview of the Report

The organisation of this report is as follows. The first chapter presents the background of this study, relevance of this project .

Chapter 2 presents the methodology and various solutions to implement

Chapter 3 presents a discussion of future scopes of the study.

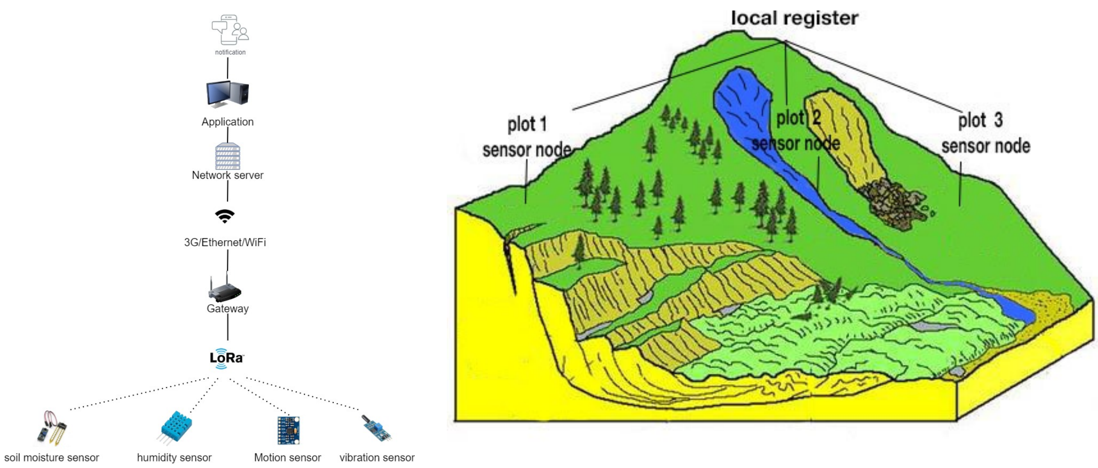
Chapter 4 presents the significant conclusions of this study.

Chapter 2

Methodology

2.1 Design

A wireless sensor network (WSN) spanning a micro-basinal locality consisting of plantations and residential area, WSN is created by interfacing sensors with a LoRa enabled microcontroller board that is connected to the cloud through a LoRa gateway.



(a) *WSN*

(b) *micro-basinal plots*

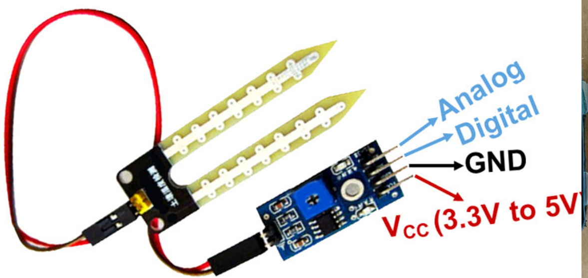
Figure (2.1): *Design*

Sensors along with transmission devices are to be placed in a micro-basinal plot of land after conducting a geophysical survey to find an appropriate placement. sensor data is collected and grouped according to the locality, the data is collectively studied, as such data of adjacent plots of land might give a wider perception of soil creep.
Data will be open source and can be accessed for analysis and further study, and significant information along with suggestions will be sent to plot owner via SMS or android app whichever is preferred.

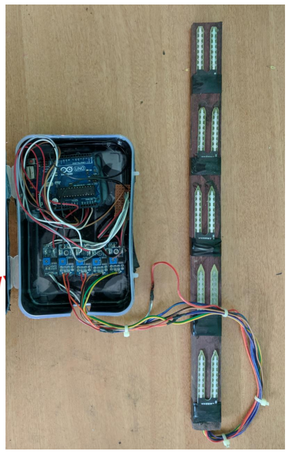
2.2 Sensors

2.2.1 Soil moisture sensor

Soil moisture sensor is placed in a pipe, and inserted into ground for measurement of soil moisture tension at various depths.The soil moisture sensor consists of two probes which are used to measure the volumetric content of water. The two probes allow the current to pass through the soil and then it gets the resistance value to measure the moisture value. the value from the sensor is given by $Moisture(inpercentage) = 100 - ((AnalogValue/1023.00) \times 100)$



