Vishwakarma Institute of Information Technology

(Department of Electronics & Telecommunication)

Group No.: - B2

A Final Year Project Synopsis
Project entitled

"PreciFarm - Integrated wired and wireless IOT solution for Precision Agriculture"

(SPONSORED BY: Infiniti Systems)

(Domain: Embedded Electronics and IoT)

Submitted By:				
Roll No.	**Division**	**Name of Student**	**E-mail**	**Contact Number**
412043	B	Anil Rajpurohit	anil.rajpurohit@viit.ac.in	9145614631
412061	B	Arpit Shrivastava	arpit.shrivastava@viit.ac.in	7020818025
412068	B	Vaishnavi Patil	vaishnavi.patil@viit.ac.in	9011037616

BE E&TC

Of Savitribai Phule Pune University (Formerly University of Pune)

Under supervision of

PROF. GAJANAN H. CHAVAN

Year 2019 – 2020

1

CERTIFICATE

This is to certify that seminar work entitled "PreciFarm - Integrated wired and wireless IOT solution for Precision Agriculture" carried out in the seventh semester by,

Roll No.	Division	Name of Student
412043	B	Anil Rajpurohit
412061	B	Arpit Shrivastava
412068	B	Vaishnavi Patil

in partial fulfillment for the award of Bachelor of Engineering degree in Electronics and Telecommunication Engineering from Vishwakarma Institute of Information Technology, Savitribai Phule Pune University, Pune during the academic year 2019-20.

Date:

Prof. Gajanan H. Chavan   **Prof. P.G. Gawande**

Guide   Project Coordinator

Dr. S. V. Kulkarni

H.O.D., E&TC Engg.

ABSTRACT

The problems faced by farming are not only affecting the efficiency for farming but is also making farmers helpless of getting into a better tomorrow. In farming maximum production requires certain parameters to be precise and some of them are soil moisture, soil temperature, air moisture, air temperature UV and light. Considering other factors of farming we know that wastage is something which comes into highlight not only water but also fertilizers. Covering the range and maintaining the precision are two factors which need to go hand in hand.

PRECIFARM is an Integrated wired and wireless IoT Solution for Precise Agriculture which can help us in solving the above-mentioned problems. With use of some latest technologies like IOT and WSN (Wireless Sensor Network) we focus on precision. These technologies help us in doing good to the precision factor and give us a broader prospective to work. Along with this we have LORA technology which has wide frequency range it works on and along with this low power consumption. We are also focusing on development of own cloud using Django.

Agriculture in today's world holds the utmost importance and working towards its precision is our duty.This is a small attempt by us where we have applied our engineering knowledge practically for a better green life tomorrow and a more happy farmer today.

ACKNOWLEDGEMENT

This work could not have been completed without the guidance and encouragement of many people. We would like to particularly acknowledge those below.

We pay our humble regards and gratitude to Prof. Gajanan H. Chavan for guiding us and giving moral support and timely boost.

We wish to express our special thanks to Dr. S.V.Kulkarni and Prof. S.H. Bhagwat , project evaluators , who helped us a lot in the preparation of our seminar topic.

<div align="right">

ANIL RAJPUROHIT

ARPIT SHRIVASTAVA

VAISHNAVI PATIL

</div>

INDEX

1. Introduction:

IoT has the capability to influence the world we live in; advanced industries, connected vehicles, and smarter cities are all components of the IoT equation. However, applying technology like IoT to the agriculture industry could have the greatest impact.

In today's world farming is something which dates many problems. The need of the hour is to automize farming and use the trending technologies to solve the major issue. Against the challenges such as extreme weather conditions and rising climate change, environmental impact, wastage, no proper monitoring, unproductive yield resulting from intensive farming practices, the demand for more food has to be met.

PRECIFARM is an Integrated wired and wireless IoT Solution for Precise Agriculture aimed at solving problems using latest technologies available.

Precision farming based on IoT technologies will enable growers and farmers to reduce waste and enhance productivity ranging from the quantity of fertilizer utilized to the number of journeys the farm vehicles have made.

This Project uses WSN (Wireless Sensor Network) to cover large area fields, along with our own Cloud with latest development tools like Django platform for making User Interface Better and customized for the use.

