CHAPTER 1

1.1 Preface:

The convergence of technology and agriculture has brought forth a new wave of innovation in agricultural technology that aims to maximize crop yield while preserving resources. Specifically, precision agriculture has been a game-changer by using cutting-edge technologies to customize fertilization and irrigation schedules to the unique requirements of individual plants. The Internet of Things (IoT), a network of networked devices with real-time data collection, transmission, and analysis capabilities, is at the center of this growth. We have the chance to transform conventional agricultural practices by utilizing the Internet of Things to effectively feed nutrients and water straight to the roots of our plants.

The goal of this project is to investigate the possibilities of employing Internet of Things technology to automatically regulate valves for precise fertilization and irrigation. Our goal is to develop a smart system that can dynamically modify irrigation and fertilizing parameters according to plant requirements, environmental factors, and soil moisture levels. To do this, we want to integrate sensors, actuators, and data analytics.We extend an invitation to readers to explore the world of precision agriculture where cutting-edge technology and the age-old art of crop cultivation collide through this preamble. Let's investigate how IoT-enabled technologies might help farmers increase output, save resources, and provide food for a growing population in an environmentally friendly manner.

Soil deterioration, water shortages, and climate unpredictability highlight the pressing need for creative solutions that can adjust to changing environmental conditions. We hope to address these issues by utilizing IoT technology to give farmers access to real-time insights and actionable intelligence so they can optimize their farming methods and make well-informed decisions. Moreover, this research has the potential to promote sustainability throughout the agricultural landscape in addition to increasing crop yields and resource efficiency. We can lessen the influence on the environment, minimize runoff, and prevent chemical leaching by carefully supplying water and nutrients to the root zone of plants.

1.2 MOTIVATION

The urgent need to transform agricultural methods to meet the demands of a world that is changing quickly is what drives the development of autonomous valve regulation for precision irrigation and fertilization to the root zone of plants utilizing IoT. Conventional irrigation and fertilization techniques frequently lead to resource waste, inefficiency, and environmental damage. Through the utilization of IoT technology, our objective is to tackle these obstacles and usher in a novel era of precision agriculture.

Our main driving force is the ambition to equip farmers with cutting-edge instruments and methods so they may optimize agricultural yields while reducing input use and environmental effect. There is unprecedented demand to produce more food with fewer resources because it is predicted that by 2050, there will be more than 9 billion people on the planet. We can streamline resource allocation, cut expenses, and guarantee the sustainable production of food for future generations by automating the regulation of valves for precision irrigation and fertilization.

While looking through the AICTE websites for current real-world concerns, we came across the problem statement ID **'1293'** from **"SMART INDIA HACKATHON 2K23"**. The problems with conventional irrigation and fertilizing in agriculture are outlined in this problem statement.

PROBLEM STATEMENT DETAILS

Problem Statement ID	1293
Problem Statement Title	Automatic regulation of valves for release of water based upon soil moisture availability in the root zone of the crop, using artificial intelligence, in a piped and micro irrigation network of irrigation system.
Description	In modern agricultural practices, efficient water management plays a critical role in achieving optimal crop yields, conserving water resources, and maintaining ecological balance. However, existing irrigation systems often lack the precision required to deliver water tailored to the actual needs of crops, leading to water wastage, suboptimal plant growth, and environmental degradation. This problem is particularly pronounced in piped and micro irrigation networks, where traditional methods of manual control fail to adapt dynamically to varying soil moisture conditions within the root zone of crops. The core issue lies in the absence of an automated mechanism that can regulate the release of water based on real-time soil moisture availability. The inconsistency in water distribution and the inability to synchronize irrigation with crop water requirements result in detrimental outcomes for both the agricultural yield and water conservation efforts. To address this problem, there is a compelling need for an innovative solution that leverages artificial intelligence (AI) to enable the automatic regulation of valves for water release in piped and micro irrigation networks. By incorporating AI-powered soil moisture monitoring and
Organization	Ministry of Jal Shakti
Category	Hardware
Domain Bucket	Agriculture, FoodTech & Rural Development
Youtube Link	
Dataset Link	NA

Fig.1.2.1 Motivation

Fig 1.2.2 conventional irrigation

Fig 1.2.3 conventional fertilization

The images above illustrate common agricultural irrigation and fertilization techniques, emphasizing their widespread use and related procedures. These techniques are usually manual or semi-manual, with farmers determining irrigation and fertilization schedules by eye inspection or simple equipment. Techniques like flood irrigation and overhead sprinklers are frequently used in irrigation, which can result in unequal water distribution, water waste from evaporation and runoff, and soil erosion. Likewise, a common technique in fertilization is the broadcast application of fertilizers over the field, which leads to an uneven distribution of nutrients, overuse of fertilizers, and pollution of the environment from seeping into water bodies.

1.3 PROBLEM STATEMENT

The current techniques frequently lead to inaccurate nutrient and water delivery, which wastes resources, lowers crop yields, and damages the environment through water runoff and leaching. Optimal resource management is hampered by the labor-intensive, time-consuming, and human error-prone nature of manual irrigation and fertilization system monitoring and modification. Therefore, in order to ensure the best possible plant health, resource efficiency, and environmental sustainability, it is important to design an automated solution using Internet of Things technology for precisely regulating irrigation and fertilizing.

1.4 ORGANIZATION OF REPORT:

We talked about our project's literature review in the second chapter. We looked at the requirement for our project and talked about papers that were relevant to it in this. The issue description of our project, its general implementation, and its hardware implementation were covered in the third chapter. and also went over the specifics of how our project's installed system and operation work. We talked about our project's software implementation in the fourth chapter. We also talked about how our project's design flow and algorithmic and flow chart-based operation function. We have talked about the outcomes of our system in the fifth chapter. The sixth chapter covers the project's characteristics, benefits, and future scope.

Summary – A brief overview of the project's motivation, preface and organization of report is provided in the first chapter.

CHAPTER 2
LITERATURE SURVEY

A review of the literature is crucial for identifying the unique approach. Comprehending the analysis conducted by multiple writers on the suggested subject and outlining the approach, along with its advantages and disadvantages, is beneficial.

Table (1) : Literature Review

Ref.	Author Names	Findings	Drawbacks
1	Uzair Ahmed. Arturo Alvino and Stefano Marino (Aprill 2022).	The authors propose an integrated approach combining IoT (Internet of Things) For smart Irrigation in agriculture. They show that their system can accurately monitor soil conditions, and improve crop yield while reducing nutrient waste.	Possible absence of field testing or actual validation to support the suggested system's success in practice.
2	P.Suganya1, Aditya Subramanian2 (September 2018)	The authors present an automated Irrigation control system specifically designed for greenhouse crop production. IoT-based irrigation systems use soil moisture sensors to measure the moisture content in the soil.	Found out absence of comprehensive analysis or validation of the system's performance under varying environmental conditions and agricultural contexts.
3	Leonor Rodríguez Sinobas and María Gil Rodríguez (December 2020)	The authors propose Subsurface drip irrigation (SDI) it is an advanced method of irrigation in which water is delivered directly to the root zone of plants through a network of buried pipes and emitters.	An examination or discussion of current developments or new difficulties in subsurface drip irrigation methods.

4	Mani Bansal, Abhay Pandey, Mandvi Singh, Nivesh Sharma. (May 2022).	This review paper summarizes the current state-of-the-art in automatic Irrigation in precision agriculture.. It discusses various approaches, technologies, and challenges involved in achieving optimal Irrigation practices	This system was developed only for irrigation purpose using Arduino uno.
5	C. Murugamani, S. Shitharth, S. Hemalatha, Et all. (June 2022)	The study emphasized how real-time data transfer made possible by 5G connectivity and highlight the use of WSN in Agriculture.	Absence of various machine learning algorithms for certain precision agriculture.

Summary – In the second chapter, we discussed our project's literature review. We have researched the requirements for our project and discussed project-related articles in this.

CHAPTER 3
IMPLEMENTED PROJECT WORK

3.1 INTRODUCTION

As the world transitions to new practices and technologies, it is essential to aim for an increase in agriculture. Numerous researchers are employed in the field of agriculture. In the twenty-first century, agriculture has a number of difficulties in producing enough food and fiber to support a growing population. Food, energy, and water security are essential for a long-term, sustainable economy. The agricultural industry uses a lot of water, and 70% of groundwater and river water is used for irrigation [1]. The collected data provide information about the various environmental factors. Monitoring the environmental factors is not the complete solution to increase the yield of crops. There are a number of other factors that decrease productivity to a greater extent. Hence automation must be implemented in irrigating fields to overcome these problems [2].

Subsurface drip irrigation or SDI, is defined as "the application of water below the soil surface through emitters with discharge rates generally in the same range as drip irrigation" by the ASAE (American Society of Agricultural Engineers) Standards. So, apart from the particulars mentioned above, an SDI unit is just a network of drip irrigation buried to a given depth. Although subsurface drip irrigation (SDI) uses less water than drip irrigation, its efficiency may be comparable. In terms of surface irrigation, it could result in water savings of up to 25% to 50% [3].

1. Design and construction:

In this project we have used some of the components like Node MCU ESP8266, NPK Sensor, Rain Sensor, Soil Moisture Sensor, DHT11 (temperature and humidity) Sensor.

1) **NPK Sensor:** Measures Nitrogen, Phosphorus, and Potassium levels in soil.
2) **Node MCU ESP8266:** Controls the NPK sensor and sends data to Firebase.
3) **Rain Drop Sensor:** Detects rainfall to adjust irrigation schedules.
4) **DHT11:** Measures temperature and humidity for environmental monitoring.
5) **Soil Moisture Sensor:** Monitors soil hydration levels for precise irrigation control.

2. Operational mechanism:

1) **NPK Sensor:**

The NPK sensor measures the levels of Nitrogen (N), Phosphorus (P), and Potassium (K) in the soil. It consists of specific probes to analyze the soil's nutrient content.

2) **Node MCU ESP8266:**

The Node MCU ESP8266 is a Wi-Fi enabled microcontroller that controls the NPK sensor and facilitates data transmission. It activates the sensor and sends the collected data to Firebase for the Android app.

3) **Firebase:**

Firebase acts as an intermediary platform for the transmission of data between the Node MCU ESP8266 and the Android app. It ensures seamless data transfer and real-time analysis.

4) **Android App Interface:**

An Android app interface is developed to receive and display the data collected by the NPK sensor. The app provides an easy-to-read format, enabling farmers to interpret the nutrient levels effectively.

5) **Interface Module:**

An interface module is used to connect the NPK sensor to the Node MCU ESP8266. It ensures smooth communication between the sensor and the microcontroller.

