SMART AGRICULTURE USING LORAWAN

This project report is submitted to
Yeshwantrao Chavan College of Engineering
(An Autonomous Institution Affiliated to Rashtrasant Tukdoji Maharaj Nagpur University)
In partial fulfilment of the requirement for the award of the degree

Of

Bachelor of Technology in Electronics & Telecommunication Engineering

by

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Prachi Jadhav
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Under the guidance of

Prof. R. P. Deshmukh

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YESHWANTRAO CHAVAN COLLEGE OF ENGINEERING,
(An autonomous institution affiliated to Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur)
NAGPUR – 441 110
2023-2024

CERTIFICATE OF APPROVAL

This is to Certify that the project report entitled "**Smart Agriculture Using LoRaWAN**" has been successfully completed by **Saylee Kelkar, Prachi Jadhav, Pranjal Kamdar, Vidhi Budhe** under the guidance of **Prof. R. P. Deshmukh** in recognition to the partial fulfilment for the award of the degree of Bachelor of Technology in Electronics & Telecommunication Engineering, **Yeshwantrao Chavan College of Engineering** ***(An Autonomous Institution Affiliated to Rashtrasant Tukdoji Maharaj Nagpur University)***

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DECLARATION

We hereby declare that

b. The work contained in this project has been done by us under the guidance of my supervisor.
c. The work has not been submitted to any other Institute for any degree or diploma.
d. We have followed the guidelines provided by the Institute in preparing the project report.
e. We have conformed to the norms and guidelines given in the Ethical Code of Conduct of the Institute.
f. Whenever we have used materials (data, theoretical analysis, figures, and text) from other sources, we have given due credit to them by citing them in the text of the report and giving their details in the references. Further, we have taken permission from the copyright owners of the sources, whenever necessary.

ABSTRACT

In an era characterized by population growth, climate uncertainties, and the imperative of sustainable practices, agriculture is central to innovation. This project presents an intelligent farming system designed to elevate traditional farming methodologies through the integration of cutting-edge technologies. Utilizing an ESP8266 microcontroller, LoRa module, DHT sensor, and LoRaWAN communication, this system provides farmers with an unprecedented view of their agricultural landscape.

The project focuses on creating a connected ecosystem where environmental parameters critical to crop health, such as temperature and humidity, are monitored in real-time. The ESP8266 microcontroller organizes seamless communication between the LoRa module, responsible for long-distance data transmission, and the DHT sensor, facilitating accurate data collection.

LoRaWAN technology, known for its efficiency in communication in a wide area, forms the backbone of the system and ensures connectivity across large agricultural areas. Through a carefully crafted hardware setup and intuitive programming logic, this intelligent farming system becomes an invaluable tool for farmers who want to optimize resource use, increase yields and adopt sustainable farming practices.

This abstract summarizes not only the technological prowess built into the design and operation of the system but also the overarching goal of empowering farmers. By fostering a symbiotic relationship between technology and agriculture, the project envisions a future where precision agriculture is not only achievable but affordable, contributing to the global effort for a resilient and sustainable food production system. The following sections delve into the intricate details of the system's construction, its working principles, and its potential benefits to the agricultural landscape.

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Chapter 1
Introduction

1.1 Introduction

In the contemporary era, agriculture stands at the intersection of tradition and technology, facing the challenges of feeding a growing global population while navigating the complexities of climate change. In response to these challenges, this project introduces a Smart Agriculture System designed to revolutionize traditional farming practices by leveraging the power of the Internet of Things (IoT) and Long-Range Wide Area Network (LoRaWAN) technology.

The essence of this project lies in the fusion of hardware and software components, including the ESP8266 Microcontroller, LoRa module, DHT sensor, and antenna, to create a comprehensive and efficient solution for precision farming. Through the implementation of this system, farmers gain the ability to monitor and manage crucial environmental factors such as temperature and humidity in real-time, facilitating informed decision-making and resource optimization.

The ESP8266 microcontroller serves as the brain of the system, orchestrating the seamless integration of the LoRa module for long-range communication and the DHT sensor for accurate environmental data collection. The utilization of LoRaWAN ensures connectivity across expansive agricultural landscapes, overcoming the limitations of traditional communication methods. As we delve into the construction and working principles of this Smart Agriculture System, it becomes evident that the project is not just about technological innovation but about empowering farmers with the tools needed to enhance productivity, conserve resources, and embrace sustainable farming practices. By bridging the gap between physical and digital agriculture, this system offers a glimpse into the future of Smart and connected farming. In the subsequent sections, we will explore the intricacies of constructing this system, detailing the connections between components, the programming logic of the microcontroller, and the utilization of LoRaWAN for efficient data transmission. Additionally, we will delve into the anticipated benefits of such a system, ranging from increased crop yields to more environmentally conscious farming practices.

In essence, the Smart Agriculture System presented in this project represents a holistic approach to addressing the challenges faced by the agricultural sector. By bringing together technology and agriculture, we aim to contribute to a future where farming is not only sustainable and efficient but also technologically advanced and responsive to the dynamic needs of our global food system.

1.2 Overview

The smart agriculture project involves the use of LoRaWAN technology with ESP8266, DHT sensor, and LoRa module to monitor and control environmental conditions in agricultural settings. The ESP8266 with the DHT sensor is used to collect temperature and humidity data, which is then transmitted wirelessly using the LoRa module to a gateway.

The gateway receives the sensor data and forwards it to a cloud platform for storage and analysis. The cloud platform processes the data and provides insights to farmers through a web or mobile application.

The project also includes plans to expand the system by adding a soil moisture sensor and motor on/off functionality using a relay module. This expansion will allow farmers to monitor soil moisture levels and remotely control irrigation systems, improving water efficiency in agriculture.

Overall, the smart agriculture project aims to help farmers make informed decisions about their crops, reduce water usage, and improve overall crop yield.

1.3 Problem Statement

"Current agricultural practices do not use real-time monitoring, as it limits farmers' ability to respond properly to environmental changes crucial for crop health. Additionally, remote areas face communication challenges, hindering the adoption of smart farming technologies. This project addresses these issues by developing a Smart Agriculture System utilizing ESP8266, LoRaWAN, and DHT sensor technologies. The goal is to empower farmers with real-time data, optimize resource usage, and enable sustainable cultivation practices, particularly in areas with limited connectivity."

1.4 Thesis Objective

The objective of this thesis is to develop a comprehensive system for smart agriculture using LoRaWAN technology, ESP8266, and various sensors to monitor and control environmental conditions in agricultural settings. The system aims to improve crop yield and efficiency by providing real-time data on temperature, humidity, and soil moisture levels, allowing farmers to make informed decisions about irrigation and crop management. Additionally, the thesis aims to explore the scalability and feasibility of the system for large-scale agricultural operations, as well as its potential for integration with other smart technologies in agriculture.

1.5 Thesis Overview

Chapter 1: Introduction

This chapter introduces the Smart Agriculture System, highlighting its significance in modern agriculture. It outlines the project's objectives, components, and the overarching goal of integrating technology with traditional farming practices.

Chapter 2: Review of Literature

This chapter provides an overview of existing literature related to smart agriculture, IoT technologies, and LoRaWAN. It establishes the context for the research and identifies gaps that the current project aims to address.

Chapter 3: Principal Components

Detailed descriptions of the key components used in the Smart Agriculture System are provided in this chapter. Each component, including the LoRa module, ESP8266, sensors, and other hardware, is discussed along with its technical specifications and functionalities.

Chapter 4: Work Done

This chapter outlines the assembly process and operational details of the Smart Agriculture System. It includes information on the system's construction, working principles, and the code used for its implementation.

Chapter 5: Results and Discussions

Here, the results obtained from the implementation of the Smart Agriculture System are presented and analyzed. Discussions on the system's performance, effectiveness, and potential improvements are provided based on the collected data and observations.

Chapter 6: Summary and Conclusion

The final chapter summarizes the key findings, contributions, and implications of the research. It also presents conclusions drawn from the study and offers recommendations for future work in the field of smart agriculture and IoT applications.

References

A list of all the sources cited throughout the thesis is provided in this section, ensuring academic integrity and acknowledging the contributions of previous research to the current study.

Social Utility

This section explores the societal benefits and implications of implementing the Smart Agriculture System, highlighting its potential to improve food security, resource efficiency, and sustainability in agricultural practices.

Appendix

CO-PO-MAPPING

This appendix provides a mapping of Course Outcomes (CO) to Program Outcomes (PO), demonstrating how the skills and knowledge gained from the thesis project align with the educational objectives of the academic program.

Chapter 2 Review of Literature

2.1 OVERVIEW

This chapter reviews the various literature survey done on Smart Agriculture Using LoRaWAN. This chapter also discussed the work done by other researcher in the field of Agriculture Methods .

2.2 LITERATURE SURVEY

The paper primarily focuses on the application of LoRa technology in smart agriculture, potentially limiting the scope of the discussion to this specific domain[1].
While it discusses various scenarios within smart agriculture where LoRa can be beneficial, it may not delve deeply into the technical challenges or limitations faced in implementing these solutions[1].

The paper focuses on modernizing traditional agricultural methods through smart agriculture using automation and IoT technologies [2].
It highlights the importance of IoT in applications such as crop growth monitoring, irrigation decision support, and overall crop productivity improvement [2].
The system aims to reduce the complexity of traditional irrigation methods by using sensors to gather data on soil humidity, temperature, and daily sunshine duration to calculate the required water quantity for irrigation [2].
By analyzing weather conditions and optimizing water and fertilizer usage, the system aims to improve crop productivity while reducing water wastage and manual labour in the fields [2].

Chapter 3 Principal Components

3.1 Principal Components of Project

A. LoRa Module SX1278 Ra-02

The term **LoRa** stands for **Long Range**. It is a **long-range, low power** wireless platform that has become the de-facto technology for **Internet of Things (IoT)** networks worldwide. LoRa is a spread spectrum modulation technique derived from c**hirp spread spectrum (CSS) technology**. LoRa was introduced by a company called Semtech.

Figure 1 : LoRa Technology Logo

LoRa modules do come in different frequency ranges, the most common being the **433MHz, 915MHz and 868MHz**. This LoRa technology can be used to transmit bi-directional information to long-distance **(15-20km)** without consuming much power. The technology can be utilized by public, private or hybrid networks and provides greater range than Cellular networks. LoRa Technology can easily plug into existing infrastructure and enables low-cost battery-operated IoT applications.

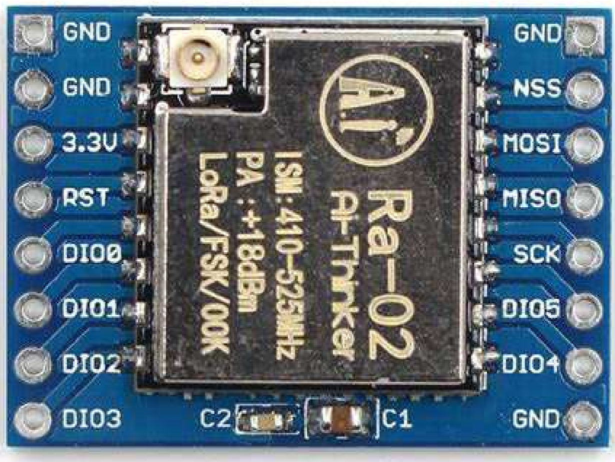

Figure 2: LORA Module SX1278 Ra-02

This Ai Thinker LoRa Series Ra-02 Spread Spectrum Wireless Module is a wireless transmission module based on SEMTECH's SX1278 wireless transceiver. It adopts advanced LoRa spread spectrum technology, with a communication distance of 10,000 meters. It has a strong ability of anti-jamming and has the function of air wake-up Consumption. Can be covering thousands of people in the district environment, particularly suitable for meter reading, smart home, burglar alarm equipment.

The LoRa series module Ra-01 is designed and developed by AI-THINKER Technology. The SX1278 RF module is mainly used for long-range spread spectrum communication. It can resist Minimize current consumption. Thanks to SEMTECH's patented LoRa modulation technology, the SX1278 has a high sensitivity of -148 dBm with a power output of +20 dBm, a long transmission distance and high reliability.

At the same time, compared with the traditional modulation technology, LoRa modulation technology has obvious advantages in anti-blocking and selection, which solves the problem that the traditional design scheme cannot consider the distance, interference and power consumption at the same time.