2. Literature Survey:

❖ In farming maximum production requires certain parameters to be precise and some of them are as follows:

1. Soil moisture
2. Soil temperature
3. Air moisture
4. Air temperature
5. UV and light

❖ The **Effects of Soil Salinity** on plant growth are various, mainly in the following aspect:

- Physiological drought - Too much soluble salt in the soil, the soil water potential was decreased with the increase of osmotic potential. Based on the principle that water flows from high water potential to low water potential, the water potential of the root cell must be lower than the water potential of the surrounding medium, so the soil salinity is higher, the root water absorption is more difficult. The body of water is dangerous and even extravasations. Thus, the general expression of salt damage is actually a drought disaster, especially in the case of low relative humidity of the atmosphere. As evaporation strengthened, salt damage is more serious, the abnormal growth of plants, Plant short stature, leaf small dark green, like drought.

- Toxic effect of ions - Plants have been excluded from the absorption of other nutrients because of absorbing excessive certain salts.

- Destruction of normal metabolism. Too much salt can inhibit the synthesis of chlorophyll and the occurrence of various enzymes in the photosynthetic apparatus, especially effects the formation of chloroplast in. Crops grown in soils with too much salt, the average net photosynthetic rate is lower than that of the plant. Chloroplast is the main site of photosynthesis in plants. The content of chlorophyll is a physiological index reflecting the intensity of photosynthesis in plants. Under the salt stress, the effect of plant photosynthesis is mainly on Chloroplast. Plants cannot absorb enough water and mineral nutrients, resulting in poor nutrition, and low chlorophyll content, affecting photosynthesis. In addition, the enzyme activity decreased and the chloroplast tended to break down, and the chlorophyll was destroyed. The biosynthesis of chlorophyll and carotenoid was blocked, stomata closure, so that the photosynthetic rate decreased, affecting crop yield.

- Effect on membrane structure of plant cells. Salt stress directly affects the membrane lipid and membrane protein, the membrane permeability increased and membrane lipid per oxidation, thereby affecting the normal physiological function of the membrane. Normal condition, cell wall and plasma membrane are exposed to each other; contraction of plasma membrane during loss of water, because of the plasma membrane is different from the cell wall, "Tear" deformation of wall, the intracellular free calcium concentration was increased, plant active oxygen burst. Salt stress causes cell loss of water, the cell swelling and osmotic pressure changes.
- Protein synthesis of crops. The effect of excessive salt on protein metabolism is obvious. Inhibition of synthesis promoting decomposition, the direct reason for the inhibition of protein synthesis may be due to the destruction of the synthesis of amino acids, Such as beans under salt stress in leaves of cytokine and methionine synthesis decreased, so as to reduce the protein content, to produce toxic substances, salt threatens to force the plant to accumulate toxic metabolites, the accumulation of free amino acids, amines, amino acids, such as the product of protein decomposition, these substances are toxic to plants, resulting in poor growth of plant leaves, inhibited root growth, tissue necrosis and so on.

❖ **Significance of measurement of soil conductivity :**
- Understanding of water and salt dynamics and its harm to crops, provide reference for the prediction of soil salt, the forecast, in order to take effective measures to ensure normal crop growth.
- Understand the comprehensive control measures the effect of saline soil.
- According to the soil salt content and its composition, saline soil classification, and make reasonable planning, in order to achieve reasonable planting, the purpose of reasonable irrigation and drainage.
- For irrigation water quality appraisal, determination of the salt content in irrigation water, so that the rational utilization of water resources, land reclamation, prevent soil salinization.

❖ The soil electrical conductivity is the indispensable parameter in the precision agriculture; it contains the soil quality and the physical properties of information. For example: salt, moisture, temperature, organic matter content in the soil and texture structure is different degree affects the soil electrical conductivity

❖ Considering other factors of farming we know that wastage is something which comes into highlight not only water but also fertilizers.

❖ Covering the range of field and maintaining the precision are two factors which need to go hand in hand.

❖ **Effect of soil moisture on plant:**

- **Effects on plant morphology** - Plant photosynthesis and dry matter accumulation by water supply, the amount of accumulation is directly reflected in the plant height, stem diameter, leaf area and yield formation. Individual plants suffered from water stress after the low photosynthetic leaf area decreased, yield decreased.

- **Effect on leaf Change** - Leaves are the main places for photosynthesis and transpiration. The mesophyll cell expansion and leaf growth are very sensitive to water conditions. Leaves to stay standing state, both rely on the cellulose support, but also to rely on the support organization in higher turgor, wilting phenomenon of water when the plant is the turgor pressure decreased performance.

- **Effect on Yield Formation** - Crop yield is the accumulation of solar energy into chemical energy on the crop. Soil moisture content affected the plant root water uptake and transpiration, which affected the accumulation of dry matter, and ultimately affected the yield of crops.