6) **Soil NPK Sensor Probe:**

The probe of the NPK sensor is inserted into the soil to measure the nutrient content. It is designed to provide accurate real-time data on soil nutrient content.

7) **DHT11 Sensor:**

The DHT11 sensor is utilized to measure temperature and humidity levels in the environment. It provides crucial environmental data necessary for assessing plant health and optimizing growing conditions.

Temperature and humidity fluctuations can impact plant growth and susceptibility to diseases, making accurate monitoring essential.

8) Soil Moisture Sensor:

The soil moisture sensor is employed to measure the water content in the soil.
It offers real-time data on soil hydration levels, allowing for precise irrigation management.
Continuous monitoring of soil moisture enables the system to adjust irrigation schedules dynamically, ensuring optimal soil conditions for plant growth.

9) Rain Drop Sensor:

The rain drop sensor detects the presence of rainfall, enabling the system to suspend irrigation operations during rainy periods.
By preventing unnecessary watering during precipitation events, the sensor helps conserve water and prevents over watering, which can lead to nutrient leaching and soil erosion.
Integration of the rain drop sensor enhances the system's efficiency by aligning irrigation activities with natural rainfall patterns.

3. Testing and Validation:

In this project, extensive testing and validation procedures were meticulously conducted to ascertain the robustness and accuracy of the system. The NPK sensor underwent rigorous calibration tests to verify its precision in measuring soil nutrient levels. Calibration involved comparing sensor readings with known concentrations of nitrogen (N), phosphorus (P), and potassium (K) solutions. Integration tests were then carried out to ensure seamless communication between the Node MCU ESP8266 and the NPK sensor.

The microcontroller was programmed to activate the sensor, collect data, and transmit it to Firebase for analysis. Firebase's role as the intermediary platform was thoroughly validated through data transmission tests, ensuring the reliable storage and retrieval of sensor data. The Android app interface underwent comprehensive testing to confirm its functionality in receiving and displaying sensor data in an easily interpretable format. Compatibility tests ensured smooth communication between the NPK sensor and the Node MCU ESP8266 through the interface module. The accuracy and responsiveness of the DHT11 and soil moisture sensors were verified through validation tests, while the rain drop sensor's ability to detect rainfall events and suspend irrigation operations was assessed under simulated conditions. Finally, overall system integration tests were conducted to evaluate performance and reliability under various environmental scenarios, guaranteeing that the system provided accurate and actionable data for effective agricultural decision-making.

4. Results and Conclusion:

The implementation of a multifaceted sensor system within the agricultural framework has yielded promising results. The NPK sensor accurately measures crucial soil nutrients—Nitrogen, Phosphorus, and Potassium—providing farmers with precise data to optimize fertilization strategies. Integrated with the Node MCU ESP8266, this system ensures efficient data collection and transmission to Firebase, facilitating real-time analysis through an intuitive Android app interface. Furthermore, the inclusion of the DHT11 sensor enables comprehensive environmental monitoring, while the soil moisture sensor and rain drop sensor enhance irrigation management by providing valuable insights into soil hydration levels and rainfall patterns. Through these advancements, farmers can make informed decisions to maximize crop yield while conserving resources and promoting sustainability.

3.2 BLOCK DIAGRAM OF SYSTEM:

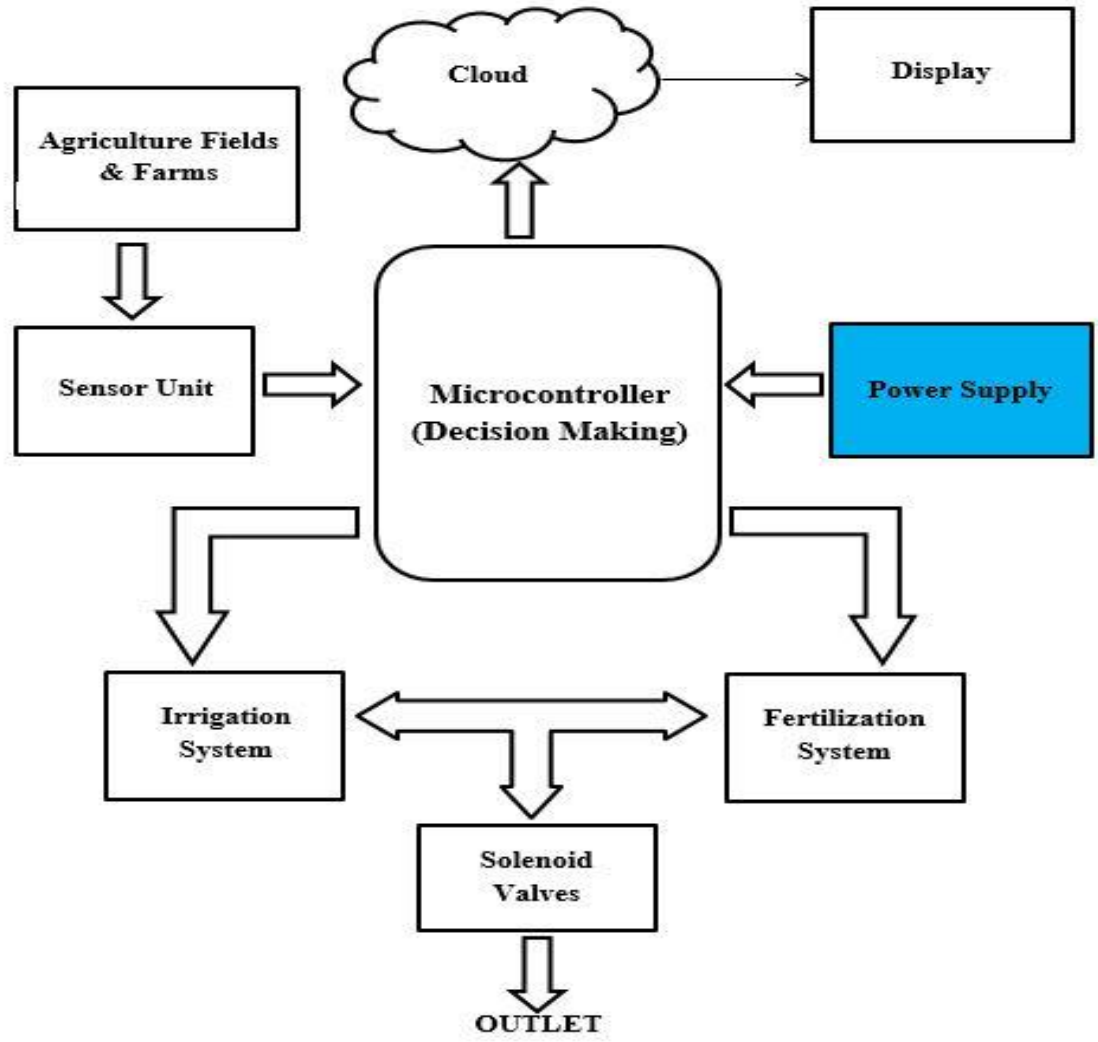

Fig. 3.2.1 Block Diagram

The block diagram consists of following blocks:

1. ESP 8266 microcontroller
2. Soil moisture sensor
3. Solar panel
4. Relay
5. Watering pump
6. Rain drop sensor
7. NPK sensor
8. Temperature sensor
9. LM2596 DC-DC buck converter.

3.3 CIRCUIT DIAGRAM OF SYSTEM:

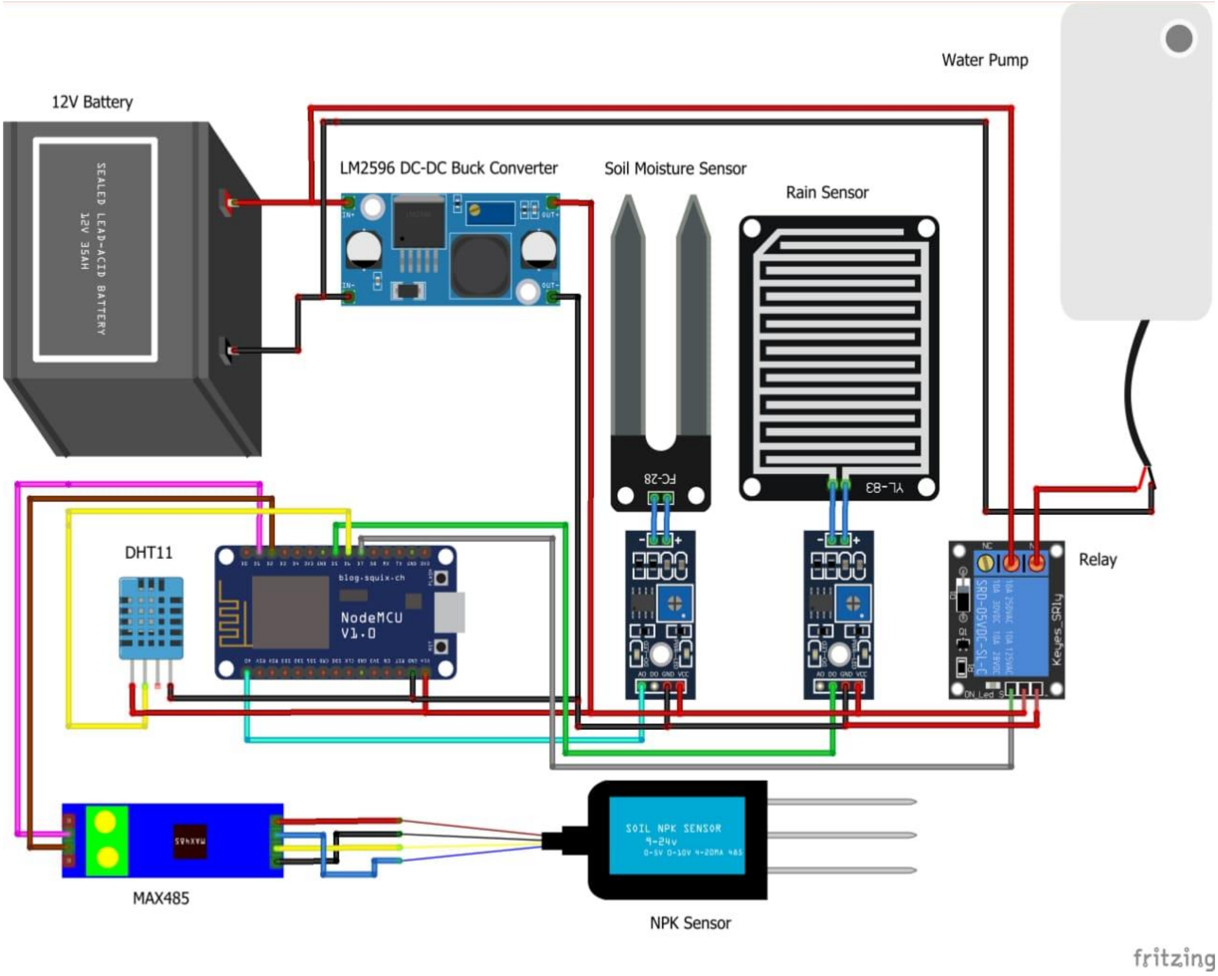

Fig.3.3.1 Circuit Diagram of system

When designing, building, and debugging electrical and electronic systems, circuit diagrams are crucial. All of the hardware components, including the ESP8266, soil moisture sensor, relay, and numerous other devices, are shown in the circuit diagram above. The circuit diagram shows how the parts are put together on the PCB board. A schematic diagram, sometimes referred to as a circuit diagram, is a visual depiction of an electrical or electronic circuit. It displays the circuit's parts and their connections in addition to the information or current flowing through the circuit.