SX1278 Ra-02 Development Board Pinout Configuration:

Pin No.	Pin Label	Description
-	ANT	Antenna
1, 2	GND	Ground
3	3.3V	3.3V power supply
4	RESET	Reset
5	DIO0	Digital IO0, software configuration
6	DIO1	Digital IO1 software configuration
7	DIO2	Digital IO2 software configuration
8	DIO3	Digital IO3 software configuration
9	GND	Ground
10	DIO4	Digital IO 4-piece configuration
11	DIO5	Digital IO5 software configuration
12	SCK	SPI clock input
13	MISO	SPI data output
14	MOSI	SPI data input
15	NSS	SPI chip select input
16	GND	Ground

Table 1: LoRa Pin Description

The left circular pin is where antenna is interfaced with the LoRa module

Features :

1. LoRa Spread Spectrum modulation technology
2. Constant RF power output at + 20dBm-100mW voltage change
3. High sensitivity: down to -148dBm
4. Half-duplex SPI communication
5. Programmable bit rates up to 300kbps
6. Supports FSK, GFSK, MSK, GMSK, LoRa and OOK modulation modes
7. 127dB RSSI dynamic range
8. Automatic RF signal detection, CAD model, and very high-speed AFC
9. Packet engine with CRC up to 256 bytes
10. Small footprint dual-row stamp-hole patch package
11. Shielded housing

B. ESP NODE MCU

Figure 3: ESP8266-NodeMCU

The **ESP8266** is a low-cost Wi-Fi microprocessor that is made in Shanghai, China by Espressif Systems and includes integrated TCP/IP networking software and microcontroller functionality.

In August 2014, the chip gained popularity among English-speaking makers thanks to the ESP-01 module produced by Ai-Thinker, a third-party producer. With the help of this little module, microcontrollers can establish basic TCP/IP connections and connect to Wi-Fi networks by utilizing Hayes-style commands.

NodeMCU is an open-source development board and firmware with Lua programming specifically designed for Internet of Things applications. It consists of hardware based on the ESP-12 module and firmware running on Espressif Systems' ESP8266 Wi-Fi SoC.

NodeMCU is a low-cost, small and powerful open source IoT platform. It initially included firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which was based on the ESP-12 module. It is compatible with Arduino IDE and micro python making prototyping faster.

The ESP-12E module, which houses the ESP8266 chip with Tensilica Xtensa 32-bit LX106 RISC microprocessor, is included with the NodeMCU ESP8266 development board. This microprocessor runs at a configurable clock frequency of 80MHz to 160MHz and supports RTOS. For storing data and programs, NodeMCU contains 4MB of Flash memory and 128 KB of RAM. It is perfect for Internet of Things projects due to its powerful processing capacity, built-in Wi-Fi and Bluetooth, and Deep Sleep Operating capabilities.

A Micro USB jack and VIN pin (External Supply Pin) can be used to power NodeMCU. It has I2C, SPI, and UART interface capability.

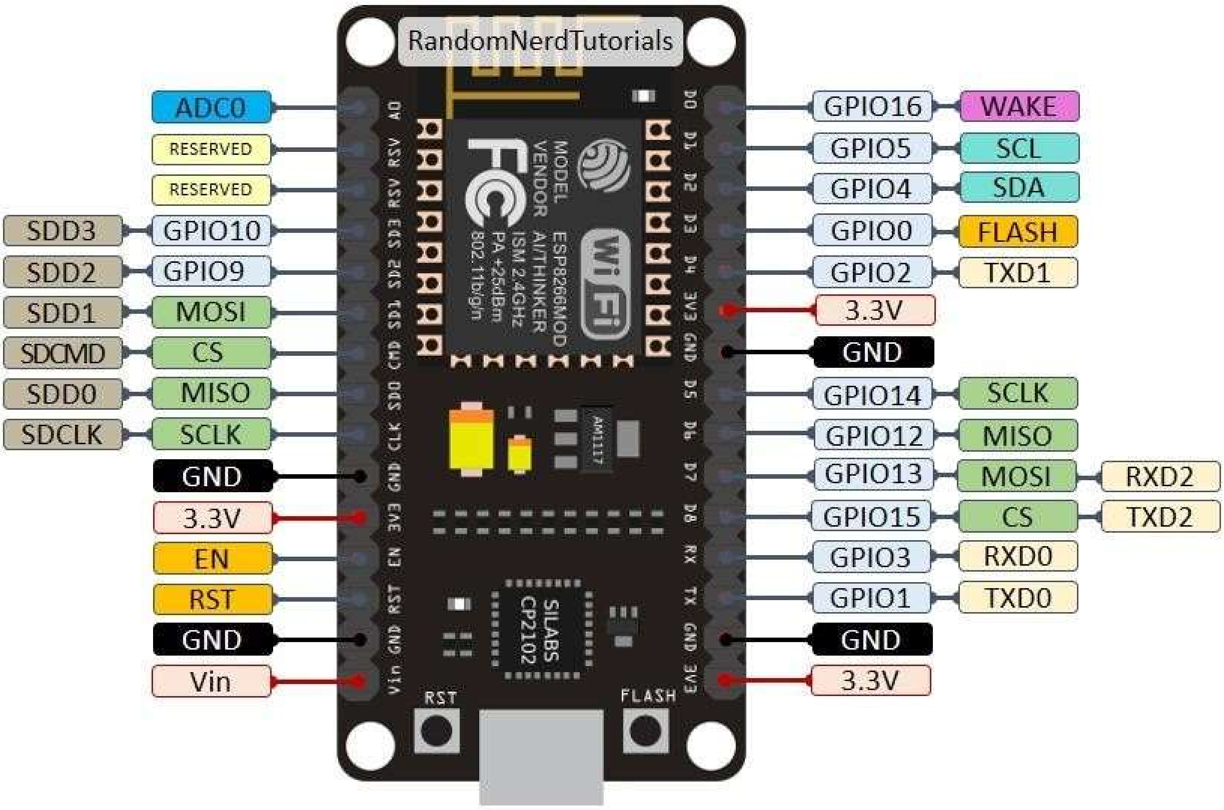

Figure 4: NodeMCU ESP8266 pinout

NodeMCU Development Board Pinout Configuration:

Pin Category	Name	Description
Power	Micro-USB, 3.3V, GND, Vin	**Micro-USB:** NodeMCU can be powered through the USB port **3.3V:** Regulated 3.3V can be supplied to this pin to power the board **GND:** Ground pins **Vin:** External Power Supply
Control Pins	EN, RST	The pin and the button reset the microcontroller
Analog Pin	A0	Used to measure analog voltage in the range of 0-3.3V
GPIO Pins	GPIO1 to GPIO16	NodeMCU has 16 general purpose input-output pins on its board
SPI Pins	SD1, CMD, SD0, CLK	NodeMCU has four pins available for SPI communication.
UART Pins	TXD0, RXD0, TXD2, RXD2	NodeMCU has two UART interfaces, UART0 (RXD0 & TXD0) and UART1 (RXD1 & TXD1). UART1 is used to upload the firmware/program.
I2C Pins		NodeMCU has I2C functionality support but due to the internal functionality of these pins, you have to find which pin is I2C.

Table 2: NodeMCU Pin Description

NodeMCU ESP8266 Specifications & Features

- Microcontroller: Tensilica 32-bit RISC CPU Xtensa LX106
- Operating Voltage: 3.3V
- Input Voltage: 7-12V
- Digital I/O Pins (DIO): 16
- Analog Input Pins (ADC): 1
- UARTs: 1
- SPIs: 1
- I2Cs: 1
- Flash Memory: 4 MB
- SRAM: 64 KB
- Clock Speed: 80 MHz

- USB-TTL based on CP2102 is included onboard, Enabling Plug n Play

C. ANTENNA

Figure 5: ANTENNA MT76813DBI Module

The MT76813DBI module is an integrated antenna solution developed by MediaTek for wireless communication applications. It incorporates both the antenna and the MT76813 chipset, offering a streamlined and efficient solution for connectivity needs. This module is designed with compactness in mind, making it suitable for deployment in space-constrained environments commonly found in IoT and smart device applications.

One of its key features is its high sensitivity, which ensures reliable communication even in challenging signal conditions. Additionally, it boasts low power consumption, making it energy-efficient and suitable for battery-powered devices. The MT76813DBI module is compatible with various wireless standards, including Wi-Fi and Bluetooth, allowing for seamless integration into a wide range of IoT, smart home, and industrial applications.

Overall, the MT76813DBI module provides a reliable, compact, and energy-efficient solution for wireless communication needs, making it an excellent choice for diverse IoT and smart device deployments.

Features :

1. Radome material: polyurethane
2. Flexible cable
3. Stable signal
4. Best for indoor applications.

Specifications:

Connector	IPX female to SMA-KY
Frequency(Hz)	900/1800
Gain(dB)	<3
VSWR	<1.5
Cable Length (cm)	14
Weight	0.07 kg
Dimensions	8 × 4 × 3 cm

Table 3: Specifications Of Antenna

D. DHT Sensor

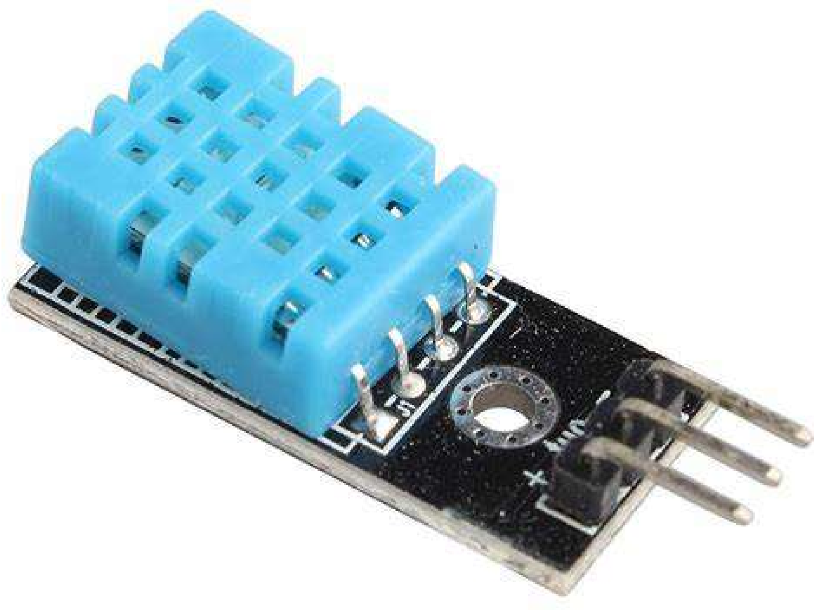

Figure 6: DHT Sensor

The DHT11 sensor is a popular digital temperature and humidity sensor.

The DHT11 sensor is a low-cost digital sensor capable of measuring both temperature and humidity with reasonable accuracy. It consists of a capacitive humidity sensor and a thermistor to measure temperature. The sensor communicates with microcontrollers via a single-wire digital interface, making it easy to integrate into projects.

Specifications:

- Temperature Range: 0°C to 50°C (±2°C accuracy)
- Humidity Range: 20% to 90% RH (±5% accuracy)
- Operating Voltage: 3.3V to 5V
- Current Consumption: <2.5mA during conversion
- Response Time: <5 seconds
- Sampling Rate: 1 reading every 2 seconds
- Dimensions: 12mm x 15.5mm x 5.5mm

Pinout:

The DHT11 sensor typically has three pins:

1. VCC: Connect to a 3.3V or 5V power supply.
2. Data: Digital data output pin for temperature and humidity readings.
3. GND: Connect to ground.

E. Soil Moisture Sensor

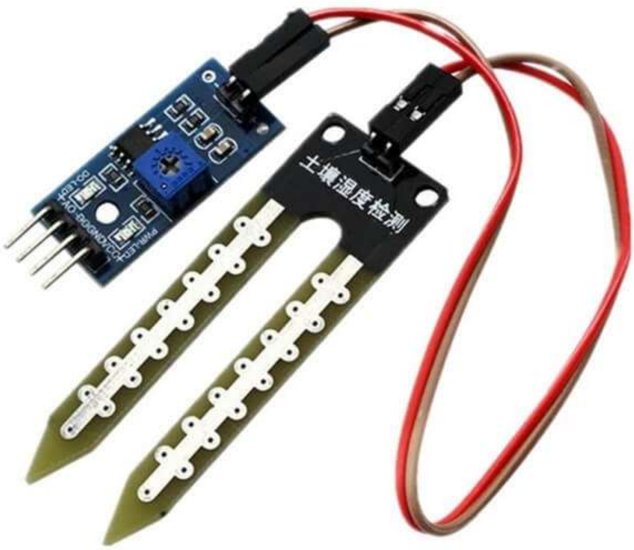

Figure 7: Soil Moisture Sensor

A Soil Moisture Sensor is one kind of low-cost electronic sensor that is used to detect the moisture of the soil. This sensor can measure the volumetric content of water inside the soil. This sensor is consisting of mainly two parts, one is Sensing Probs and another one is the Sensor Module. The probes allow the current to pass through the soil and then it gets the resistance value according to moisture value in soil. The Sensor Module reads data from the sensor probes and processes the data and converts it into a digital/analog output. So, the Soil Moisture Sensor can provide both types of output Digital output (DO) and Analog output(AO).

Features-

Safe and durable in both hot and freezing temperatures.
Measure within a range of 0 to 240 centibar (cb) or kilopascal (kPa).
Corrosion-resistant and made of high-grade stainless steel.
Internally compensated for commonly found salinity levels.