(a) *moisturesensor*



(b) *moisture sensor arrangement*

Figure (2.2): *soil moisture sensor*

2.2.2 Humidity Sensor DHT11

The DHT11 is a basic, ultra low-cost digital temperature and humidity sensor. DHT11 sensor consists of a capacitive humidity sensing element and a thermistor for sensing temperature. The humidity sensing capacitor has two electrodes with a moisture holding substrate as a dielectric between them. Change in the capacitance value occurs with the change in humidity levels. The IC measure, process this changed resistance values and change them into digital form. DHT11 sensor has four pins- VCC, GND, Data Pin and a not connected pin. A pull-up resistor of 5k to 10k ohms is provided for communication between sensor and micro-controller.

Figure (2.3): *Humidity and Temperature sensor*

2.2.3 Vibration Sensor:

The Grove - Vibration Sensor (SW-420) is a high sensitivity non-directional vibration sensor. When the module is stable, the circuit is turned on and the output is high. When the movement or vibration occurs, the circuit will be briefly disconnected and output low

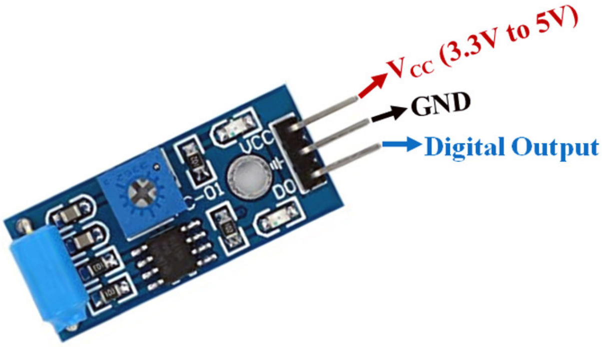


Figure (2.4): *Vibration Sensor(SW420)*

2.2.4 MPU 6050

The MPU 6050 is a 6 DOF (Degrees of Freedom) or a six axis IMU sensor, which means that it gives six values as output. Three values from the accelerometer and three from the gyroscope. The MPU 6050 is a sensor based on MEMS (Micro Electro Mechanical Systems) technology. Both the accelerometer and the gyroscope is embedded inside a single chip. This chip uses I2C (Inter Integrated Circuit) protocol for communication. MPU 6050 can be considered as an alternative to vibration sensor it give a directional output ie. it provides position ,velocity and acceleration. Will be instrumental in correlating the movement of landmass with the other factors ie,moisture increase,temperature and vibration.

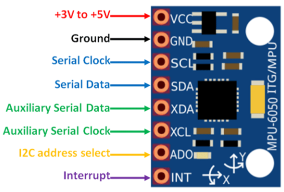


Figure (2.5): *MPU6050*

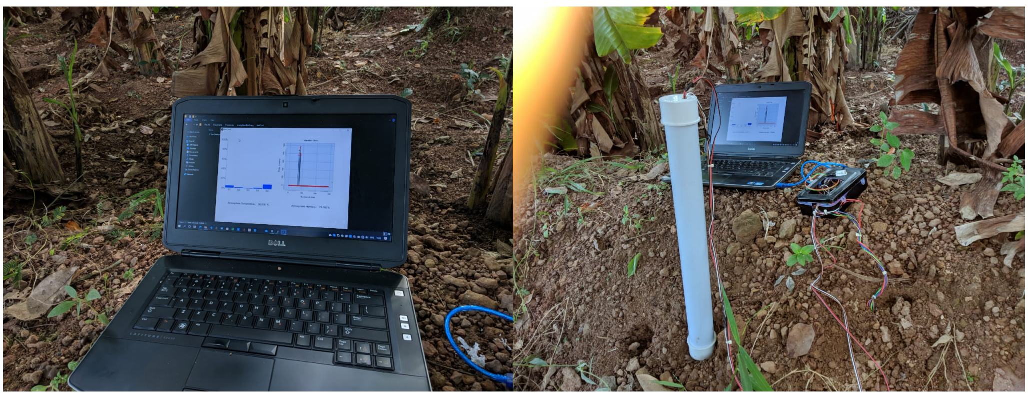


Figure (2.6): *Initial ground test of the sensors*

2.3 Transmission and Data handling

2.3.1 LoRa integrated microcontroller board

In this project we are using HELTEC WiFi LoRa which has Microprocessor: ESP32 (dual-core 32-bit MCU + ULP core), with LoRa node chip SX1276/SX1278. This is directly connected to the sensors. Reasons to consider Heltec Wifi LoRa microcontrolller board