3.4 FLOW CHART OF SYSTEM:

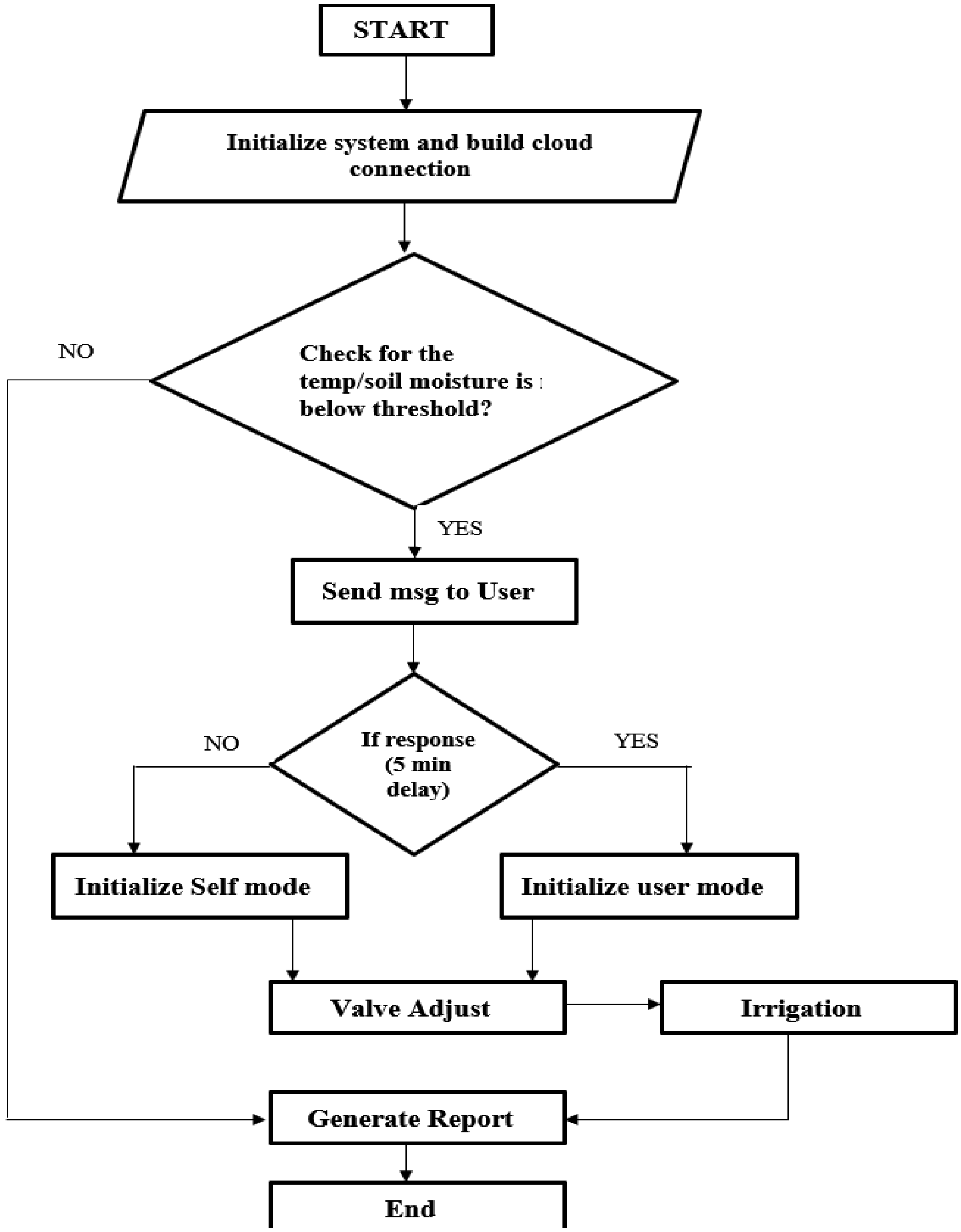

Fig 3.4.1 Flowchart of irrigation system

The irrigation flow chart visually outlines the sequential steps involved in the irrigation process, from water source selection to distribution and application onto agricultural fields. It serves as a guide for farmers and irrigation system operators to ensure systematic and efficient management of water resources in crop cultivation.

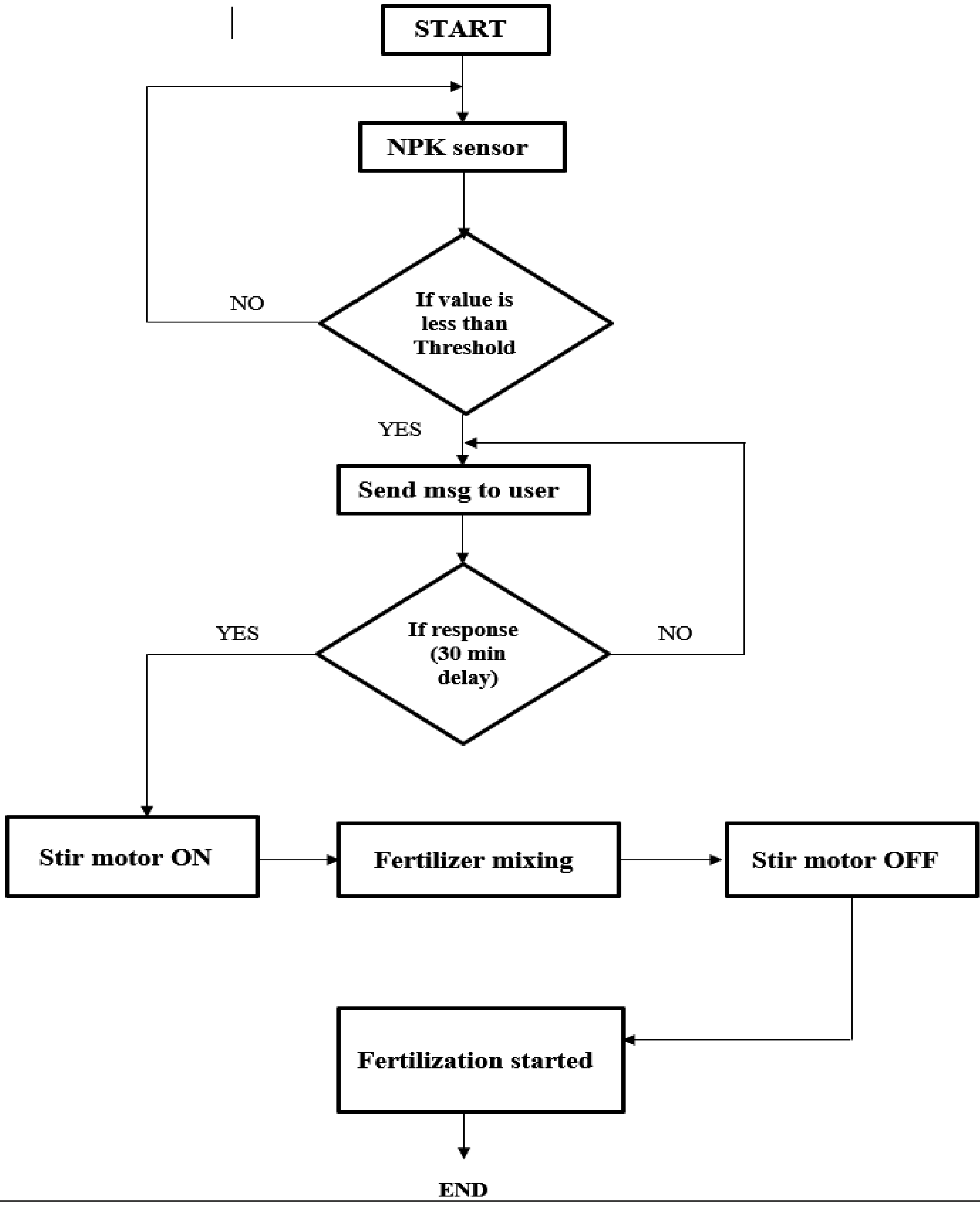

Fig 3.4.2 Flowchart of fertilization system

The fertilization flow chart provides a systematic visual representation of the sequential steps involved in the fertilization process, facilitating clear understanding and implementation of fertilization protocols.

Summary – In this chapter we have discussed about the introduction problem statement, block diagram, circuit diagram and flowchart of the implemented system.

CHAPTER 4

HARDWARE AND SOFTWARE IMPLEMENTATION

4.1 HARDWARE IMPLEMENTATION:

The implementation of the system comprises both hardware and software components. This section provides details about the hardware aspects of the project.