F. Relay

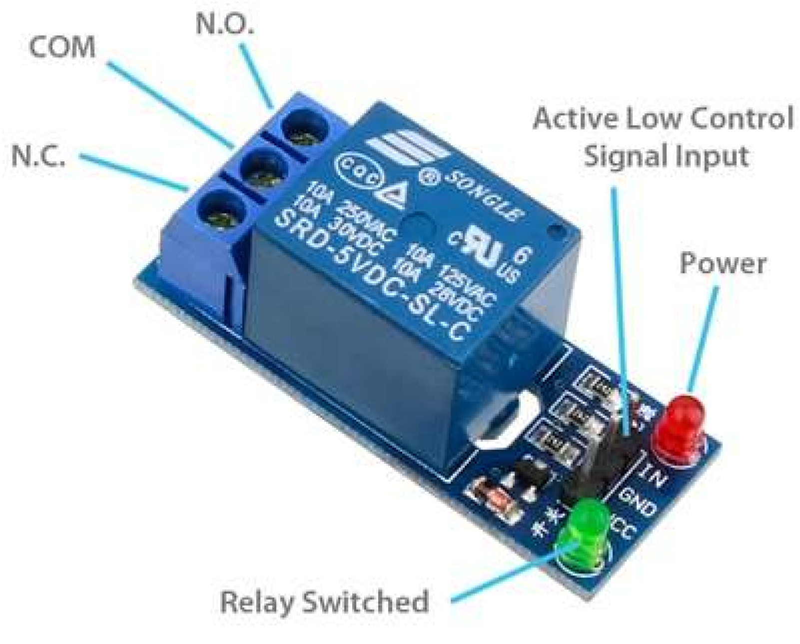

Figure 8: Relay

A Relay is a simple electromechanical switch. While we use normal switches to close or open a circuit manually, a Relay is also a switch that connects or disconnects two circuits. But instead of a manual operation, a relay uses an electrical signal to control an electromagnet, which in turn connects or disconnects another circuit.
Relays can be of different types like electromechanical, solid state. Electromechanical relays are frequently used. Let us see the internal parts of this relay before knowing

about it working. Although many different types of relays were present, their working is same.

Features-

Switching capacity: This refers to the maximum amount of electrical current and voltage that the relay can handle.
Contact resistance: This refers to the resistance of the contacts when they are closed. Low contact resistance is desirable for high-current applications.
Bounce time: Bounce time refers to the time it takes for the contacts to stabilize after closing or opening.

G. Water Pump

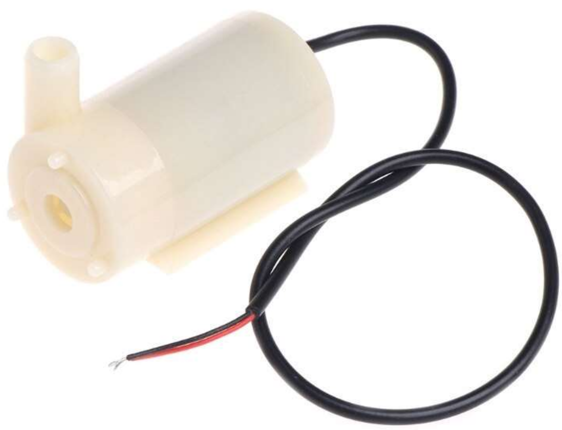

Figure 9: Water Pump

A water pump is an electromechanical machine used to increase the pressure of water to move it from one point to another. Modern water pumps are used throughout the world to supply water for municipal, industrial, agricultural, and residential uses.
Pumps are used to move fluids from one point to another. This can include moving water for irrigation, pumping oil or gas for transportation or industrial processes, moving air in vacuum cleaners, and many other applications. Pumps are essential in many industries and are used in a wide range of applications.

Features –

Pumps can be single-stage or multi-stage.
Single-stage models have one impeller which sucks up and pumps the water; multi-stage models have several impellers.
The advantage of pump is that the water pressure is progressively increased by each impeller.

H. OLED Display

Figure 10 : OLED Display

OLED (Organic Light-Emitting Diode) is a self light-emitting technology composed of a thin, multi- layered organic film placed between an anode and cathode. In contrast to LCD technology, OLED does not require a backlight. OLED possesses high application potential for virtually all types of displays andis regarded as the ultimate technology for the next generation of flat-panel display. It is 128x64-Blue-I2C-OLED-Display.

This 2.44 cm (0.96 Inch) I2C/IIC 4pin OLED Display Module BLUE can be interfaced with any microcontroller using SPI/IIC/I2C protocols. It is having a resolution of 128x64. The package includesdisplay board, display, 4 pin male header pre-soldered to board.

OLED monochrome 128x64 dot matrix display module. The characteristics of this display module arehigh brightness, self-emission, high contrast ratio, slim/thin outline, wide viewing angle, wide temperature range and low power consumption.

There are four pins in this display. Imprinted as VCC, GND, SCL, and SDA respectively. The VCC and GND pins will power the OLED display and will be connected with the ESP board's power supply pins as they require a driving voltage of 3.3-5V. The SCL and SDA pins are necessary for generating the clock signal and in the transmission of data respectively. Both of these pins will be connected with the I2C pins of the ESP8266 board.

Specifications:-

- OLED Driver IC: SSD1306
- Resolution: 128 x 64
- Visual Angle: >160°
- Display Color: Area Color (White)
- Input Voltage: 3.3V ~ 6V
- Compatible I/O Level: 3.3V, 5V
- Only Need 2 I/O Port to Control
- Full Compatible with Arduino
- Working temperature: -30°C ~ 70°C
- Interface: I2C

3.2 Software Details

A. Arduino IDE Software

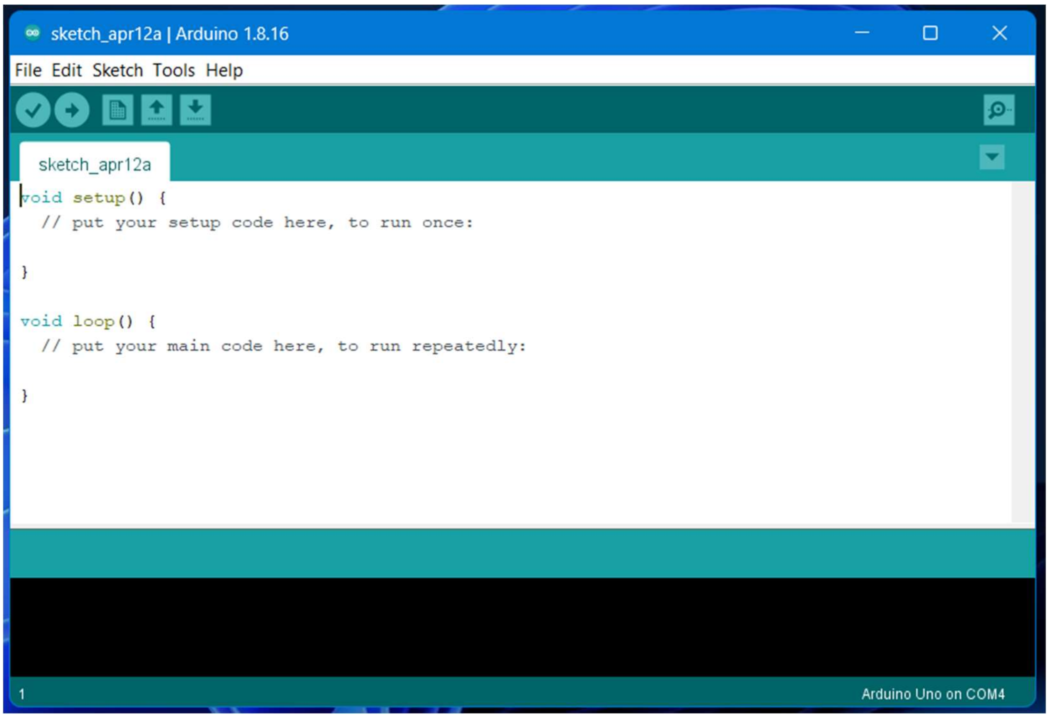

Figure 11: Arduino IDE Software

The Arduino Integrated Development Environment (IDE) encompasses a text editor for writing code, it connects to the Arduino and Genuino hardware to upload programs and transmit with them . The programs are written using IDE are knows as sketches. And the file extension of the program is ".ino". Like other editors, Arduino IDE has also featured for cutting/pasting and for searching/replacing text. The console of IDE provides error messages and other information, and the bottom right-hand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor .

B. BLYNK IOT

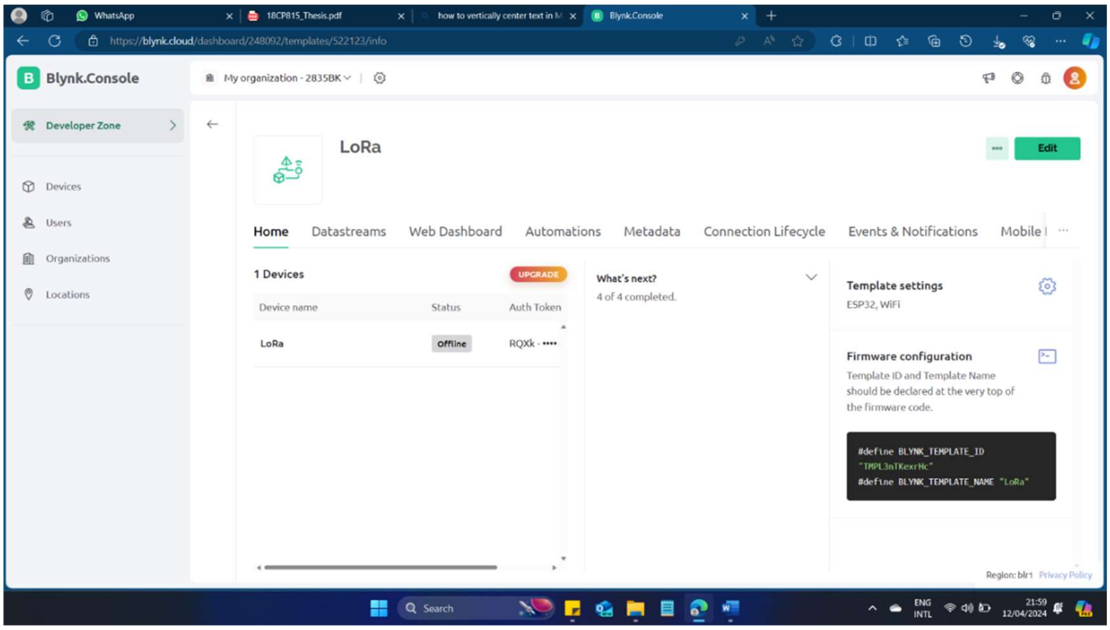

Figure 12: BLYNK IOT SOFTWARE

Blynk empowers users to build Internet of Things (IoT) applications without needing to be a coding expert. It achieves this through a visual programming interface. Instead of writing lines of code, you simply drag and drop widgets to design the user interface (UI) for your IoT application on your smartphone or web browser. Blynk also boasts impressive hardware compatibility. Forget limitations - Blynk offers open-source libraries that work with a wide range of popular development boards like Arduino, ESP32, and Raspberry Pi. This gives you the freedom to choose the hardware that best suits your project. To control your IoT devices and see real-time sensor data, Blynk provides a dedicated mobile app for iOS and Android. Finally, Blynk offers a choice for data storage. You can leverage their free cloud service for communication and remote access, or opt for the additional security and control of deploying your own private Blynk server. With its combination of user-friendly visual programming, extensive hardware support, mobile app, and flexible cloud/server options, Blynk simplifies the process of building IoT applications, making it attractive for both beginners and experienced developers.

Chapter 4 Work Done

Assembly of Project

The assembly of the project consist of mainly two nodes transmitter node and the receiver node

The transmitter node transmits the data to the receiving node.