- The **Influence of moisture on Root Development** - Plant root is the main organ of water absorption, its development is affected by many aspects, but the main function are soil moisture condition and ventilation condition. The vertical distribution of soil water status of root, when the soil moisture content is higher, Root diffusion is affected by soil resistance, it helps the new root formation, root developed. Soils usually contain some usable water, so the root itself not prone to water deficit. When the soil is dry or the water supply is insufficient, the root system absorbs the limited water.

- **Influence on photosynthesis** - Photosynthesis is the main source of energy for green plants. The size of photosynthetic rate is closely related to the water status of plants. Experiments show that when the plant tissue water approaches saturation, the strongest photosynthetic; too much water, saturated water content, stomatal passive off, photosynthesis was inhibited. Lack of water, photosynthesis decreasing; serious water shortage to leaf wilting, photosynthetic decline sharply, or even stop. Soil water status also affected the photosynthesis of plants.
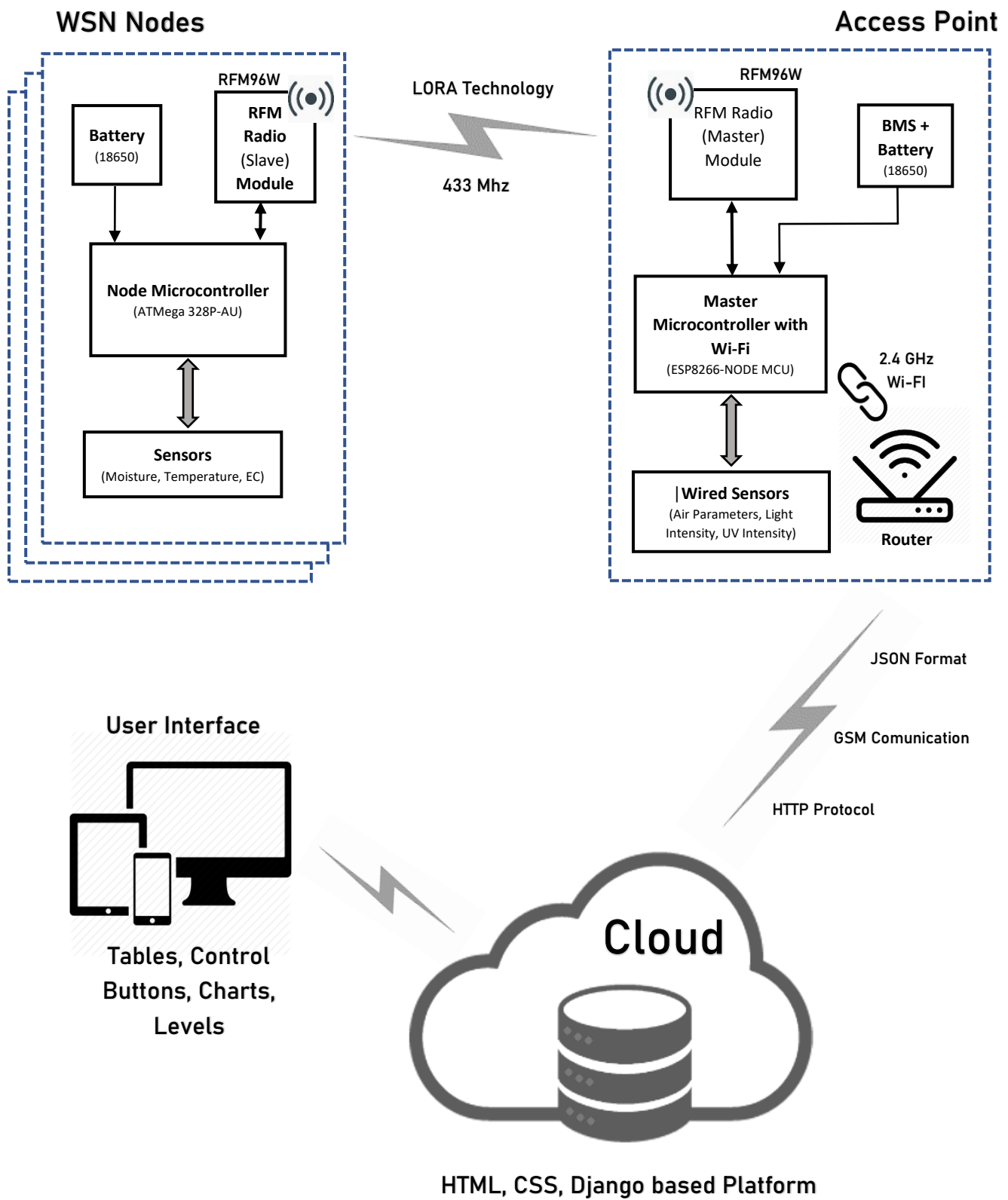
3. Objectives:

- To precisely monitor the parameters and build a robust interface in order to increase the overall efficiency of agriculture.
- Automation of the overall process along with increasing the efficiency, in order to increase the yield.
- To commercialize the project into a product for future development in the agriculture industry.