Hardware Implementation:

- Node MCU ESP8266
- Soil Moisture Sensor
- Rain Drop Sensor
- Watering pump
- DHT11 (Temperature and Humidity) Sensor
- Relay
- NPK Sensor

4.1.1 ESP8266 12-E NodeMCU Kit:

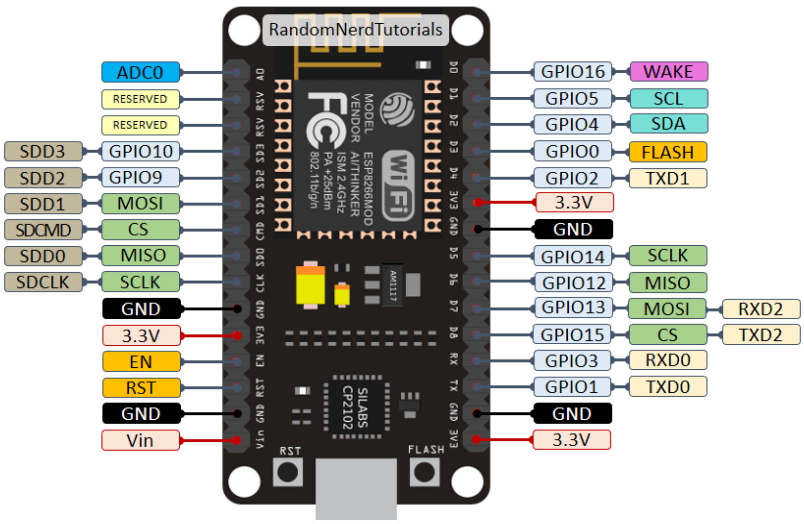

Fig.4.1.1 Node MCU ESP8266

The ESP8266 Wi-Fi module has 32 KB of instruction RAM, 80 KB of user data RAM, and 64 KB of boot ROM. It has the ability to support a 2.4 GHz 802.11 b/g/n Wi-Fi network in addition to SPI, I2C, 10-bit ADC, and I2C interfacing with DMA functions. A serial port makes it simple to interface this module with the microcontroller. Only when the operating voltage is higher than 3.6 volts does an external voltage converter become necessary. Because of its inexpensive cost and small size, it is most commonly employed in robotics and Internet of Things applications.

4.1.2 Soil moisture sensor:

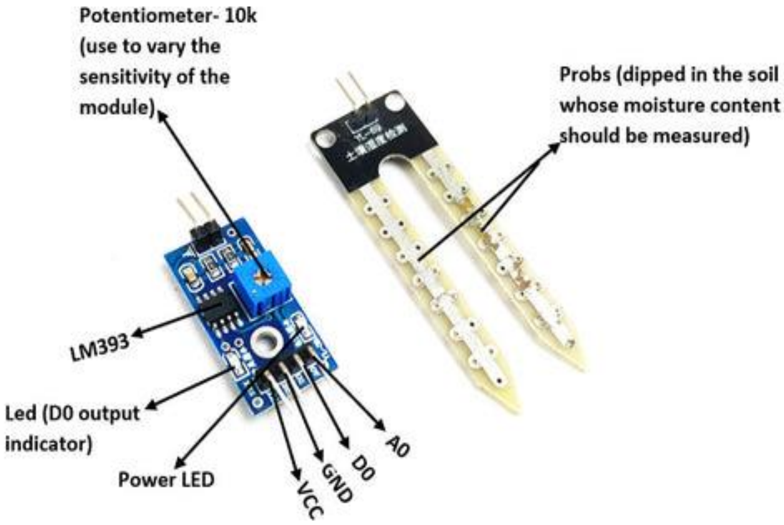

Fig.4.1.2 Soil moisture sensor

One type of sensor used to measure the volumetric content of water in the soil is the soil moisture sensor. In addition to sample weighting, drying, and elimination of the straight gravimetric dimension of soil moisture are required. Through the use of many additional soil properties such as electrical resistance, dielectric constant, interaction with neutrons, and moisture content replacement, these sensors measure the volumetric water content without direct assistance.

4.1.3 Rain drop sensor:

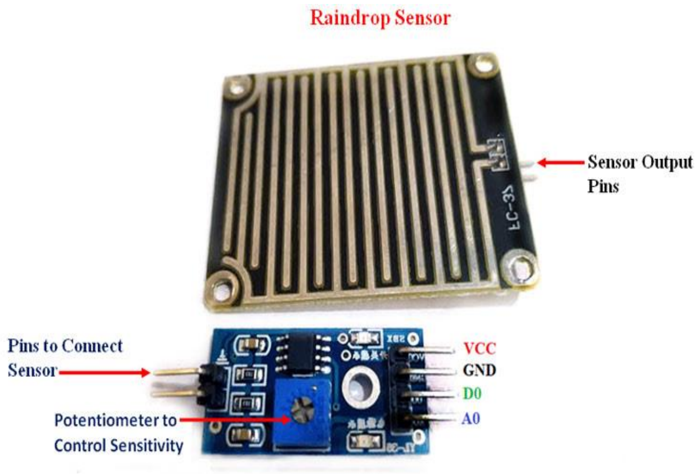

Fig.4.1.3 Rain drop sensor

Raindrops that land on the sensor surface allow electricity to flow through the circuit by forming a conductive route between the electrodes. This change in conductivity is detected by the control circuit, which then outputs a signal to indicate the presence of rainfall. Raindrop sensors are widely used to detect rainfall and trigger appropriate actions or alarms in a variety of applications, including smart home automation, autonomous irrigation systems, and weather monitoring stations.

4.1.4 NPK Sensor

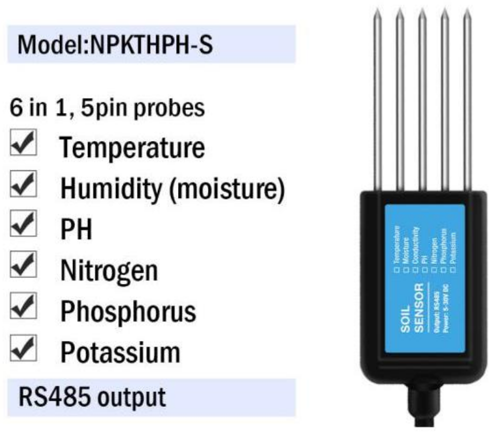

Fig.4.1.4 NPK sensor

The usual purpose of soil NPK sensors is to gauge the concentrations of potassium (K), phosphorus (P), and nitrogen (N) in the soil. These sensors often come in a variety of configurations, such as stand-alone devices or soil-penalizing probes.

Features:

1. The seven items of soil moisture content, electrical conductivity, temperature, nitrogen, phosphorus and potassium, and pH value are combined in one.

2. The operation is simple, no reagent is needed, and it can be reused.

3. The electrode is made of specially treated alloy material, which can withstand strong external impact and is not easily damaged.

4. Completely sealed, resistant to acid and alkali corrosion, and can be buried in soil or directly into water for long-term dynamic testing.

5. High precision, fast response, good interchangeability, probe plug-in design to ensure accurate measurement and reliable performance.

6. It can also be used for the conductivity of water and fertilizer integrated solutions, as well as other nutrient solutions and substrates.

7. The PH value measurement accuracy is high, up to ±0.3PH accuracy, and the response speed is fast.

Specifications:-

1. All-in-One Measurements: NPK, pH, EC (Electrical Conductivity), Temperature, Humidity.

2. Seamless Connectivity: RS485 for smooth data transmission.

3. Sensor Design: 5-Pin configuration for holistic soil analysis.

4. Ideal for Agriculture: Tailored to meet the demands of crops and farming.

5. Unparalleled Precision: High accuracy ensures dependable results.

6. User-Centric: Easy installation and intuitive interface.

7. Built to Last: Designed to endure various environmental factors.

8. Real-Time Data: Monitor and analyze data in real time.

4.2 SOFTWARE IMPLEMENTATION:

In this section, the following applications are used to design the IoT-based Smart Poultry Farm Application in which the real-time data is displayed on the mobile screen. The application is developed in embedded C++. For designing this Android application, the Arduino IDE and Kodular software are used. Some information about the applications is as follows:

4.2.1 Arduino IDE :

The Arduino integrated development environment(IDE) is an across-platform application (for Windows, macOS, Linux) that is written in the programming language Java. It is used to write and upload programs to Arduino-compatible boards, but also, with the help of third party cores, other vendor development boards.

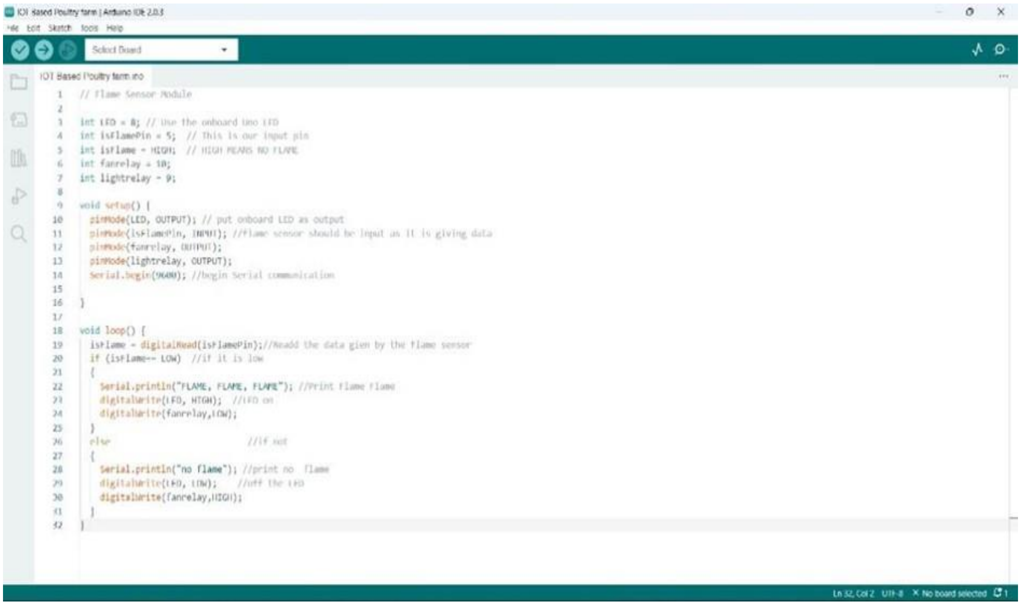

Fig4.2.1 Arduino IDE

The source code for the IDE is released under the License version. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provide many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub main () into an executable cyclic executive program with the GNU tool chain, also included with the IDE distribution.