Following shows the assembly of the transmitter node:-

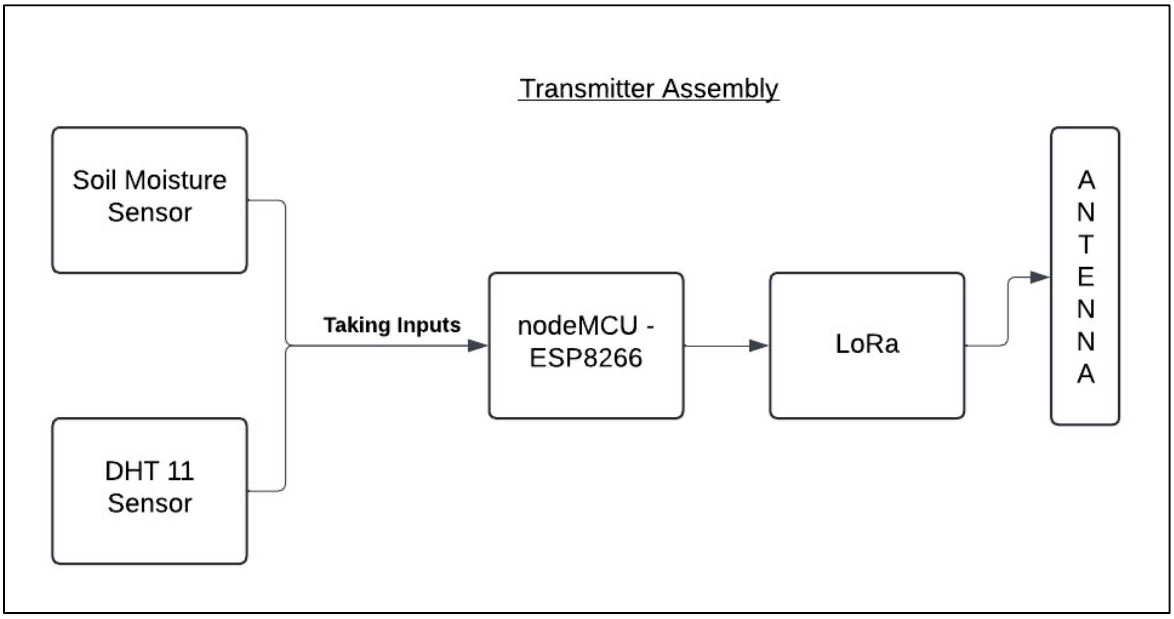

Figure 13: Transmitter assembly

It consists of the NodeMCU which is ESP8266 Microcontroller Unit.

Further this microcontroller unit takes data from various sensors .

These sensors are DHT sensor and the Soil Moisture Sensor.

DHT sensor is a Digital Humidity Temperature sensor which is a digital component takes the data digitally of Temperature and Humidity of the atmosphere.

Further this NodeMCU which is ESP8266 Microcontroller Unit interprets the data collected from the sensors and transmits the data in real time to the Lora Ra-02 module which is then connected to the antenna transmits the data in the packets format.

Following shows the assembly of the receiver node:-

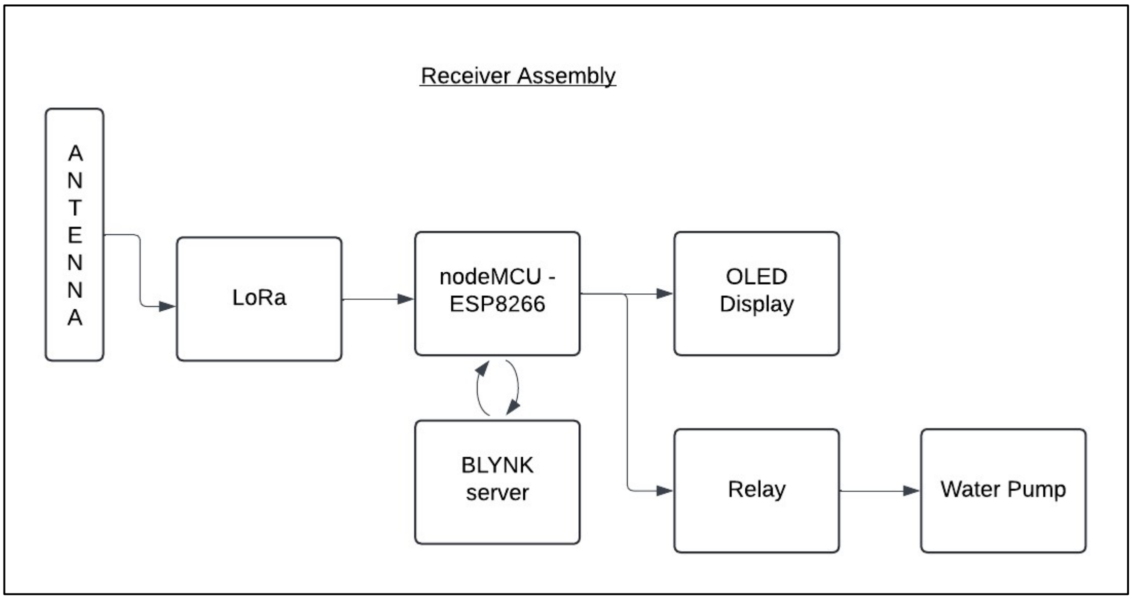

Figure 14: Receiver assembly

It consists of the Antenna which acts as a receiver which takes the encoded data transmitted by the transmitter through the lora Ra-02 module which then transmit it forward towards NodeMCU which is ESP8266 Microcontroller Unit.

This ESP 8266 decodes the data and then interprets it finally display it to the OLED Display and according to the inputs gives command to the switch and it turns on the Water pump which is motor.

NodeMCU is an WIFI enabled module and is connected to the server .

In this case the Module is connected to the Blynk server and sends time the real time data.

Which will eventually beneficial to the modern farming to monitor the agriculture field.

For the working of the project first we have done the following steps:

i. Interfacing of Antenna with LoRa

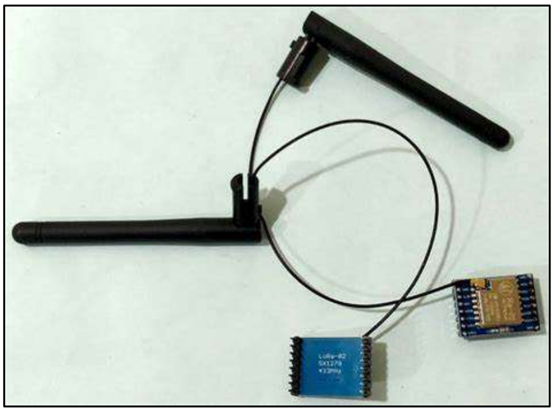

Figure 15 : Interfacing Of Antenna with LoRa

We have assembled the LoRa device with the antenna soldered the LoRa Module as shown in above figure[15].

All the rings of the antenna properly fitted in and it is linked with the LoRa device to the top left corner as shown in figure[15].

ii. Interfacing Of Soil Moisture Sensor with nodeMCU ESP8266

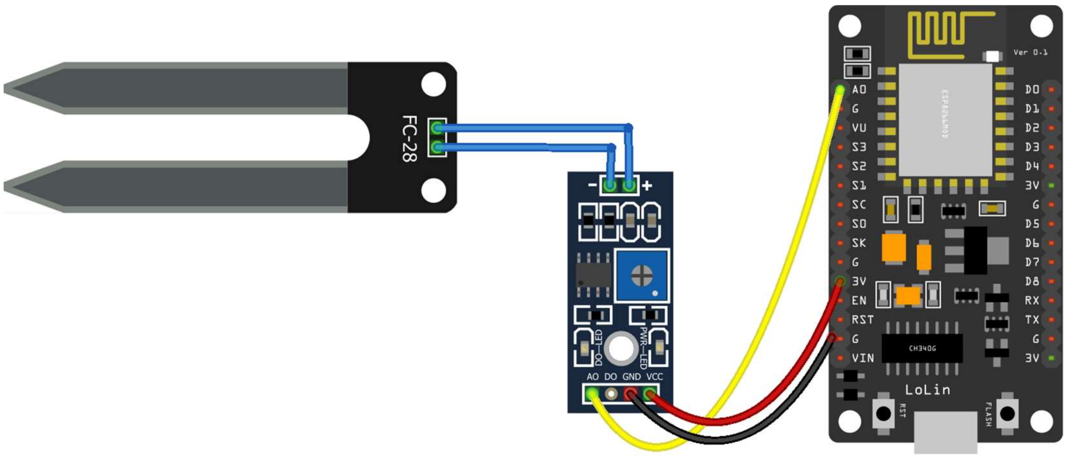

Figure 16: Interfacing of soil moisture sensor with nodeMCU ESP8266

We have interfaced the Soil-Moisture sensor with nodeMCU ESP8266 as shown in figure[16] .

We have also checked whether its properly working or not with online simulation with the interfaced modules and the code.

iii. Interfacing Of DHT-11 Sensor with nodeMCU ESP8266

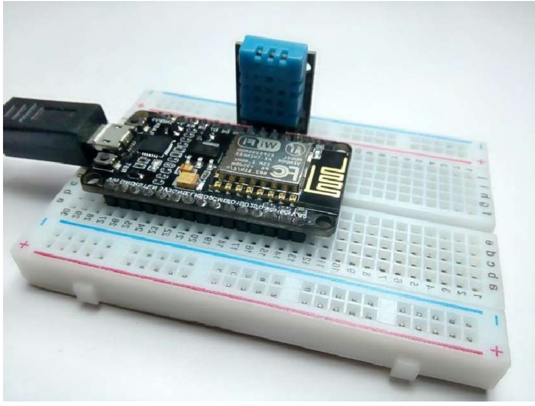

Figure 17: Interfacing Of DHT11Sensor with nodeMCU ESP8266

We have interfaced the DHT-11 with nodeMCU ESP8266 as shown in figure[17] .
We have also checked whether its properly working or not with online simulation with the interfaced modules and the code.

iv. Interfacing Of OLED display with nodeMCU ESP8266

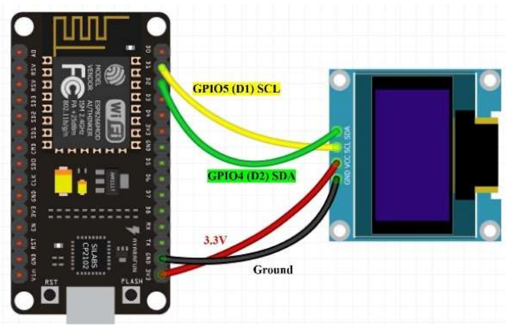

Figure 18: Interfacing OLED Display with nodeMCU ESP8266

We have interfaced the OLED Display with nodeMCU ESP8266 as shown in figure[18] .
We have also checked whether its properly working or not with online simulation with the interfaced modules and the code.

v. Interfacing Of Relay with nodeMCU ESP8266

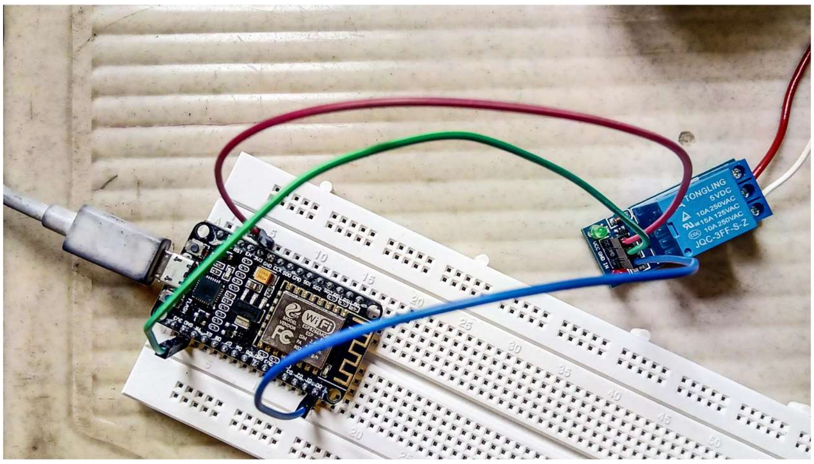

Figure 19: Interfacing of relay with nodeMCU ESP8266

We have interfaced the Switched Relay with LED and with nodeMCU ESP8266 as shown in figure[19] .

We have also checked whether its properly working or not with online simulation with the interfaced modules and the code.

vi. Interfacing Of Water pump with relay and nodeMCU ESP8266

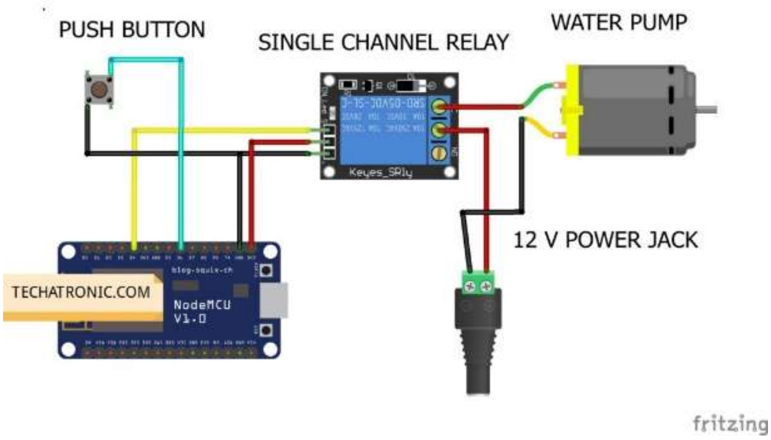

Figure 20: Interfacing Of Water pump with relay and nodeMCU ESP8266

We have interfaced the Switched Relay with Water Pump (here motor) and with nodeMCU ESP8266 as shown in figure[20] .