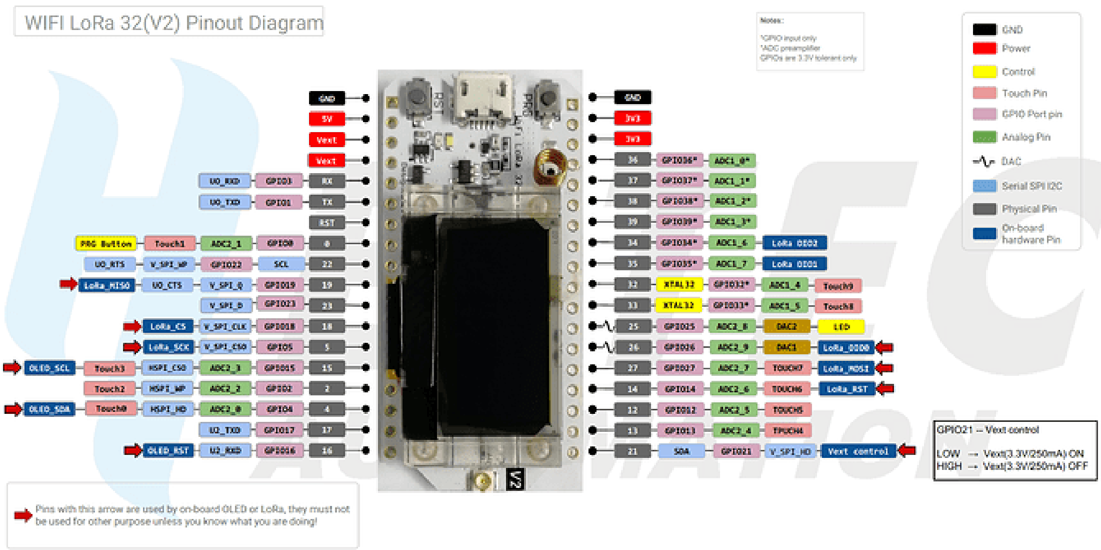


Figure (2.7): *Heltec LoRa WiFi 32 pinout*

- Long Range wireless transmission.
- Easy interfacing with sensors.
- WiFi Data transmission.
- Compatiblity with programming platform like arduino ide

2.3.2 LoRa

LoRa Alliance™ Technology. LoRaWAN™ is a Low Power Wide Area Network (LPWAN) specification intended for wireless battery operated Things in a regional, national or global network. LoRaWAN targets key requirements of Internet of Things such as secure bi-directional communication, mobility and localization services.

Advantages of using LoRa Technology

· GEOLOCATION: Enables GPS-free, low power tracking applications

· LOW COST: Reduces costs three ways: infrastructure investment, operating expenses and end-node sensors

· STANDARDIZED: Improved global interoperability speeds adoption and roll out of LoRaWAN-based networks and IoT applications

· LOW POWER: Protocol designed specifically for low power consumption extending battery lifetime up to 20 years

· LONG RANGE: Single base station provides deep penetration in dense urban/indoor regions, plus connects rural areas up to 30 miles away

· SECURE: Embedded end-to-end AES128 encryption

· HIGH CAPACITY: Supports millions of messages per base station, ideal for public network operators serving many customer

LoRa Gateway

LoRa gateways are intermediaries that allow sensing devices to transmit data to the cloud. Providing coverage in difficult-to-reach indoor locations, the long-range wireless picocell gateway is an IoT platform that accompanies the LoRaWAN. This enables WSN as it connects thousands of sensors in plantation or residential community within a specific range for outdoor sensor connectivity.
The Device we are using here is RAK831

Figure (2.8): *RAK831 LoRa Gateway*

2.3.3 Software

Significant software used along the project are:

Arduino IDE

The Arduino Integrated Development Environment is a cross-platform application that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards. we have used this to program HELTEC WiFi LoRa board.