4.2.2 Kodular App :

Creating an app with Kodular is a relatively simple process, especially if you're new to app development. Kodular uses a block-based interface that makes it easy to create Android apps without needing to write code. Here's a step-by-step guide to creating a basic app using Kodular:

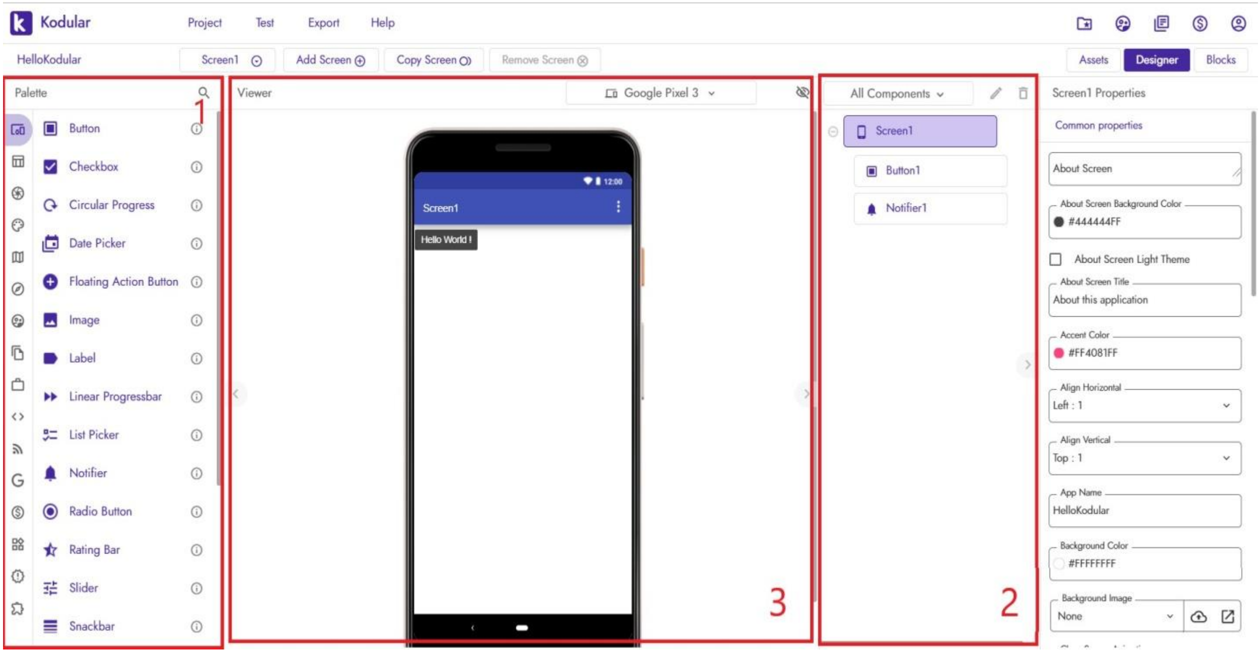

Fig4.2.2 Kodular App

Step 1: Create an Account

If you haven't already, visit the Kodular website (**https://www.kodular.io/**) and create a free account. You'll need this account to save and manage your projects.

Step 2: Start a New Project

Once you're logged in, click on the "Create Project" button or "My Projects" to access your existing projects and start a new one.

Step 3: Design Your App

Kodular uses a visual interface for designing your app's user interface. You'll find a variety of components and layout options to choose from. Here's a brief overview:

4.2.3 Project Code :

```
#include <ESP8266WiFi.h>
#include <FirebaseArduino.h>
#include <SoftwareSerial.h>
#include <DHT.h>

const char* ssid = "";
const char* password = "";

#define FIREBASE_HOST "npkfarm-6c142-default-rtdb.firebaseio.com"
#define FIREBASE_AUTH "AIzaSyBdrug5cFPtt1TisI4m84zZcVB5pSr85_M"
#define RX_PIN D1
#define TX_PIN D2
#define DHT_PIN D6
#define RAIN_PIN D5
#define SOIL_MOISTURE_PIN A0
#define RELAY_PIN D7
#define DHTTYPE DHT11

SoftwareSerial mySerial(RX_PIN, TX_PIN);
DHT dht(DHT_PIN, DHTTYPE);
void setup() {
  Serial.begin(9600);
```

```
  mySerial.begin(4800);


  WiFi.begin(ssid, password);
  Serial.print("Connecting to WiFi");
  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.print(".");
  }
  Serial.println();
  Serial.print("WiFi connected, IP address: ");
  Serial.println(WiFi.localIP());


  Firebase.begin(FIREBASE_HOST, FIREBASE_AUTH);
  pinMode(RELAY_PIN, OUTPUT); // Set relay pin as output
}
void loop() {
  // Read sensor data from the first device
  byte queryData[] = {0x01, 0x03, 0x00, 0x00, 0x00, 0x07, 0x04, 0x08};
  byte receiverData[19];


  mySerial.write(queryData, sizeof(queryData));
  delay(1000);
  if (mySerial.available() >= sizeof(receiverData)) {
```

```
  mySerial.readBytes(receiverData, sizeof(receiverData));


  unsigned int nitrogen = (receiverData[11] << 8) | receiverData[12];

  unsigned int phosphorus = (receiverData[13] << 8) | receiverData[14];

  unsigned int potassium = (receiverData[15] << 8) | receiverData[16];


  Serial.print("Nitrogen: ");

  Serial.println(nitrogen);


  Serial.print("Phosphorus: ");

  Serial.println(phosphorus);


  Serial.print("Potassium: ");

  Serial.println(potassium);

  Serial.println("/////////////////////////////////////////////////////////");

  Firebase.setInt("Nitrogen", nitrogen);

  Firebase.setInt("Phosphorus", phosphorus);

  Firebase.setInt("Potassium", potassium);

}

// Read sensor data from the second device

float t = dht.readTemperature();

float h = dht.readHumidity();
```

```
if (isnan(h) || isnan(t)) {
  Serial.println("Failed to read from DHT sensor!");
  delay(2000);
  return;
}
Serial.print("Temperature = ");
Serial.print(t);
Serial.println(" °C");
Serial.print("Humidity = ");
Serial.print(h);
Serial.println("%");

int rain_state = digitalRead(RAIN_PIN);
if (rain_state == HIGH) {
  Serial.println("The rain is NOT detected");
  Firebase.setInt("Rain", 0);
} else {
  Serial.println("The rain is detected");
  Firebase.setInt("Rain", 1);
}
float moisture_percentage = 100.00 - ((analogRead(SOIL_MOISTURE_PIN) /
1023.00) * 100.00);
Serial.print("Soil Moisture (in Percentage) = ");
```

```
  Serial.print(moisture_percentage);
  Serial.println("%");

  if (moisture_percentage < 50) {
    // If moisture is less than 50%, turn on the relay (motor)
    digitalWrite(RELAY_PIN, LOW);
    Serial.println("Motor ON");
    Firebase.setInt("Relay", 1); // Send relay status to Firebase
  } else {
    // If moisture is 50% or greater, turn off the relay (motor)
    digitalWrite(RELAY_PIN, HIGH);
    Serial.println("Motor OFF");
    Firebase.setInt("Relay", 0); // Send relay status to Firebase
  }
  Firebase.setFloat("Temperature", t);
  Firebase.setFloat("Humidity", h);
  delay(2000); // Add delay after sensor readings
}
```

Summary – In this chapter, we have discussed about all the detailed information related to hardware components and software used in this system.

CHAPTER 5
RESULTS

5.1 RESULTS

In the following Fig. 5.1.1 it shows the initial condition of the system the soil in this figure is dry and the moisture level is low. The threadshold value is below 50 when the soil is dry.