We have also checked whether its properly working or not with online simulation with the interfaced modules and the code.

vii. Interfacing between nodeMCU ESP8266 and LoRa Ra-02

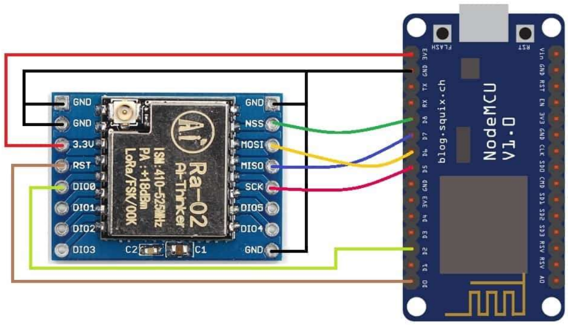

Figure 21:Interfacing between nodeMCU ESP8266 and LoRa Ra-02

We have interfaced LoRa Ra-02 module with nodeMCU ESP8266 as shown in figure[21].

We have also checked whether its properly working or not with online simulation with the interfaced modules and the code.

viii. Communication between two LoRa Modules

After doing all these steps finally we assembled the project in hardware and software also.

Firstly, we combined the component in circuit diagram and after that we have combined the hardware.

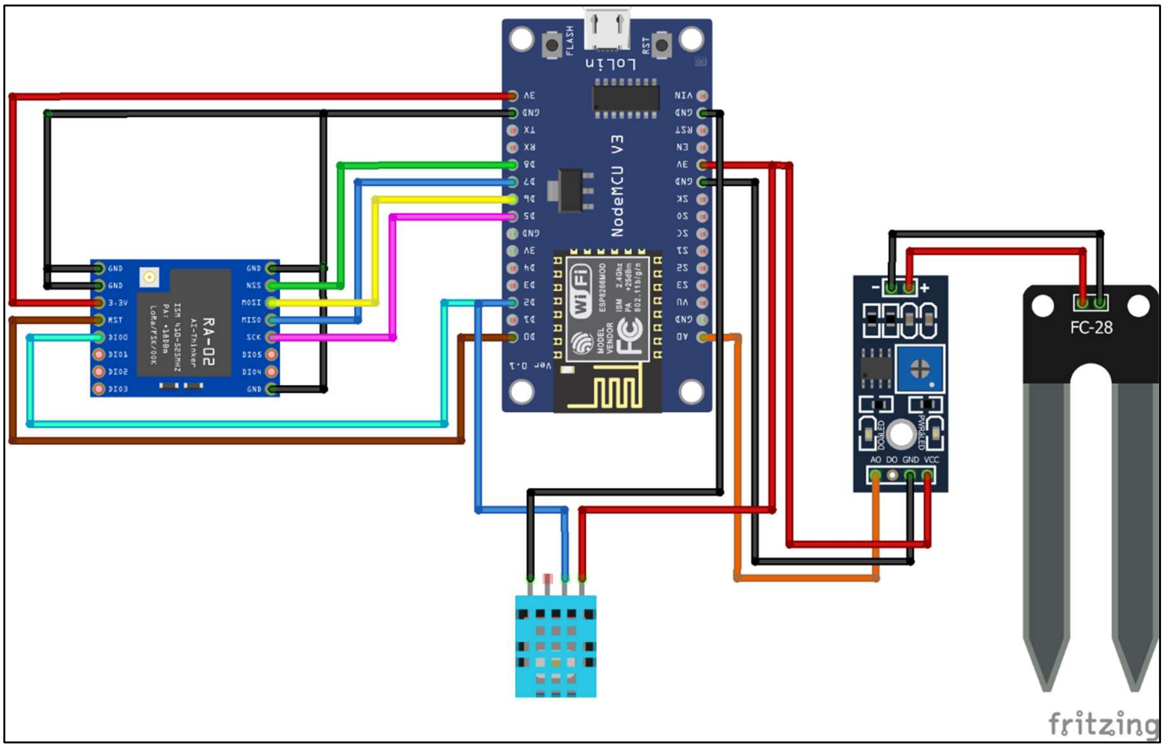

Figure 22: Circuit Diagram Of the Transmitter

The Figure[22] is the transmitter module in which the data is sensed through the nodeMCU(Micro Controller Unit) transfer it to the LoRa and it sends in to the receiver.

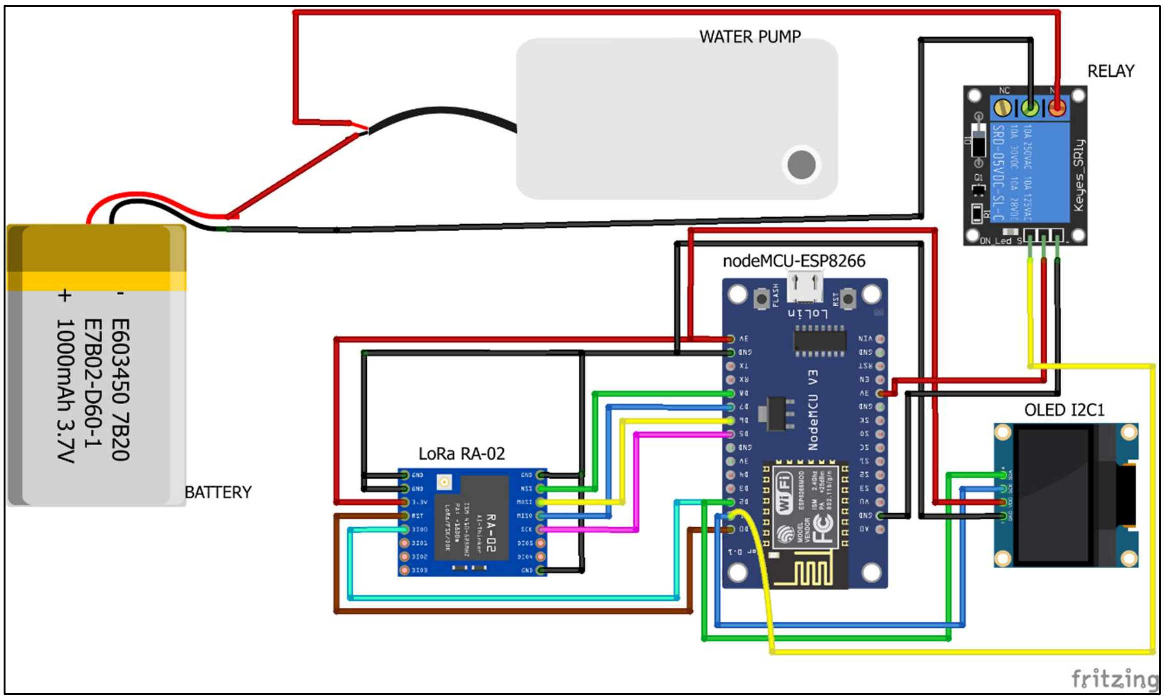

Figure 23: Circuit Diagram Of the Receiver

As shown in the above figure[23] , the sensed data is received through the LoRa Ra-02 module and it transfers the data to the ESP8266 this device interprets the data and shows the real time values in the OLED display. It is also linked with the Blynk IOT web server and application the same real time data is displayed over there also. The real time Agriculture field monitoring is done through this project which was the main objective of this project and It can also control the Motor through the Blynk Website and Application and irrigate the agricultural field.

Working

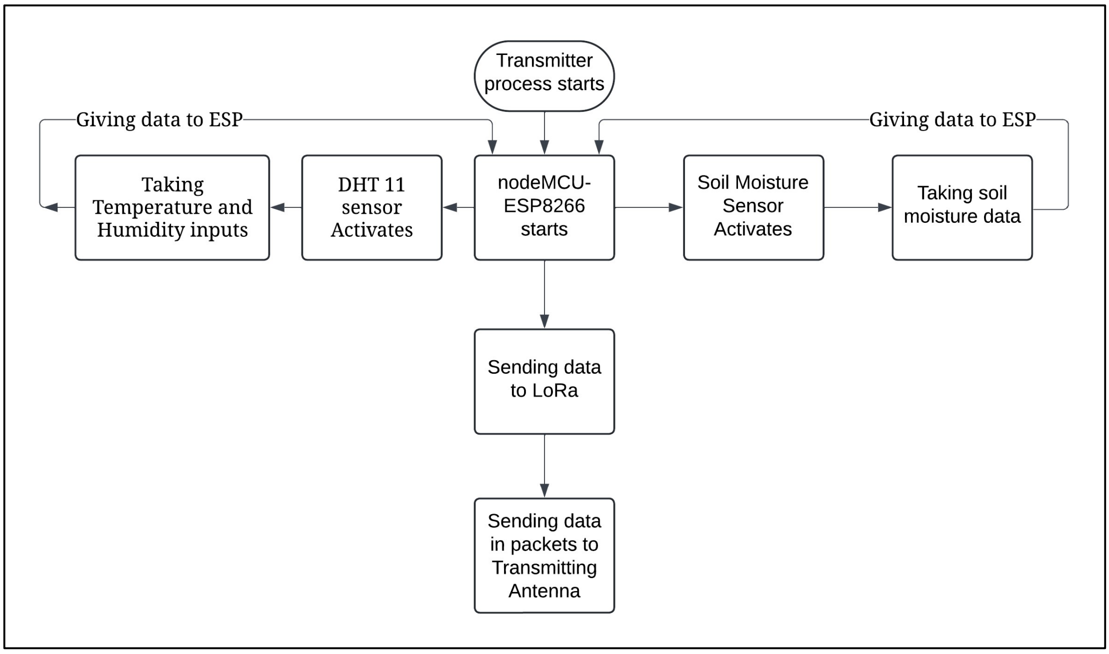

Figure 24: Block Diagram of the Transmitter

The working of the project is done successfully after assembling it in the software simulation the hardware modelling and dumping the code to the code to the nodeMCU ESP8266.

It consists of the NodeMCU which is ESP8266 Microcontroller Unit.

Further this microcontroller unit takes data from various sensors .

These sensors are DHT sensor and the Soil Moisture Sensor.

DHT sensor is a Digital Humidity Temperature sensor which is a digital component takes the data digitally of Temperature and Humidity of the atmosphere.

Further this NodeMCU which is ESP8266 Microcontroller Unit interprets the data collected from the sensors and transmits the data in real time to the Lora Ra-02 module which is then connected to the antenna transmits the data in the packets format.

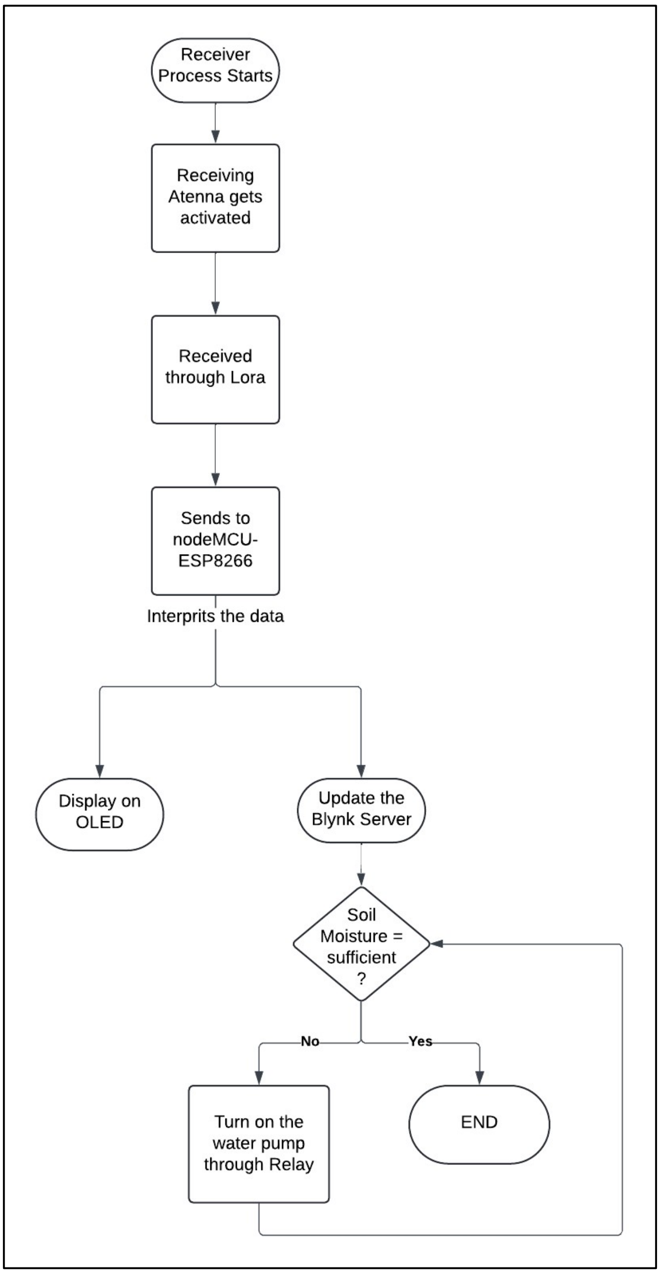

Figure 25: Block Diagram of the Receiver

It consists of the Antenna which acts as a receiver which takes the encoded data transmitted by the transmitter through the lora Ra-02 module which then transmit it forward towards NodeMCU which is ESP8266 Microcontroller Unit.

This ESP 8266 decodes the data and then interprets it finally display it to the OLED Display and according to the inputs gives command to the switch and it turns on the Water pump which is motor.