Google Firebase

Google firebase is an online database platform that enables direct viewing of data along with a basic setup for data to be available on applications.

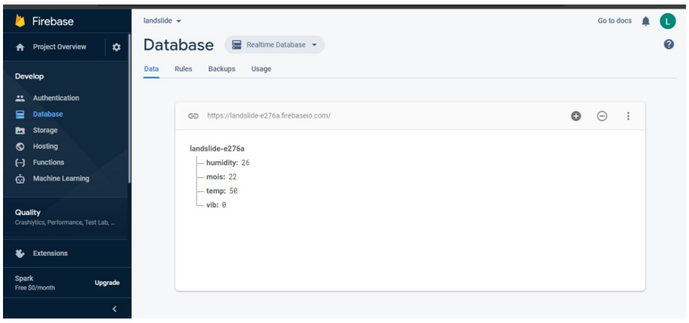


Figure (2.9): *Firbase Console*

Android App

An android app is developed inhouse ,providing critical informations graphically and factually to the user.

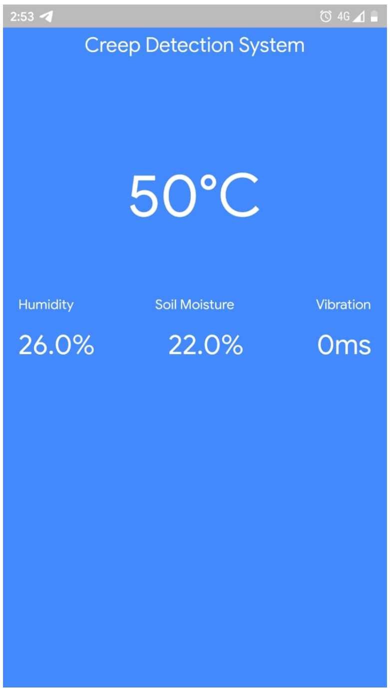


Figure (2.10): *App*

Website

A website display data has been made with the help of PHP.It displays Live data feed from sensors the following webpage shows a sample of data collected. landslide.techwithus.com

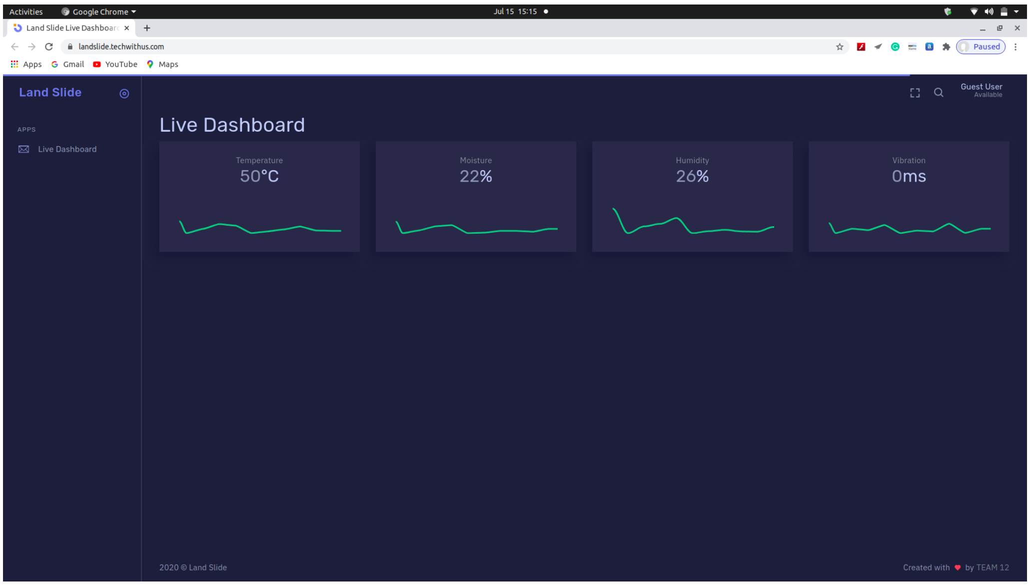


Figure (2.11): *web*

2.3.4 PC based Software

Software that gives a graphical representation of data .Software is made using processing Java .