4. Motivation:

- Agriculture in today's world holds the utmost importance and working towards its precision is our duty.

- This is a small attempt by us where we have applied our engineering knowledge practically for a better green life tomorrow and a happier farming today.

5. Block Diagram:

WSN Nodes

- Battery (18650)
- RFM96W — RFM Radio (Slave) Module
- Node Microcontroller (ATMega 328P-AU)
- Sensors (Moisture, Temperature, EC)

LORA Technology

433 Mhz

Access Point

- RFM96W — RFM Radio (Master) Module
- BMS + Battery (18650)
- Master Microcontroller with Wi-Fi (ESP8266-NODE MCU)
- 2.4 GHz Wi-FI
- |Wired Sensors (Air Parameters, Light Intensity, UV Intensity)
- Router

JSON Format

GSM Comunication

HTTP Protocol

User Interface

Tables, Control Buttons, Charts, Levels

Cloud

HTML, CSS, Django based Platform

❖ From generation of data till user interface and analysis of it following steps are executed:

1. Data Generation – Sensors are used to generate data as follows:

   - Soil Sensor - for measuring Soil Moisture.
   - Rain Sensor – for sensing precipitation within an area.
   - Temperature Sensor – DS18B20 for Soil temperature sense.
   - UV Sensor – ML8511 sensor for sensing UV exposure within an area.
   - Light Sensor – BH1750 sensor for sensing Light Intensity in area.
   - BME280 – it gives air temperature, air moisture, altitude and pressure.
   - DHT11 – it gives the air temperature and air humidity at node side.
   - Leaf Sensor – it is used to sense the humidity over leaf surfaces.
   - Battery and Pump – Pump is used to operate the irrigation valves and battery for power of modules.

2. Data Transfer – RFM96W LoRa Technology modules.

   - The RFM69HCW transmits in the ISM (Industry Scientific and Medical) band, a set of frequencies set aside for low-power, short-range, license-free radios.
   - How far will the signal reach? Outside with few obstructions, you should be able to get a solid link for hundreds of meters. Indoors we've seen it work for over 50 meters through multiple walls.
   - The RFM69HCW is capable of transmitting at up to 100 mW and up to 300 kb/s, but you can change both of those values to fit your application. For example, you can maximize range by increasing the transmit power and reducing the data rate. Or you can reduce both for short-range wireless sensor networks that sip battery power.

3. Data Storage – Once collected at the base station it is converted to a format suitable to transfer to the cloud and then the data is stored in the Cloud, Django is used for this purpose. Its important features are:

   - Secure
   - Modular
   - Dynamic
   - Python Based.

4. Data Usage – In the cloud we store the data and this data is stored and represented visually using HTML and CSS.

6. Methodology:

- ❖ Initiation (requirements specification)
    - ▪ Listing of Hardware and Software Requirements
    - ▪ Selecting of Radio Modules
    - ▪ Selecting of Controllers
    - ▪ Selection of Battery and Management Systems
- ❖ Planning and design
    - ▪ Access Point Development (Hardware)
    - ▪ Node Development (Hardware + Software)
    - ▪ Node and Access Point Integration (Software)
    - ▪ Cloud Platform Development (Django)
    - ▪ User Interface Development (HTML, CSS)
- ❖ Execution (construction and coding)
    - ▪ Construction of needed Libraries for LoRa Mesh
    - ▪ Hardware Design and PCB Manufacturing
    - ▪ Integration of Code from Sensors till cloud
    - ▪ Django and Interface Integration Code
- ❖ Control and integration
    - ▪ PCB Assembly
    - ▪ Hardware Integration
- ❖ Validation (testing and debugging)
    - ▪ Testing and Debugging at every stage
    - ▪ Node and Access testing
    - ▪ Mesh Testing
    - ▪ Access Point with Cloud testing
    - ▪ Django Data Handling testing
    - ▪ User Interface to Hardware Connectivity and Control
- ❖ Closure (installation and maintenance)
    - ▪ Design of IPA rated Hardware Enclosure
    - ▪ Enclosure for various Sensors
    - ▪ 3D Printing of Enclosures