NodeMCU is an WIFI enabled module and is connected to the server .

In this case the Module is connected to the Blynk server and sends time the real time data.

Which will eventually beneficial to the modern farming to monitor the agriculture field.

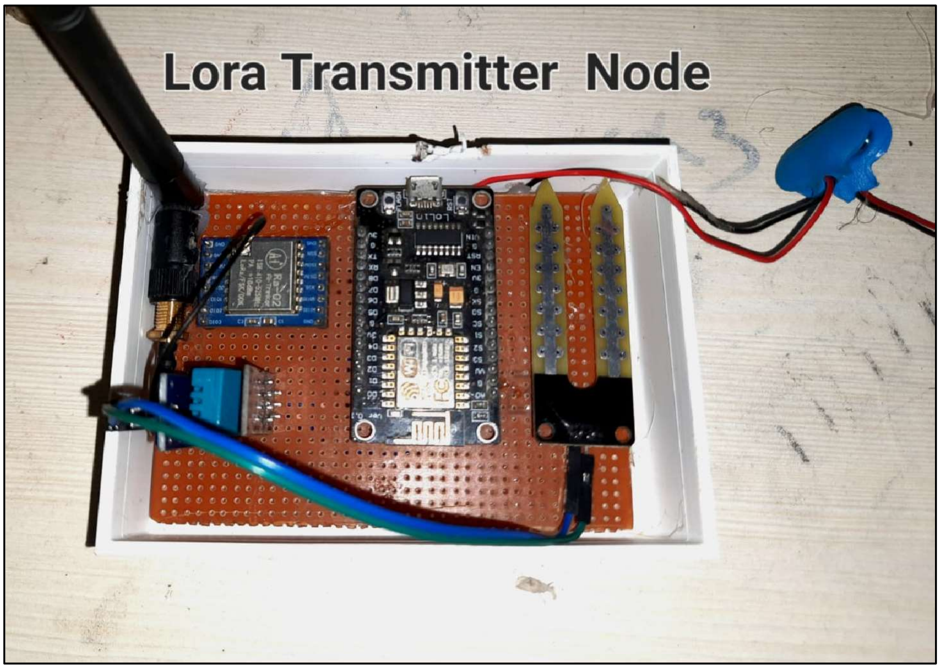

Figure 26: Hardware of Transmitter Module

Figure 27: Hardware of Receiver Module

These are the Hardware working images of our project “Smart Agriculture Using LoRaWAN”.

Working Code Of the Project

A. Transmitter code

```
//trans. #include <Wire.h>
#include <SPI.h>
#include <LoRa.h>
#include <DHT.h>
#define DHTPIN 2        // pin where the DHT22 is connected
#define SOIL_MOISTURE_PIN A0  // analog pin where the soil moisture sensor is
connected
#define DHT_TYPE DHT11

DHT dht(DHTPIN, DHT_TYPE);
#define ss 15
#define rst 16
#define dio0 4
String LoRaMessage = "";
int counter = 0;
void setup() {
  Serial.begin(115200);
  dht.begin();
  pinMode(SOIL_MOISTURE_PIN, INPUT);
  while (!Serial);
  Serial.println("LoRa Sender");
  LoRa.setPins(ss, rst, dio0);
  if (!LoRa.begin(433E6)) {
    Serial.println("Starting LoRa failed!");
    delay(100);
    while (1);
  }
}
void loop() {
  float h = dht.readHumidity();
  float t = dht.readTemperature();
  if (isnan(h) || isnan(t)) {
    Serial.println("Failed to read from DHT sensor!");
    return;  }
  int soilMoisture = analogRead(SOIL_MOISTURE_PIN);
  Serial.print("Temperature: ");
  Serial.print(t);
  Serial.println("°C");
  Serial.print("Humidity: ");
  Serial.print(h);
  Serial.println("%");
  Serial.print("Soil Moisture: ");
  Serial.println(soilMoisture);
  Serial.println("");
  Serial.print("Sending packet: ");
  Serial.println(counter);
  LoRaMessage = String(counter) + "@" + String(t) + "$" + String(h) + "%" +
String(soilMoisture) ;
  // send packet
```

```
  LoRa.beginPacket();
  LoRa.print(LoRaMessage);
  LoRa.endPacket();
  counter++;
  delay(1500); }
```

B. Receiver code

```
#define BLYNK_TEMPLATE_ID "TMPL3nTKexrHc"
#define BLYNK_TEMPLATE_NAME "LoRa"
#define BLYNK_AUTH_TOKEN "RQXkBMmEryEUPige-xGTr-9ooGGDMmGC"

#include <SPI.h>
#include <LoRa.h>
#include <Adafruit_Sensor.h>
#include <Adafruit_GFX.h>
#include <Adafruit_SSD1306.h>
#include <ESP8266WiFi.h>
#include <ESP8266WebServer.h>
#include <BlynkSimpleEsp8266.h>

#define ss 15
#define rst 16
#define dio0 4

#define SCREEN_WIDTH 128
#define SCREEN_HEIGHT 64
#define OLED_RESET -1
Adafruit_SSD1306 display(SCREEN_WIDTH, SCREEN_HEIGHT, &Wire,
OLED_RESET);

const char *ssid = "Galaxy S";
const char *password = "Frequency";
const char *blynkAuthToken = "RQXkBMmEryEUPige-xGTr-9ooGGDMmGC";

ESP8266WebServer server(80);

String receivedTemperature;
String receivedHumidity;
int receivedSoilMoisture; // Variable to hold received soil moisture data

BlynkTimer timer;

const int relayPin = 2; // GPIO pin to which the relay is connected

void setup()
{

  Serial.begin(115200);
  delay(100);
   digitalWrite(relayPin,HIGH);
  Serial.println("Connecting to ");
  Serial.println(ssid);
```

```
  WiFi.begin(ssid, password);
  while (WiFi.status() != WL_CONNECTED)
  {
    delay(1000);
    Serial.print(".");
  }

  Serial.println("");
  Serial.println("WiFi connected..!");
  Serial.print("Got IP: ");
  Serial.println(WiFi.localIP());

  Blynk.begin(blynkAuthToken, ssid, password);

  pinMode(relayPin, OUTPUT); // Set relay pin as output

  LoRa.setPins(ss, rst, dio0);

  if (!LoRa.begin(433E6))
  {
    Serial.println("Starting LoRa failed!");
    while (1);
  }

  display.begin(SSD1306_SWITCHCAPVCC, 0x3C);
  display.clearDisplay();
  display.setTextColor(WHITE);

  server.on("/", handle_OnConnect);
  server.onNotFound(handle_NotFound);

  server.begin();
  Serial.println("HTTP server started");

  // Set up a Blynk timer to send data to Blynk every 5 seconds
  timer.setInterval(5000L, sendSensorDataToBlynk);
}

void loop()
{

  server.handleClient();
  Blynk.run();
  timer.run();

  int pos2, pos3, pos4; // Add pos4 for soil moisture position
  int packetSize = LoRa.parsePacket();
  if (packetSize)
  {
    Serial.print("Received LoRa packet: ");
    String LoRaData = LoRa.readString();
    Serial.print(LoRaData);
```

```
   while (LoRa.available())
   {
    Serial.print((char)LoRa.read());
   }

   Serial.print("' with RSSI ");
   Serial.println(LoRa.packetRssi());

   pos2 = LoRaData.indexOf('@');
   pos3 = LoRaData.indexOf('$');
   pos4 = LoRaData.indexOf('%'); // Find the position of the '%' symbol

   receivedTemperature = LoRaData.substring(pos2 + 1, pos3);
   receivedHumidity = LoRaData.substring(pos3 + 1, pos4); // Extract humidity until
'%'
   receivedSoilMoisture = LoRaData.substring(pos4 + 1).toInt(); // Extract soil moisture
after '%'

   Serial.print(F("Received Temperature: "));
   Serial.print(receivedTemperature);
   Serial.println(F("°C"));

   Serial.print(F("Received Humidity = "));
   Serial.print(receivedHumidity);
   Serial.println(F("%"));

   Serial.print(F("Received Soil Moisture = "));
   Serial.println(receivedSoilMoisture);

   Blynk.virtualWrite(V1, receivedTemperature.toFloat());
   Blynk.virtualWrite(V2, receivedHumidity.toFloat());
   Blynk.virtualWrite(V3, receivedSoilMoisture); // Send soil moisture to Blynk V3

   Serial.println();

   display.clearDisplay();
   display.setTextSize(1);
   display.setCursor(0, 0);
   display.print("Received Temperature: ");
   display.setTextSize(2);
   display.setCursor(0, 10);
   display.print(receivedTemperature);
   display.print(" ");
   display.setTextSize(1);
   display.cp437(true);
   display.write(167);
   display.setTextSize(2);
   display.print("C");
   display.setTextSize(1);
   display.setCursor(0, 35);
   display.print("Received Humidity: ");
   display.setTextSize(2);
```

```
    display.setCursor(0, 45);
    display.print(receivedHumidity);
    display.print(" %");
    display.display();
    delay(1500);
  }
}

void handle_OnConnect()
{
  server.send(200, "text/html", SendHTML(receivedTemperature, receivedHumidity));
}

void handle_NotFound()
{
  server.send(404, "text/plain", "Not found");
}

String SendHTML(String receivedTemp, String receivedHum)
{
  String ptr = "<!DOCTYPE html> <html>\n";
  ptr += "<head><meta name=\"viewport\" content=\"width=device-width, initial-scale=1.0, user-scalable=no\">\n";
  ptr += "<link href=\"https://fonts.googleapis.com/css?family=Open+Sans:300,400,600\" rel=\"stylesheet\">\n";
  ptr += "<title>ESP8266 Weather Report</title>\n";
  ptr += "<style>html { font-family: 'Open Sans', sans-serif; display: block; margin: 0px auto; text-align: center;color: #333333;}\n";
  ptr += "body{margin-top: 50px;}\n";
  ptr += "h1 {margin: 50px auto 30px;}\n";
  ptr += ".side-by-side{display: inline-block;vertical-align: middle;position: relative;}\n";
  ptr += ".humidity-icon{background-color: #3498db;width: 30px;height: 30px;border-radius: 50%;line-height: 36px;}\n";
  ptr += ".humidity-text{font-weight: 600;padding-left: 15px;font-size: 19px;width: 160px;text-align: left;}\n";
  ptr += ".humidity{font-weight: 300;font-size: 60px;color: #3498db;}\n";
  ptr += ".temperature-icon{background-color: #f39c12;width: 30px;height: 30px;border-radius: 50%;line-height: 40px;}\n";
  ptr += ".temperature-text{font-weight: 600;padding-left: 15px;font-size: 19px;width: 160px;text-align: left;}\n";
  ptr += ".temperature{font-weight: 300;font-size: 60px;color: #f39c12;}\n";
  ptr += ".superscript{font-size: 17px;font-weight: 600;position: absolute;right: -20px;top: 15px;}\n";
  ptr += ".data{padding: 10px;}\n";
  ptr += "</style>\n";
  ptr += "</head>\n";
  ptr += "<body>\n";

  ptr += "<div id=\"webpage\">\n";

  ptr += "<h1>YCCE Weather Report</h1>\n";
```

```
  ptr += "<div class=\"data\">\n";

  // Display received temperature
  ptr += "<div class=\"side-by-side temperature-icon\">\n";
  ptr += "<svg version=\"1.1\" id=\"Layer_1\" xmlns=\"http://www.w3.org/2000/svg\"
xmlns:xlink=\"http://www.w3.org/1999/xlink\" x=\"0px\" y=\"0px\"\n";
  ptr += "width=\"9.915px\" height=\"22px\" viewBox=\"0 0 9.915 22\" enable-
background=\"new 0 0 9.915 22\" xml:space=\"preserve\">\n";
  ptr += "<path fill=\"#FFFFFF\" d=\"M3.498,0.53c0.377-0.331,0.877-0.501,1.374-
0.527C5.697-0.04,6.522,0.421,6.924,1.142\n";
  ptr +=
"c0.237,0.399,0.315,0.871,0.311,1.33C7.229,5.856,7.245,9.24,7.227,12.625c1.019,0.5
39,1.855,1.424,2.301,2.491\n";
  ptr += "c0.491,1.163,0.518,2.514,0.062,3.693c-0.414,1.102-1.24,2.038-2.276,2.594c-
1.056,0.583-2.331,0.743-3.501,0.463\n";
  ptr += "c-1.417-0.323-2.659-1.314-3.3-2.617C0.014,18.26-
0.115,17.104,0.1,16.022c0.296-1.443,1.274-2.717,2.58-3.394\n";
  ptr += "c0.013-3.44,0-6.881,0.007-
10.322C2.674,1.634,2.974,0.955,3.498,0.53z\"/>\n";
  ptr += "</svg>\n";
  ptr += "</div>\n";
  ptr += "<div class=\"side-by-side temperature-text\">Received Temperature</div>\n";
  ptr += "<div class=\"side-by-side temperature\">";
  ptr += receivedTemp;
  ptr += "<span class=\"superscript\">°C</span></div>\n";

  ptr += "</div>\n";

  // Display received humidity
  ptr += "<div class=\"data\">\n";
  ptr += "<div class=\"side-by-side humidity-icon\">\n";
  ptr += "<svg version=\"1.1\" id=\"Layer_2\" xmlns=\"http://www.w3.org/2000/svg\"
xmlns:xlink=\"http://www.w3.org/1999/xlink\" x=\"0px\" y=\"0px\"\n";
  ptr += "width=\"12px\" height=\"17.955px\" viewBox=\"0 0 13 17.955\" enable-
background=\"new 0 0 13 17.955\" xml:space=\"preserve\">\n";
  ptr += "<path fill=\"#FFFFFF\"
d=\"M1.819,6.217C3.139,4.064,6.5,0,6.5,0s3.363,4.064,4.681,6.217c1.793,2.926,2.13
3,5.05,1.571,7.057\n";
  ptr += "c-0.438,1.574-2.264,4.681-6.252,4.681c-3.988,0-5.813-3.107-6.252-4.681C-
0.313,11.267,0.026,9.143,1.819,6.217\"></path>\n";
  ptr += "</svg>\n";
  ptr += "</div>\n";
  ptr += "<div class=\"side-by-side humidity-text\">Received Humidity</div>\n";
  ptr += "<div class=\"side-by-side humidity\">";
  ptr += receivedHum;
  ptr += "<span class=\"superscript\">%</span></div>\n";

  ptr += "</div>\n";

  // Display received soil moisture
  ptr += "<div class=\"data\">\n";
  ptr += "<div class=\"side-by-side humidity-icon\">\n";
```

```
  ptr += "<svg version=\"1.1\" id=\"Layer_2\" xmlns=\"http://www.w3.org/2000/svg\" xmlns:xlink=\"http://www.w3.org/1999/xlink\" x=\"0px\" y=\"0px\"\n";
  ptr += "width=\"12px\" height=\"17.955px\" viewBox=\"0 0 13 17.955\" enable-background=\"new 0 0 13 17.955\" xml:space=\"preserve\">\n";
  ptr += "<path fill=\"#FFFFFF\" d=\"M1.819,6.217C3.139,4.064,6.5,0,6.5,0s3.363,4.064,4.681,6.217c1.793,2.926,2.133,5.05,1.571,7.057\n";
  ptr += "c-0.438,1.574-2.264,4.681-6.252,4.681c-3.988,0-5.813-3.107-6.252-4.681C-0.313,11.267,0.026,9.143,1.819,6.217\"></path>\n";
  ptr += "</svg>\n";
  ptr += "</div>\n";
  ptr += "<div class=\"side-by-side humidity-text\">Received Soil Moisture</div>\n";
  ptr += "<div class=\"side-by-side humidity\">";
  ptr += receivedSoilMoisture;
  ptr += "</div>\n";

  ptr += "</div>\n";

  ptr += "</div>\n";
  ptr += "</body>\n";
  ptr += "</html>\n";
  return ptr;
}

void sendSensorDataToBlynk()
{
  Blynk.virtualWrite(V1, receivedTemperature.toFloat());
  Blynk.virtualWrite(V2, receivedHumidity.toFloat());
  Blynk.virtualWrite(V3, receivedSoilMoisture); // Send soil moisture to Blynk V3
}

// Blynk callback function to handle button press
BLYNK_WRITE(V4)
{
  int relayState = param.asInt(); // Get the state of the button (1 for ON, 0 for OFF)
  digitalWrite(relayPin, relayState); // Set the relay state accordingly
}
//Receiver Code
```