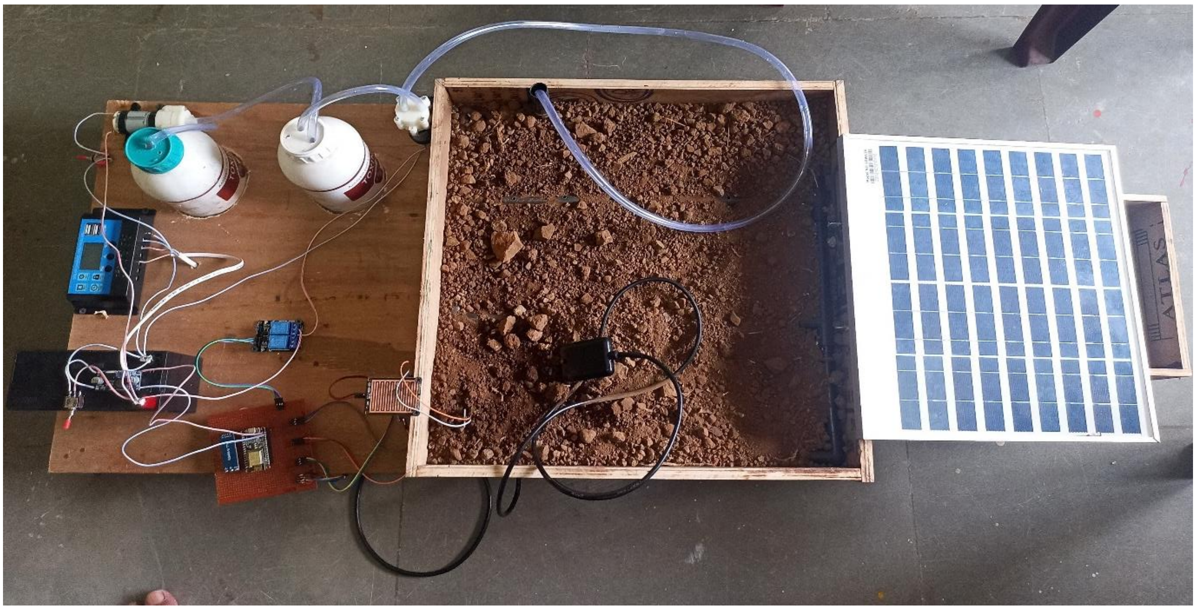

Fig 5.1.1 Before Irrigation and Fertilization

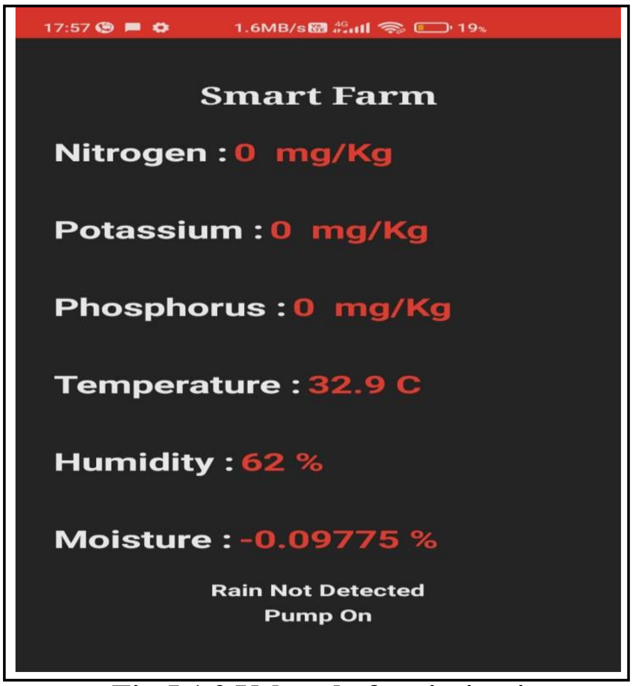

Fig 5.1.2 Values before irrigation

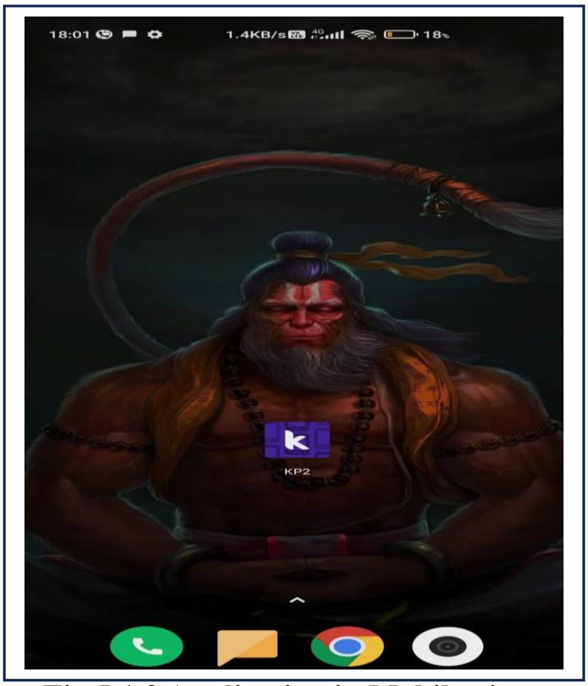

Fig 5.1.3 Application in Mobile view

In the fig 5.1.2 it shows the values of various nutrients like Nitrogen, Potassium, and Phosphorous these three values are used for fertilization and it also shows Temperature, Humidity, and Moisture levels for irrigation.

Here in this Figure, the values of NPK is 0 at the dry surface which is initial and moisture is -0.0977 so the system will be ON condition for the irrigation process.
In the figure 5.1.3, it shows the application in the mobile view.

5.1.4 After Irrigation
The Fig 5.1.4 shows the irrigated system at this stage the water is flown through the pipes to the field for irrigation purpose.

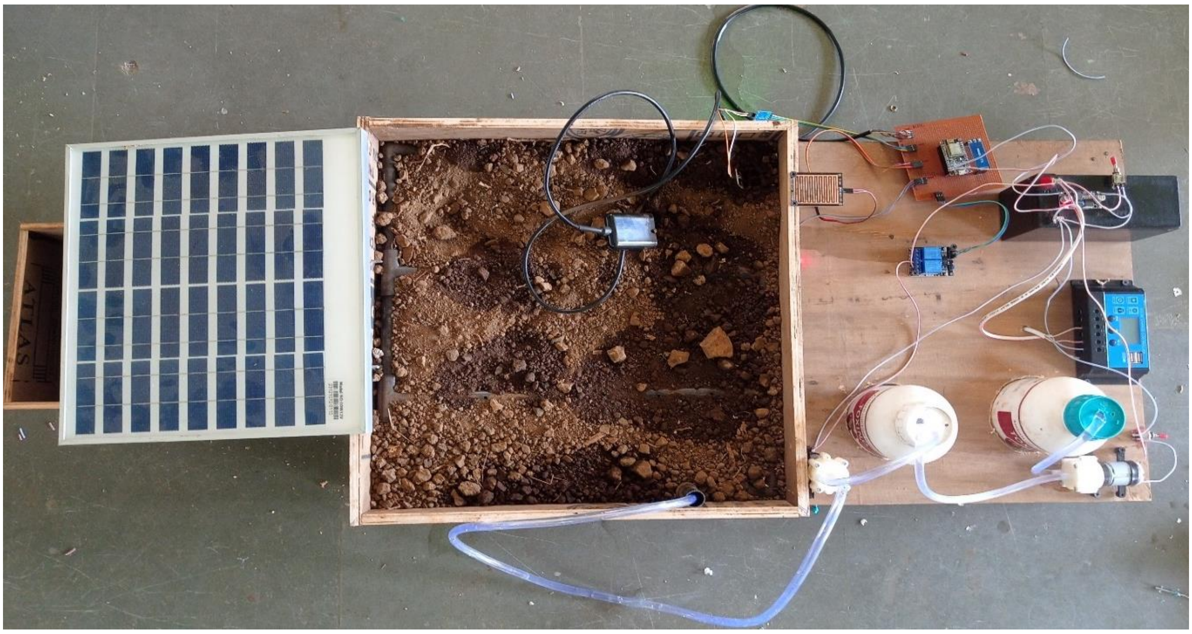

Fig 5.1.4 After Irrigation and Fertilization

From the following figures 5.1.4 we can observe the working module of the automatic irrigation and fertilization system project. Fig. 5.1.1 illustrates the conditions before activating the system, while Fig. 5.1.4 displays the system in operation.

5.1.5 After Irrigation
Here in this Figure, the values of NPK is 0 at the dry surface which is initial and moisture is -0.0977 so the system will be ON condition for the irrigation process.
In the figure 5.1.3 it shows the application in the mobile view.

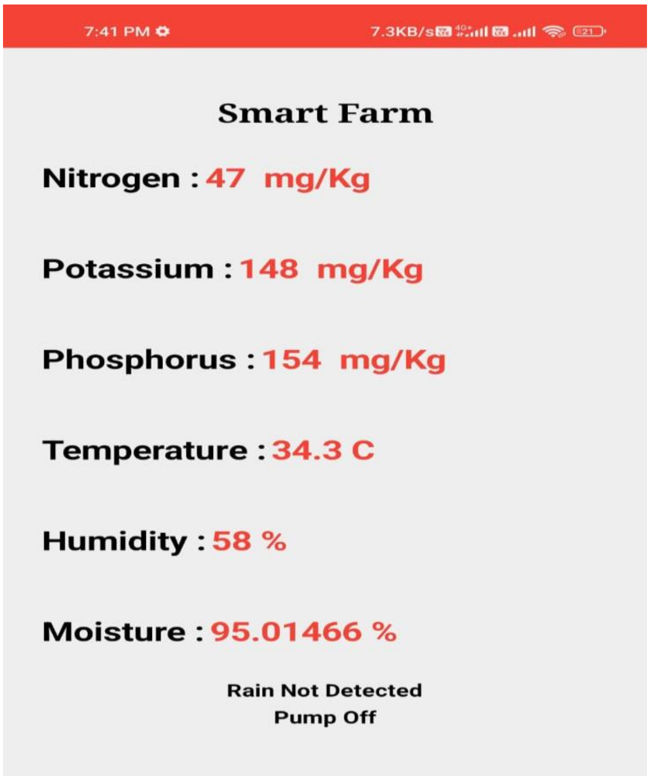

Fig 5.1.5 Values after irrigation

WORKING OF OUR MODULE

1. Irrigation Process:

1. The system utilizes a soil moisture sensor to measure the moisture level in the soil. This sensor continuously provides moisture data to an ESP8266 microprocessor.

2. When the soil moisture falls below a predefined threshold, indicating the need for watering, the microprocessor triggers the irrigation process.

3. The microprocessor controls the irrigation system, which likely includes valves or pumps connected to water sources.

4. Water is then delivered from Storage 2, which holds irrigation water, to the soil through a network of pipes or drip irrigation systems.

5. This automated process ensures that plants receive water when needed, optimizing their growth and health.

2. Fertilization Process:

1. Fertilization in this system is manually initiated.
2. The user manually starts the motor responsible for mixing fertilization liquids.
3. These liquids are stored in Storage 1, specifically designated for fertilization purposes.
4. Once the motor is activated, it initiates the mixing process, blending the fertilization liquids as required.
5. After mixing, the fertilization solution is transferred from Storage 1 to Storage 2. Storage 2 contains water meant for irrigation purposes.
6. The mixed fertilization solution is then available in Storage 2 for irrigation.
7. Similar to the irrigation process, when the soil moisture level indicates the need for watering, the system delivers the mixed fertilization solution to the soil alongside irrigation water.

Summary- In this chapter we discussed about software, Hardware module and working related information and programs used in the system.

CHAPTER 6

FEATURES, ADVANTAGES AND DISADVANTAGES OF IMPLEMENTED SYSTEM

6.1 FEATURES:

1. NPK Sensor: Measures soil Nitrogen, Phosphorus, and Potassium levels for precise fertilization.

2. DHT11 Sensor: Monitors temperature and humidity to optimize growing conditions and assess plant health.

4. Soil Moisture Sensor: Provides real-time data on soil hydration levels to inform irrigation management.

5. Rain Drop Sensor: Detects rainfall and adjusts irrigation schedules to conserve water and prevent over watering.

6. Node MCU ESP8266: Controls sensor operations and facilitates data transmission to Firebase for analysis.

7. Firebase Integration: Acts as an intermediary platform for seamless data transfer and 8. real-time analysis.

8. Android App Interface: Allows farmers to access and interpret sensor data in an easy-to-use format.

9. Interface Module: Facilitates communication between sensors and the Node MCU ESP8266 for smooth operation.

6.2 ADVANTAGES:

1. Precision Agriculture: The integration of advanced sensors enables precise monitoring and management of soil nutrients, moisture levels, and environmental conditions, leading to optimized crop yield.

2. Resource Conservation: By providing real-time data on soil moisture and rainfall,

the system facilitates efficient irrigation management, minimizing water usage and reducing the risk of over watering.

3. Increased Efficiency: Automated data collection and analysis streamline agricultural operations, saving time and labor for farmers.

4. Data-Driven Decision Making: Access to accurate and timely information empowers farmers to make informed decisions regarding fertilization, irrigation, and crop management.

5. Sustainability: By promoting efficient resource utilization and reducing environmental impact, the system contributes to sustainable agricultural practices.

6.3 DISADVANTAGES:

1. Initial Investment: The cost of purchasing and installing advanced sensor systems may pose a barrier to entry for some farmers.

2. Complexity: Integrating multiple sensors and managing data streams requires technical expertise, which may be challenging for some users.

3. Reliance on Technology: Dependence on sensor systems for critical agricultural decisions may leave farmers vulnerable to technical failures or malfunctions.

4. Data Security Concerns: Transmitting sensitive agricultural data over digital platforms like Firebase raises potential privacy and security risks.

5. Maintenance Requirements: Regular calibration and maintenance of sensor equipment are necessary to ensure accurate and reliable performance.

Summary- In this chapter, the discussion is carried out about the features, advantages, and disadvantages of the implemented system.

CHAPTER 7
FUTURE ENHANCEMENT AND CONCLUSION

7.1 FUTURE ENHANCEMENT :

1. Improved Sensor Accuracy: Enhance sensor technology to provide even more precise measurements of soil nutrients, moisture levels, and environmental parameters.