7. Hardware and Software Requirement

- ❖ Hardware:
  - ATMEGA 328P-PU
    - ➤ Low power consumption
    - ➤ Throughput up to 20 MIPS
  - RFM 96W (LoRa Radio Module)
    - ➤ Ultra-long Range
    - ➤ Low power Consumption
    - ➤ High Interference Immunity
  - NodeMcu 1.0
    - ➤ Open Source Platform
    - ➤ Wi-Fi SoC from Espressif Systems
  - WIFI Hotspot
    - ➤ Remote monitoring
  - Battery Management Systems
    - ➤ battery protection circuitry
  - Battery
  - 3D Printer
- ❖ Software:
  - Arduino IDE
    - ➤ Integrated Development Environment
    - ➤ functions from C and C++
    - ➤ Used to write and upload programs to Arduino compatible boards.
  - KiCad
    - ➤ Integrated environment for schematic capture and PCB layout design.
    - ➤ Easy and robust development.
  - Espressif IDE
    - ➤ Easier inbuilt feature modifications of Espressif gateway.
  - TinkerCad

8. Results and Analysis:

❖ We have made some simple range tests under the following conditions:

- rf96_node connected to a Monopole antenna.
- rf96_gateway connected to 17.3cm 1/4 wavelength antenna at 1m height, no ground plane.
- Both configured for 13dBm, 434MHz, Bw = 125 kHz, Cr = 4/8, Sf = 4096chips/symbol, CRC on. Slow + long range
- Minimum reported RSSI seen for successful comms was about -4
- Range over flat ground through heavy trees and vegetation approx. 2km.
- At 20dBm (100mW) otherwise identical conditions approx. 3km.
- At 20dBm, along salt water flat sandy beach, 3.2km.

❖ Leaf Sensor Development results:
- At 5v Vcc connected to sensor
- At no moisture 2.26volts
- At dry hand 1.7volts
- Fully wet conditions 0.6volts

9. Budget:

Sr. No.	Components	Price(₹)
1	**Node**	
1.1	RFM 96W LORA Module	340
1.2	ATMega 328P-AU	110
1.3	Battery (18650)	150
1.4	Sensor (Soil Moisture, Temperature, EC)	150
2	**Access Point**	
2.1	RFM 96W LORA Module	340
2.2	ESP-8266 NODE MCU	280
2.3	Battery (18650) - 3P	240
2.4	Sensor (UV Intensity, Light Intensity, Air Parameters)	1000
2.5	Battery Management System	300
2.6	LCD 16*2	150
2.7	SMPS Buck Converter	150
3	**Other components, packaging, wires, etc.**	1000
	TOTAL	**₹4210**

10.Applications

❖ Farming

       PRECIFARM is a precision agriculture organization focused on ultra-modern agronomic solutions while specializing in the management of precision irrigation.

❖ Smart Greenhouses

This design intelligently monitors as well as controls the climate, eliminating the need for manual intervention.

For controlling the environment in a smart greenhouse, different sensors that measure the environmental parameters according to the plant requirement are used. We can create a cloud server for remotely accessing the system when it is connected using IoT.

This eliminates the need for constant manual monitoring. Inside the greenhouse, the cloud server also enables data processing and applies a control action. This design provides cost-effective and optimal solutions to the farmers with minimal manual intervention.

11.Implementation Plan

Month	Work Plan
July 2019	Listing Features and Sensor Requirements
Aug 2019	Making of Components Lists
Sept 2019	Starting with master node (Hardware and Programming)
Oct 2019	Code for master Station
Nov 2019	Node Module Design And code
Dec 2019	Implementing LoRa Mesh And Setting up Mesh with master
Jan 2020	Starting with Cloud
Feb 2020	Frontend & Backend
Mar 2020	Integration and Packaging

References :

- **Precision Agriculture (2019) 20:926–958**:
  https://doi.org/10.1007/s11119-018-09624-8

- **LoRa Mesh Network Documentation:**
  https://nootropicdesign.com/projectlab/2018/10/20/lora-mesh-networking/

- **Iot in Agriculture:**
  https://www.iotforall.com/iot-applications-in-agriculture/

- **MEC10 ECE SENSOR DATASHEET**:
  http://www.infwin.com/manage_zheqin/ewebeditor5_5/attachment/20170718114523993.pdf

- **LORA Module**:
  http://www.open-sensing.org/lorablog/2017/2/28/working-with-adafruit-rfm9x-lora-radio-transceiver-modules

- **Django Documentation**:

  https://docs.djangoproject.com/en/2.2/intro/

- **GitHub links:**

  https://github.com/sandeepmistry/arduino-LoRa

  https://github.com/nootropicdesign/lora-mesh

  https://github.com/rptshri/Project_Major

  https://github.com/rptshri/Project-Major-Documentation

Project Guide:

Prof. G.H.CHAVAN