Chapter 5 Results and Discussions

5.1 Results and Discussions

In this project we finally achieved the outcome as our agenda was to make a device which is IOT based helps in the agriculture field to the breadwinner of the world our beloved farmers.

We have used the LoRa Technology and help the farmer to monitor and control his agriculture field from one point that is the farmhouse.

We have faced many challenges while executing the project and finally we have successfully finished the project remaining our agenda as it is.

Here are the results we get after successfully executing the project.

In this picture[28] , This is the Result of OLED display at the receiver . In which we see the received temperature as well as the received humidity and besides that we see the Soil-Moisture range.

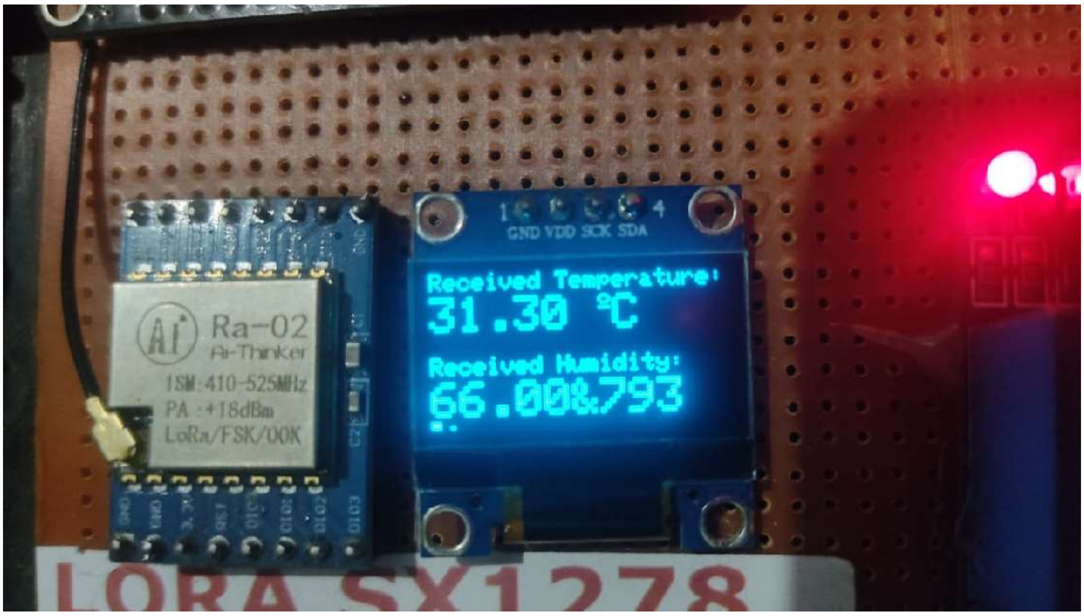

Figure 28 : OLED Display RESULT

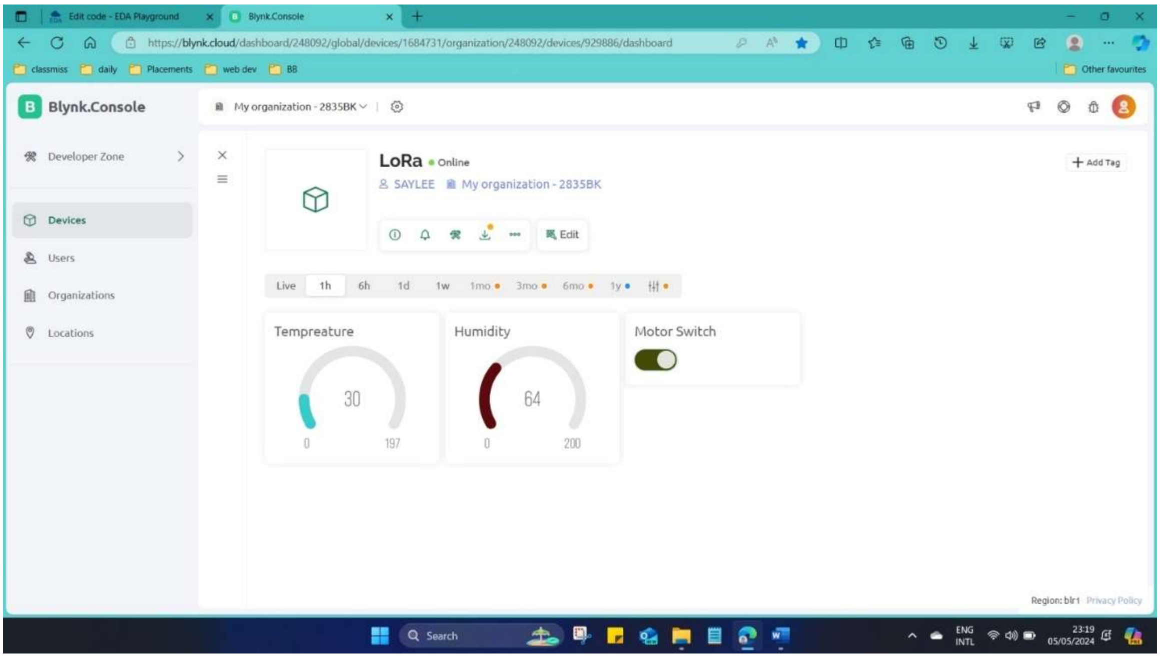

Figure 29: OUTPUT OF THE BLYNK

In this picture[29] , we see the blynk server dashboard where we see the temperature and humidity output in the analog as well as the digital format.

Also we can access and control the switch of the motor remotely from anywhere through the website application as soon as we see the temperature or the moisture is not according to the crop required in the agriculture field.

We have collected various data where result is not just displaying but its also changing in real time

Figure 30 : Idle output when Moisture sensor is not inserted to ground

This is the result that we get when the soil moisture sensor is not inserted to the ground. As a result we get the output as 1024 which is the maximum level(default) set of the moisture sensor at RHS of the humidity level.

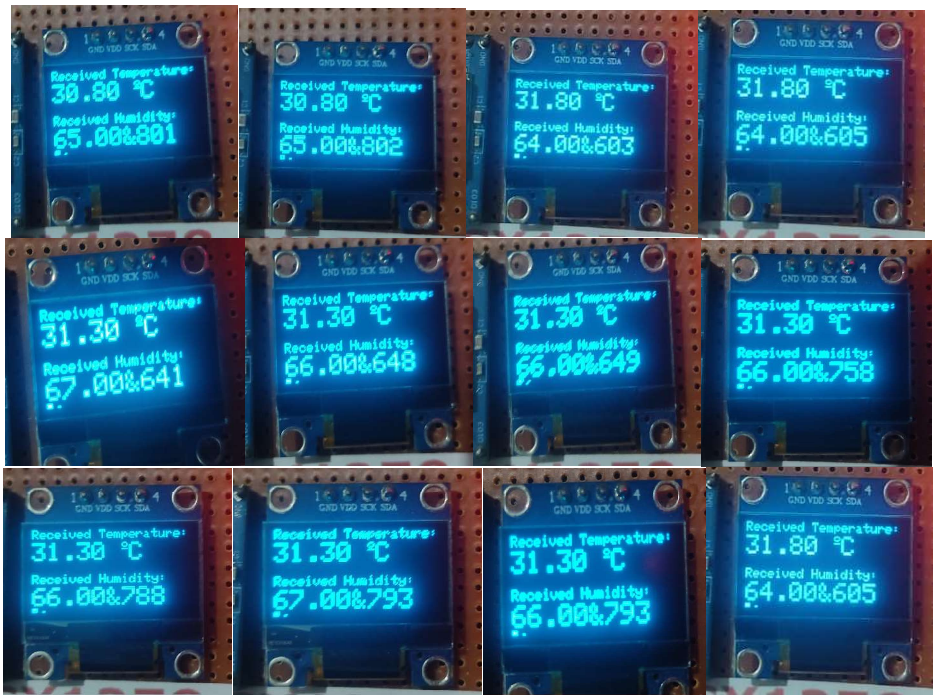

Figure 31: Outputs at OLED

These are the real time outputs that we get at the OLED display.

We see that the input data such as : Temperature , Humidity , and the Soil Moisture is changes according to the real time inputs changes surroundings to the input sensors such as DHT11 which is digital sensor senses temperature and humidity, we also have soil-Moisture sensor which senses moisture of the soil.

Hence the real time monitoring is done successfully.

Chapter 6 Summary and Conclusion

6.1 Summary

The project aims to develop a smart agriculture system using LoRaWAN technology, ESP8266, and various sensors to monitor and control environmental conditions in agricultural settings. The system will collect real-time data on temperature, humidity, and soil moisture levels, allowing farmers to make informed decisions about irrigation and crop management.

The system will consist of hardware components including ESP8266, DHT sensor for temperature and humidity monitoring, soil moisture sensor, LoRa module for long-range communication, and a relay module for motor on/off functionality. These components will be integrated to create a sensor network that collects and transmits data to a gateway.

The gateway will receive the sensor data and forward it to a cloud platform for storage and analysis. The cloud platform will process the data and provide insights to farmers through a web or mobile application. The application will allow farmers to monitor environmental conditions, receive alerts for critical situations, and remotely control irrigation systems.

The project also aims to explore the scalability and feasibility of the system for large-scale agricultural operations. It will investigate the system's performance in different agricultural settings and its potential for integration with other smart technologies in agriculture.