2. Enhanced Data Analysis: Develop advanced algorithms for real-time data analysis, providing actionable insights and predictive analytics to farmers.

3. Integration with AI: Incorporate artificial intelligence algorithms to automate decision-making processes and optimize agricultural practices based on historical data and predictive modeling.

4. Remote Monitoring and Control: Implement remote monitoring and control capabilities, allowing farmers to manage sensor systems and make adjustments from anywhere using mobile or web-based interfaces.

5. Scalability: Design the system to be easily scalable, allowing farmers to expand sensor networks and add additional features as needed to meet evolving agricultural needs.

7.2 CONCLUSION

This automated irrigation and fertigation system successfully implements irrigation and fertigation automation, leading to the conclusion that it is a useful system. The irrigation automation operates in accordance with the constant monitoring of the sensor threshold values. The message is sent in response to irrigation demand, causing the irrigation to begin or stop right away. We also receive continual sensor status updates via the Kodular platform. Finally, we may access and operate the electrical and water flow control system remotely with the help of this technology.

Summary – In this chapter we have discussed about future enhancement and conclusion of our project.

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- **https://doi.org/10.3390/w11112285**
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- **https://www.instructables.com/Interface-Raindrop-Sensor-to-NodeMcu-for-Beginner/**

APPENDIX

APPENDIX-A: PROJECT COMPETITION PARTICIPATION

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SANT GAJANAN MAHARAJ COLLEGE OF ENGINEERING

Mahagaon, Tal - Gadhinglaj, Dist - Kolhapur.

NATIONAL LEVEL TECHNICAL EVENT

NAVAPRAVARTYA 2K24

CERTIFICATE OF PARTICIPATION

This is to Certify that Mr./ Mrs./ Ms./ Bharat Laxman Gawade

of Institute SGMCOE has participated in

Project Expo. Event of ''Navapravartya 2k24'' Organized on 21 st & 22 nd March 2024 at

Sant Gajanan Maharaj College of Engineering, Mahagaon.

Mrs. M. N. Patil	Mr. V. K. Salunkhe	Mr. S. P. Deshmukh	Dr. S. H. Sawant
Asst. Prof. of Dept. of Electrical Engg.	Asst. Prof. of Dept. of E & Tc. Engg.	Asst. Prof. of Dept. of Civil Engg.	Principal, SGMCOE, Mahagaon
Co-Coordinator	Co-Coordinator	Coordinator	Convenor

NAAC ' B++' Accredited and ISO 9001 : 2015 Certified Institute

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Mahagaon, Tal - Gadhinglaj, Dist - Kolhapur.

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Sant Gajanan Maharaj College of Engineering, Mahagaon.

Mrs. M. N. Patil	Mr. V. K. Salunkhe	Mr. S. P. Deshmukh	Dr. S. H. Sawant
Asst. Prof. of Dept. of Electrical Engg.	Asst. Prof. of Dept. of E & Tc. Engg.	Asst. Prof. of Dept. of Civil Engg.	Principal, SGMCOE, Mahagaon
Co-Coordinator	Co-Coordinator	Coordinator	Convenor

NAAC ' B++' Accredited and ISO 9001 : 2015 Certified Institute

SANT GAJANAN MAHARAJ COLLEGE OF ENGINEERING

Mahagaon, Tal - Gadhinglaj, Dist - Kolhapur.

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Mrs. M. N. Patil	Mr. V. K. Salunkhe	Mr. S. P. Deshmukh	Dr. S. H. Sawant
Asst. Prof. of Dept. of Electrical Engg.	Asst. Prof. of Dept. of E & Tc. Engg.	Asst. Prof. of Dept. of Civil Engg.	Principal, SGMCOE, Mahagaon
Co-Coordinator	Co-Coordinator	Coordinator	Convenor

APPENDIX-B: RESEARCH PAPER PUBLISHED/ACCEPTANCE

International Journal of Innovative Research in Computer and Communication Engineering

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|| Volume 12, Issue 4, April 2024 ||

| DOI: 10.15680/IJIRCCE.2023.1111001 |

Automatic Irrigation And Fertilization to the Root Zone of Plants.

[1]Roshan A Avadan, [2]Bharat L Gawade, [3]Abhishek D Kole, [4]Prof. S .T Matale

[1,2,3]Final Year Engineering Students, [4]Assistant Professor

[1,2,3,4]Department of Electronics and Telecommunication Engineering, Sant Gajanan Maharaj College of Engineering, Mahagaon Maharashtra, India.

ABSTRACT : One of the biggest consumers of water resources is the agricultural industry. Water is a valuable resource that must be protected with the most recent technological advancements. By replacing manual labor and static farming practices with intelligent, dynamic systems, modern technologies and digital tools can increase productivity while requiring less human oversight. This proposed outlines of the agronomic models that ought to be incorporated into an intelligent system that schedules fertilization and irrigation in accordance with the needs of the plants and uses automatic watering to monitor and maintain the appropriate level of soil moisture using the smart sensors and Internet of Things [IoT]. This study presents a cutting-edge drip system for precision irrigation and fertilization, the efficiency of subsurface drip irrigation [SDI] could be similar to drip irrigation but it uses less water. The device initiates the watering function to allow water to be drained to the root zone using pipework if the soil moisture value is found to be within the predetermined range.

KEYWORDS: **IOT (Internet of Things), precision irrigation, fertilization, root zone, subsystem drip irrigation.**

I. INTRODUCTION

As the world transitions to new practices and technologies, it is essential to aim for an increase in agriculture. Numerous researchers are employed in the field of agriculture. In the twenty-first century, agriculture has a number of difficulties in producing enough food and fiber to support a growing population. Food, energy, and water security are essential for a long-term, sustainable economy. The agricultural industry uses a lot of water, and 70% of groundwater and river water is used for irrigation[1]. The information about the numerous environmental elements is provided by the collected data. Crop output can be increased, but not entirely by monitoring environmental conditions. Numerous additional factors also contribute to a greater degree of productivity decline.Hence automation must be implemented in irrigating fields to overcome these problems [2].

According to the ASAE (American Society of Agricultural Engineers) Standards, subsurface drip irrigation, or SDI, is "the application of water below the soil surface though emitters with discharge rates generally in the same range as drip irrigation".So, apart from the particulars mentioned above, an SDI unit is just a network of drip irrigation buried to a given depth.Although subsurface drip irrigation (SDI) uses less water than drip irrigation, its efficiency may be comparable. In terms of surface irrigation, it could result in water savings of up to 25% to 50% [3].

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II. LITERATURE SURVEY

A review of the literature is crucial for identifying the unique approach. Comprehending the analysis conducted by multiple writers on the suggested subject and outlining the approach, along with its advantages and disadvantages, is beneficial.

Table No.1- Literature Survey

Ref.	Findings
[1]	-This article elaborates the potential of solar fertigation systems to improve sustainability, efficiency, and productivity in agriculture while also reducing environmental impacts. -The authors propose an integrated approach combining IoT (Internet of Things) For smart Irrigation in agriculture.
[2]	-The authors present an automated Irrigation control system specifically designed for greenhouse crop production. -IoT-based irrigation systems use soil moisture sensors to measure the moisture content in the soil. These sensors provide real-time data, helping the system determine when and how much water is needed.
[3]	-This article provides a comprehensive overview of SDI technology, its management practices, benefits, and challenges involved in agricultural water management. -The authors propose Subsurface drip irrigation (SDI) it is an advanced method of irrigation in which water is delivered directly to the root zone of plants through a network of buried pipes and emitters. -Researchers often investigate the management of nutrients in SDI systems, ensuring that fertilizers are effectively delivered to the root zone while minimizing nutrient loss.
[4]	-This review paper summarizes the current state of the art in automatic Irrigation in precision agriculture. -It discusses various approaches, technologies, and challenges involved in achieving optimal Irrigation practices.
[5]	-The study emphasized how real-time data transfer made possible by 5G connectivity improves precision agriculture decision-making's responsiveness and speed. -The purpose of this study was to highlight the use of WSN and IoT in agriculture and to provide a comprehensive analysis of sensor and IoT data analytics for agricultural applications.
[6]	-In order to maximize system efficiency and lifetime, the study emphasized the significance of choosing the appropriate installation depth depending on soil type, crop characteristics, and local environmental circumstances.
[7]	-This paper uses ARM7 (LPC2148), Raspberry-pi and zigbee modules. -The paper shows two primary sections: the field area, which has the ARM7, zigbee, and sensors, and the control section, which has the raspberry pi and the zigbee components.

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III. BLOCK DIAGRAM

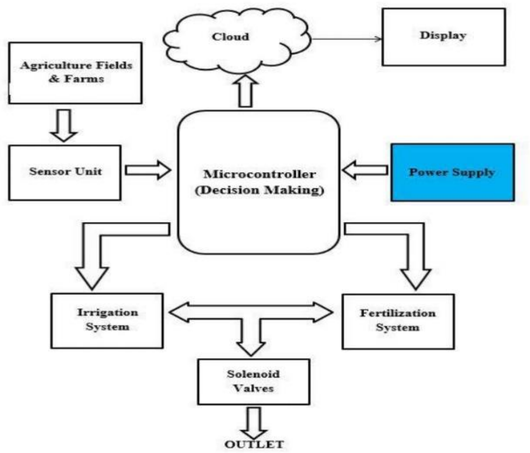

Fig No.1 Block Diagram

IV. CIRCUIT DIAGRAM

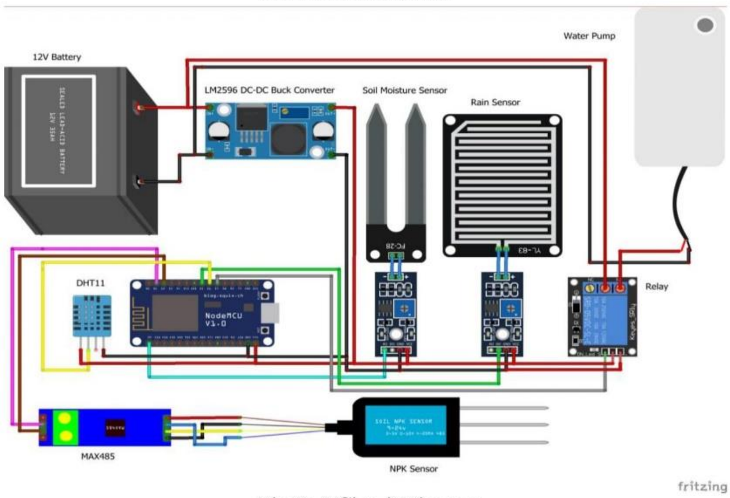

Fig No.2 Circuit Diagram

Fig No.2 shows the designing, building, and debugging electrical and electronic systems. All of the hardware components, including the ESP8266, soil moisture sensor, relay, and numerous other devices, are shown in the circuit diagram above. The circuit diagram shows how the parts are put together on the PCB board. It displays the circuit's parts and their connections in addition to the information or current flowing through the circuit.