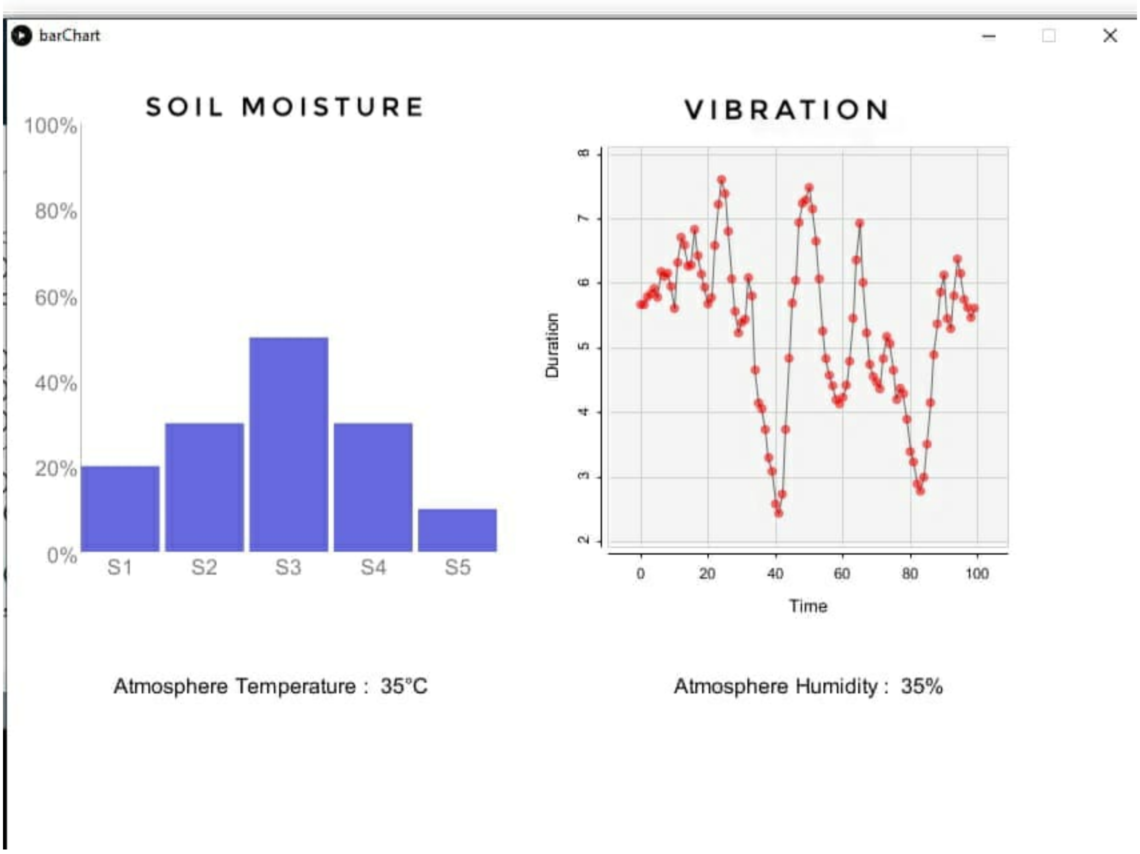


Figure (2.12): *Software UI*

2.4 Power Supply Unit

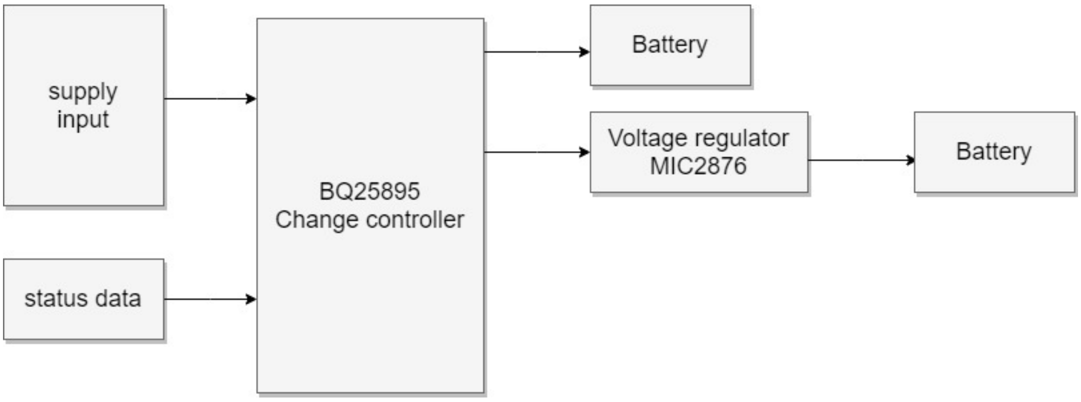


Figure (2.13): *Power supply unit Block Diagram*

The power supply circuit contains two parts ,

- Charging discharging controller.
- Boost voltage regulator.

2.4.1 discharging controller BQ25895

The BQ25896 is a highly integrated 3 A switch mode battery charge management and system power path management device for cingle cell Li-ion and Li-polymer battery.The devices support high input voltage fast charging.The low impedance power path optimizes switch-mode operation efficiency,reduces battery charging time and extends battery life during discharging phase.The I2C serial interface with charging and system settings makes the device a truly flexible solution.

2.4.2 Boost Voltage regulator MIC2576

The MIC2876 is a compact and highly efficient 2 MHz synchronous boost regulator with a 4.8A switch. It features a bi-directional load disconnect function that prevents any leakage current between the input and output when the device is disabled. The MIC2876 operates in bypass mode automatically when the input voltage is greater than the target output voltage. At light loads, the boost converter goes to the PFM mode to improve the efficiency. The MIC2876 also features an integrated anti-ringing switch to minimize EMI.

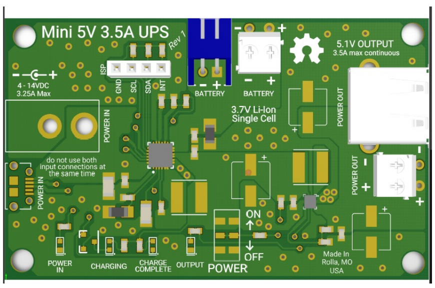


Figure (2.14): *Power supply unit Board*

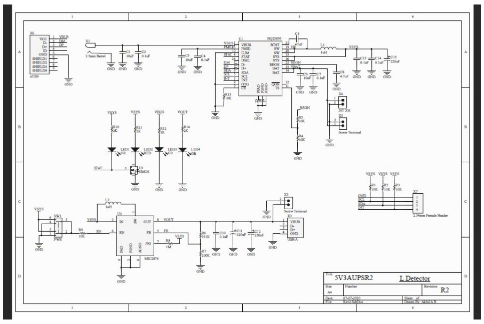


Figure (2.15): *Power supply unit Circuit*

2.5 Geophysical survey

The sensors and transmission device have to be placed in the plot of land . the correct placement of sensors will give optimal dataset. Two major surveying methods we will be using are:

2.5.1 Resistivity Methods