Overall, the project aims to improve crop yield and efficiency, reduce water usage, and enable sustainable agricultural practices through the implementation of a smart agriculture system.

6.2 Conclusion

In conclusion, the smart agriculture project presents a promising solution to enhance agricultural practices by leveraging IoT technologies. The system's ability to monitor and control environmental conditions in real-time offers farmers valuable insights for improving crop yield, reducing water usage, and promoting sustainable agriculture. The project's focus on scalability and feasibility ensures its potential for application in various agricultural settings. Overall, the smart agriculture system represents a significant step towards modernizing agriculture and addressing the challenges faced by the farming community.

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Yeshwantrao Chavan College of Engineering

Project Preliminary Investigation Report

Name of Department:

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Name of Project Guide:

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Title of the Project:

Smart Agriculture Using LoRaWAN

Area of Project Work:

Agriculture

Problem Statement:

"The aim of this project is to develop a comprehensive simulation environment for smart agriculture systems leveraging LoRaWAN technology. The objective isto address the challenges faced by modern agriculture, such as efficient resource management, environmental monitoring, and crop yield optimization, by utilizing LoRaWAN's capabilities for long-range, low-power communication. The simulation will provide a platform for testing and optimizing various smart agriculture applications, including soil moisture monitoring, crop health assessment, livestock tracking, and irrigation control, ultimately leading to sustainable and data-driven agricultural practices."

Prior Art (Patent Search):

Patent Application No.	Title of Patent	Existing Solutions (Abstract of Patent)
US 2017/0127622 A1	SMART CONTROL/IOT SYSTEM FOR AGRICULTURE ENVIRONMENT CONTROL	An Internet-of-Thing (IoT) method for improving ROI of farming includes placing a plurality of sensor hubs in predetermined locations in a farm, each hub including a meteorological data acquisition system and an environmental data collection system; and monitoring key elements in the growing of plants from a plurality of sensor hubs including lighting, humidity, temp, Soil moisture, and elements that influence plant growth.
US 2018 / 0262571 A1	United States Patent Application Publication	Currently there is no viable end to end integrated technology solution platform available to increase overall crop yield nor well-established communication platform nor infrastructure for agriculture management, logistics, storage, distribution, and delivery. This patent is offering a global solution to this

		problem where it will provide a consolidated and integrated IoT (internet of things) system platform with AI (artificial intelligence) where data collection, monitoring, control and communication platform are all managed using a single platform. The utility model relates to the technical field of wireless sensing, specifically an agricultural IoT (Internet of Things) monitoring device based on optical fiber sensing, wherein the device can monitor the temperature, humidity, vibration and other parameters of an agricultural cultivation base. The device is characterized in that the device is provided with a microcontroller, a parameter recorder and the parameter recorder is connected with the sensors. For example: soil temperature sensor and humidity sensors, a soil moisture sensor, a soil conductivity sensor, an air temperature and humidity transducer, a soil salinity sensor, etc. The upper computer is connected with the parameter recorder and the air temperature and humidity transducer through a communication circuit and using Wi-Fi mesh network, data is transferred to a remote laptop or smart phone. Data is stored in cloud for predictive data analysis with AI and real time data analysis which automatically or remotely trigger proactive & preventive actions, thereby increasing crop yield, reduce water consumption and food waste during storage and streamlined logistics of food distribution to the market. User has the option to control how often data is generated and the relevant information. User can set automatic trigger to manage proactive and preventive action on the control

		system. User can also remotely access and manual set future action either via smart phone or tablet based on actionable output from predictive data analytics. This single integrated IoT system platform is providing end to end solution that is reliable, suitable and effective for agriculture, greenhouse, lawn / yard and garden (both indoor and outdoor) applications. This integrated IoT system is also applicable in various sector such as : Geotechnical soil testing , Oil and Gas Industries (drilling , flow control , oil pipeline management , oil refineries management) , Air quality and Waste management , Semiconductor fabrication and Chemical Plant management , Oceanography and atmospheric / environmental science data monitoring for global warming , Fisheries / Aquaculture management , Data center and Cloud device management , Enterprise sustainability management , Inventory , logistics and Supply Chain management and Infrastructure (road, bridges, tunnels, dams, airports, electric grid) management . This integrated IoT system is also applicable to detect earthquake and tsunami where the sensor devices are embedded with multiple sensors installed in the buildings, bridges, bus stops, underground pits, lakes, roads, nearby mountains etc, different data can be captured and analyzed for earthquake predictability and structural integrity of the buildings to prevent collapse during earthquake, a smart alert is sent to mobile phones to authorities to minimize death and destruction

Literature Review:

Title of Paper	Details of Publication with Date and Year	Literature Identified for Project
“Smart agriculture using LORA technology”	volume 3, April-2020	International journal of research in engineering, science and management
“A survey on LORA module for smart agriculture current trends and future prospectives.”	volume 10 NO.4 ,15 February 2023	IEEE international journal of internet of things

Current Limitations :

1. In agricultural around 40% of water is wasted out of 70% due to poorwater management agriculture system.
2. Rainfall variability impacts the soil's water availability to crops, causingreduced crop production.
3. The New Delhi-based National Academy of Agricultural Sciences (NAAS) says India's annual soil loss is about 15.35 tons per ha, resultingin a loss of almost 9 million tons of nutrients and crop productivity.
4. There are smart IOT based smart agriculture system but how LoRa is differentiable from them.
5. As if the manpower is required more for acres of Agriculture field tomonitor.

Proposed Solution :

1. Water conservation is important worldwide, and agriculture consumes a lotof the usable water on the planet. LoRaWAN can be used to monitor and control usage, which has been demonstrated to reduce water consumption by up to 30 percent, while also reducing manual labor costs for irrigation checks and so on.
2. Farmers can accurately record rainfall and other climatic conditions andset flood risk alarms and other alerts for changes in water quality or overuse of phytosanitary products.

   Accurately and remotely record rainfall across different parts of the farm.Enables efficient irrigation scheduling.

   Regular updates permit quick assessment of rain events. This all benefitsof LoRaWAN.
3. Farmers can monitor soil quality from the surface to roots, compare areas,modulate fertilizing, analyze historical patterns, and better manage crops long-term.

   Manage soil quality from topsoil to below roots.

   Detailed soil quality data including soil moisture, salinity, and NPK atthree different depths.

   Diagnose problem areas and compare soil between zones.
4. LoRa Technology's long range, low power wireless qualities enable the use of low-cost sensors to send data from the farm to the Cloud where itcan be analyzed to improve operations.
5. Due to LoRaWAN module we are directly minimizing the required manpower for acres of Agriculture field.

Objectives and Scope of Work :

Objectives:

1. Smart agriculture aims to tackle three main objectives: sustainably increasing agricultural productivity and incomes; adapting and building resilience to climate change; and reducing and/or removing greenhouse gas emissions, where possible.
2. IoT techniques enhance the produce quantity and quality with reduced cost and precision.
3. Effects of climate change will have greater impact on agriculture (IPCC - UN Panel on climate change prediction).
4. IoT based methods provide improved irrigation techniques and help decide theright quantity and right time for water.

Scope Of Work

In smart agriculture using IOT the agriculture IoT devices can help them identify herd health, predict crop water requirements, and collect environmental and machine metrics. An IoT-based agriculture monitoring system will reduce the number of visits to check on crop spraying, equipment performance, and the condition of arable land.

Smart farming helps farmers to better understand the important factors such as water, topography, aspect, vegetation and soil types. This allows farmers to determine the best uses of scarce resources within their production environment and manage these in an environmentally and economically sustainable manner

IoT allows businesses and people to be more connected to the world around them, and to do more meaningful, higher-level work

Feasibility Assessment:

I. Expected Outcomes of the Project

The outcome of the present invention is this single system platform whichprovides a solution to collect and
monitor agriculture data in real time using IoT (Internet of Things) platform integrated with Artificial Intelligence to provide predictive dataanalytics to proactively trigger preventive actions automatically or remotely. And it also provides communication infrastructure system withsocial media platform for
connecting growers to the marketplace and optimizing logistics of food storage and distribution and food delivery to the market. This integratedIoT system will
increase crop yield, reduce water consumption, reduce waste during food storage and distribution and food security

II. Innovation Potential

The project "Smart Agriculture using LoRaWAN" holds significant innovation potential by leveraging Low Power Wide Area Network (LoRaWAN) technology to revolutionize farming practices. LoRaWANenables long-range, low-power communication for various sensors and devices across vast agricultural landscapes. This innovation enables real- time monitoring of soil moisture, temperature, and crop health, optimizingresource allocation and reducing water and energy wastage. The data- driven insights generated through this system enable farmers to make informed decisions, enhancing crop yield, reducing environmental impact,and contributing to sustainable agriculture practices.

III. Task Involved

- “Smart agriculture using LoRaWAN” involves tasks like interfacingof LoRa module to the Arduino and the sensors in online mode
  And development the prototype of the project hardware using LoRamodule, Arduino and other sensors.
- Develop the interface where we will be monitoring the data and synchronize it with the ideal case.
- Testing for proper functioning and connectivity of component after prototyping of hardware. Installing entire hardware component in the acrylic box and final checks for proper and expected output of the project to be done.

IV. Expertise Required

1. Inhouse Expertise- for development of IOT Interface Hardware andSoftware both.
2. External Expertise-App and Website environmental development

V. Facilities Required

1. Smart agriculture solution including several agriculture sensors: ambient temperature and humidity sensor, soil electrical conductivity, temperature and moisture sensor, light sensor; one LoRaWAN gateway which can cover the whole farm and connectto hundreds of sensors.

Milestones and Time Plan

	Task	SEP 2023	OCT 2023	NOV 2023	DEC 2023	JAN 2024	FEB 2024	MAR 2024	APR 2024
Design	Conceptual Design	✓							
	Detailed design		✓						
	Design Modifications			✓					
	Final Design			✓					
Develop	Procurement (If any)			✓					
	Prototyping				✓				
	Modifications					✓			
Deliver	Testing and Validation					✓			
	Final Modifications						✓		
	IPR / patent draft							✓	
	Thesis and Poster								✓

Name and Signature of Project Guide

Signature of HOD

Social Utility

Smart Agriculture Using LoRaWAN holds significant social relevance and utility in modern agricultural practices. By integrating IoT technology with agriculture, we are addressing key challenges faced by farmers and co–ntributing to sustainable farming practices. The following points define how this project can impact to the society

1. Enhanced Crop Yield: Real-time monitoring of soil moisture, humidity, and temperature optimizes irrigation, leading to increased yield and better produce quality, addressing food security concerns.

2. Water Conservation: Real-time data-driven irrigation management conserves water resources, crucial for sustainable agriculture, especially in regions facing water scarcity.

3. Environmental Sustainability: Smart agriculture reduces chemical usage and minimizes environmental impact by precisely applying water and nutrients, preserving soil health and biodiversity.

4. Remote Monitoring and Management: IoT-enabled remote monitoring allows farmers to access real-time data and manage operations conveniently, saving time and effort.

5. Data-Driven Decision Making: Data analytics empower farmers with insights for informed decisions on crop selection, planting strategies, and resource allocation, enhancing productivity and profitability.

7. Educational Opportunities: Implementation in agricultural colleges offers students hands-on experience in IoT technology, inspiring future innovators and entrepreneurs in agriculture.

Our final year project on Smart Agriculture Using LoRaWAN has the potential to revolutionize the agricultural sector by promoting sustainability, efficiency, and innovation. By leveraging IoT technology to monitor and manage agricultural processes, we are not only addressing current challenges but also shaping the future of farming towards greater resilience and productivity.

Appendix

Sr. NO.	Authors	Title of Paper	Name of International Journal / Conference	Place and Date of Publication with Citation Index
1	Prof R. P. Deshmukh Saylee Kelkar Pranjal Kamdar Vidhi Budhe Prachi Jadhav	"ENHANCING AGRICULTURAL PRACTICES THROUGH IOT: A CASE STUDY OF SMART AGRICULTURE USING LORAWAN"	International Journal of Innovative Science and Research Technology(IJISRT) www.ijisrt.com ISSN No :- 2456-2165 Impact Factor :- 7.176	Paper ID: "IJISRT24MAY972" Accepted
2	Prof R. P. Deshmukh Saylee Kelkar Pranjal Kamdar Vidhi Budhe Prachi Jadhav	"ENHANCING AGRICULTURAL PRACTICES THROUGH IOT: A CASE STUDY OF SMART AGRICULTURE USING LORAWAN"	International Journal of Engineering and Advanced Technology (IJEAT).	Paper ID: E447513050624 In Process

CO-PO-MAPPING

				PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
VIII	ET2451 : Major Project	1	Design and analyze application based electronic systems.	3	3	3	3	3	3	3	3	3	3	3	3	3	3
		2	Implement core / multidisciplinary / industrybased electronics projects in cost effective manner.	3	3	3	3	3	3	3	3	3	3	3	3	3	3
		3	Communicate technical details effectively	3				3		3	3	3	3	3	3	3	3

Table 4: Co-Po Mapping