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The hardware specifications for the implementation are provided in the ensuing section.

a) ESP8266 Microcontroller:

The ESP8266 microcontroller chip is a popular and affordable microcontroller chip with built-in Wi-Fi capabilities, which makes it perfect for Internet of Things applications. It allows for quick prototyping and provides a wealth of support resources because to its compatibility with Arduino and vast developer community.

b) Soil moisture sensor:

A soil moisture sensor is a tool used to gauge the soil's moisture content. Usually, two or more probes are put into the soil, and the electrical resistance between the probes is used to calculate the moisture content. In order to improve irrigation schedules and avoid overwatering or underwatering of plants, soil moisture sensors are widely employed in gardening and agriculture.

c) DHT11 sensor:

Accurate temperature measurements between 0°C and 50°C and humidity readings between 20% and 90% are provided by the DHT11 sensor. The DHT11 sensor is frequently used in applications including weather stations, environmental monitoring, and home automation systems because of its user-friendly interface and reasonable cost.

d) Watering pump:

For all of your water pumping needs, the R385 Diaphragm Mini Water Pump 12VDC is the ideal choice. This pump operates on 12V DC and provides dependable performance, guaranteeing a constant water flow.A premium diaphragm pump made for effective water pumping is the R385 Diaphragm Mini Water Pump 12VDC.

e) NPK sensor:

A tool called an NPK sensor is used to gauge the concentrations of potassium (K), phosphorus (P), and nitrogen (N) in soil and other media. These sensors measure the amounts of these vital nutrients using a variety of methods, including spectroscopy, electrochemical analysis, and ion-selective electrodes.

f) Rain drop sensor:

An electrical device called a raindrop sensor is used to identify raindrops or other water droplets. Usually made up of two conductive electrodes, it measures how the conductivity varies in the presence of water and outputs a signal.

The following section gives the datails regarding software used for the implementation.

For app developers, Kodular offers a vast array of capabilities and components, ranging from more sophisticated features like camera integration, database connectivity, and social media integration to user interface elements like buttons, labels, and text boxes. In addition, the platform comes with a companion app that lets users test their apps in real time on their devices—all without requiring an emulator or a physical device. App developers can choose from a range of revenue streams offered by Kodular, such as in-app purchases, in-app advertising, and

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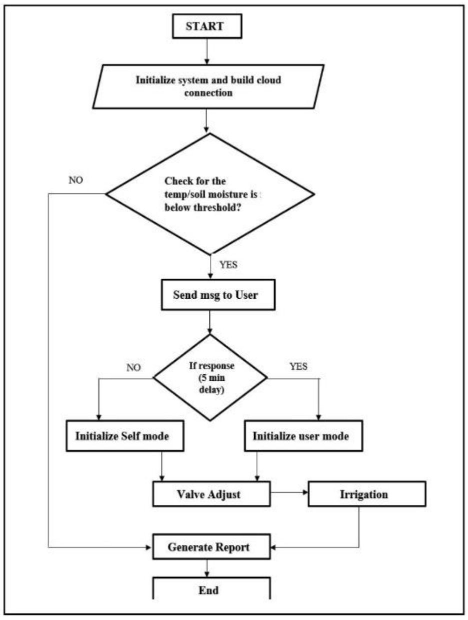
subscriptions. Additionally, the platform offers data tracking and analytical tools that let developers keep an eye on how well their apps are performing and decide what needs to be updated or improved.

V. FLOW CHART



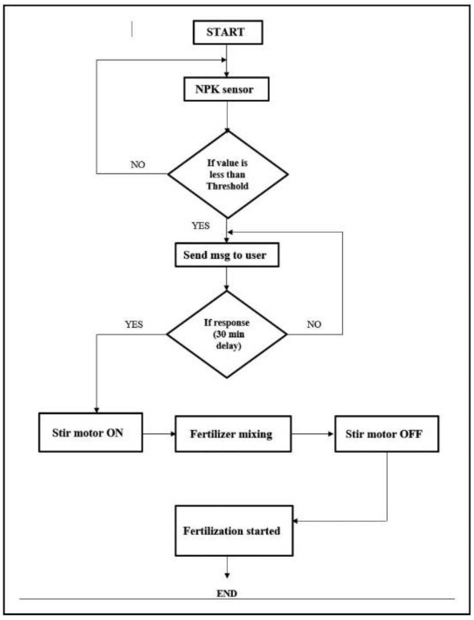


Fig No.3 Flow chart for Irrigation **Fig No.4 Flow chart for Fertilization**

VI. RESULTS

Soil moisture, nutrient levels, and possibly weather conditions are monitored by sensors placed in the soil.Data from these sensors is transmitted to a ESP8266 controller for analysis.The controller processes this data to determine the precise irrigation and fertilization requirements for plant's root zone.Based on the analysis, the controller sends signals to motors connected to pipes, regulating the flow of water and fertilizers.

Feedback mechanisms is employed to continuously monitor soil conditions and adjust irrigation and fertilization parameters in real-time.This automated system ensures that plants receive optimal hydration and nutrient levels, promoting healthy growth while conserving resources.

a) Irrigation system :

The fig no.5 shows the actual irrigation system at the time of demonstration, if the threadshold value of soil moisture sensor becomes >50 the subsurface irrigation system starts.Their are two containers which provides irrigation and fertilization to the field. The pipelines are buried inside the soil to ensure minimal use of water and nutrients.

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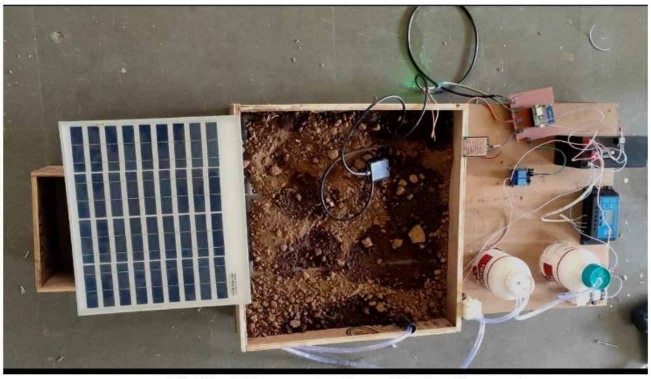

Fig No.5 Demonstration of irrigation system

b) Application for displaying values:

The fig no.6 and 7 shows the values detected by the moisture, NPK, and temperature sensor and shows whether the rain is detected or not. If rain is detected the moisture level will increase above 50 and then irrigation system will stop.

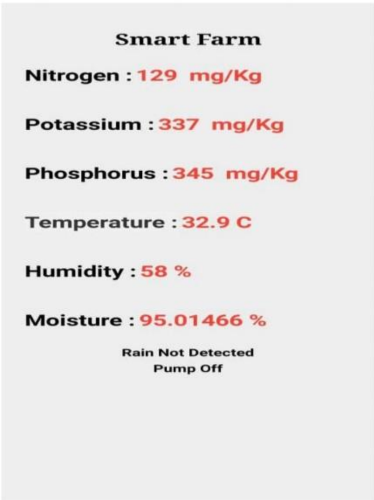

Fig No.6 Pump OFF status

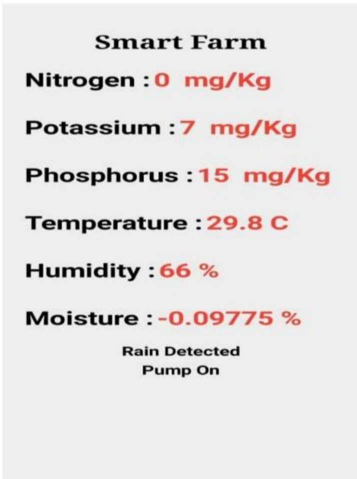

Fig No.7 Pump ON status

c) Fertilization system:

The fig no.8 shows the implementation of fertilization, the first container contains fertilizer and second contains water. If fertilization is required then fertilizer is added into the water manually and then it is distributed to the field.

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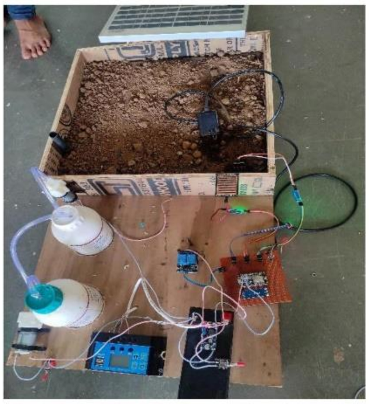

Fig No.8 Demonstration of fertilization system

Emitters along the drip lines discharge water and nutrients in exact amounts that reach the plant's root zone. By reducing weed growth and minimizing water loss through evaporation, the subsurface placement of drip lines improves plant health and efficiency.The solar panel acts as an energy source to the overall system.

VII. CONCLUSION

This automated irrigation and fertigation system successfully implements irrigation and fertigation automation, leading to the conclusion that it is a useful system. The irrigation automation operates in accordance with the constant monitoring of the sensor threshold values. The message is sent in response to irrigation demand, causing the irrigation to begin or stop right away. We also receive continual sensor status updates via the Kodular platform. Finally, we may access and operate the electrical and water flow control system remotely with the help of this technology.

VIII. ACKNOWLEDGEMENT

We wish to express our deep, sincere gratitude to our guide Prof. S. T. Matale for their excellent guidance, encouragement, support, and insightful comments throughout the period of our bachelor's degree. Whatever knowledge and experience we have gained during ours study here; we owe it to him. He has been our pillar of strength during times of downfalls.

Our work could not have been completed without the support of our collage, other teaching as well as non- teaching staff members of the electronics and telecommunication engineering department. We are also thankful To SGM Education Group and Research Centre Mahagaon, for giving us the opportunity to carry out our project work.

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The Board of IJIRCCE is hereby awarding this certificate to

ROSHAN A AVADAN

Final Year Engineering Student, Department of Electronics and Telecommunication Engineering, Sant Gajanan Maharaj College of Engineering, Mahagaon Maharashtra, India

in Recognition of Publication of the Paper Entitled

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in IJIRCCE, Volume 12, Issue 4, April 2024

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