Surface electrical resistivity surveying is based on the principle that the distribution of electrical potential in the ground around a current-carrying electrode depends on the electrical resistivities and distribution of the surrounding soils and rocks

2.5.2 ElectroMagnetic Telluric method

Natural currents are induced in the Earth as a result of atmospheric disturbances (e.g., lightning strikes) and bombardment of the upper atmosphere by the solar wind—a radial flow of protons, electrons, and nuclei of heavier elements emanating from the outer region of the Sun. Magnetotelluric methods measure orthogonal components of the electric and magnetic fields induced by these natural currents. Such measurements allow researchers to determine resistivity as a function of depth. The natural currents span a broad range of frequencies and thus a range of effective penetration depths. Related to the above techniques is the telluric-current method, in which the electric current variations are measured simultaneously at two stations. Comparison of the data permits determining differences in the apparent resistivity with depth at the two stations

Chapter 3

Discussion

This project if further developed can lead upto a product that will be useful for plantations and recidents living in amicrobasinal community ,further collection of data and analysis can help setting up preventive methods for soil creep and thus reduce risks of landslides and such landmass related incidents.

Chapter 4

Conclusions

IoT based detection system are very comfortable to use and are cheap they provide remote acess to truly remote places where landslides might occur and they provide an updatable infrastructure that can be modernised and improvised as the time progress.

Chapter 5

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