PROJECT REPORT

PROJECT NAME : Smart Farmer - IoT Enabled Smart Farming Application

TEAM ID : PNT2022TMID53630

TEAM LEAD : Revilla Jyosthna

TEAM MEMBERS : Pannave . K

Iyswarya . S

Pritha . R

Project Report Format

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1. INTRODUCTION

1.1 Project Overview

IoT-based agriculture system helps the farmer in monitoring different parameters of his field like soil moisture, temperature, and humidity using some sensors. Farmers can monitor all the sensor parameters by using a web or mobile application even if the farmer is not near his field. Watering the crop is one of the important tasks for the farmers. They can make the decision whether to water the crop or postpone it by monitoring the sensor parameters and controlling the motor pumps from the mobile application itself.

The parameters like temperature, humidity, and soil moisture are updated to the Watson IoT platform. The device will subscribe to the commands from the mobile application and control the motors accordingly. APIs are developed using Node-RED service for communicating with Mobile Application. A mobile application is developed using the MIT App inventor to monitor the sensor parameters and control the motors.

1.2 Purpose

In order to meet the current global needs of humanity, new solutions and technologies are constantly being proposed and implemented. This has led to the advent of the Internet of Things (IoT). IoT is defined as the network of all objects that are embedded within devices, sensors, machines, software and people through the Internet environment to communicate, exchange information and interact in order to provide a comprehensive solution between the real world and the virtual world . In recent years, IoT has been applied in a series of domains, such as smart homes , smart cities , smart energy , autonomous vehicles , smart agriculture , campus management , healthcare , and logistics . Series of other IoT applications have been described by Shafique et al.

In recent years, with the aim of increasing agricultural production, new solutions and technologies have been introduced in the agriculture sector . An emerging trend is the application of the IoT and big data. A significant number of studies have been focused on research, experiments, and applications . According to the Cisco forecast, over 500 billion loT devices will be connected to the Internet by 2030 . The use of loT and big data will enable smart agriculture and is expected to enhance efficiency and productivity .

2.LITERATURE SURVEY

2.1 Existing problem

Smart Farming using IoT, a solution for optimally monitoring farming conditions

The product will assist farmers by getting live data (Temperature, humidity, soil moisture, UV index, IR) from the farmland to take necessary steps to enable them to do smart farming by also increasing their crop yields and saving resources (water, fertilizers). Tools used are ESP32s, DHT11 Temperature, Humidity Sensor, Soil Moisture Sensor, SI1145 Digital UV Index ,IR ,Visible Light Sensor. Technology used is Node MCU.

2020 IEEE International Students' Conference on Electrical,Electronics and Computer Science (SCEECS)

An IoT based advanced solution for monitoring the soil conditions and atmosphere for efficient crop growth is presented. The developed system is capable of monitoring several sensors connected to it. Also, a notification in the form of SMS will be sent to farmer's phone using Wi-Fi about environmental condition of the field. Tools used are temperature sensors, humidity sensors , wireless LAN, soil moisture level monitoring ,microcontrollers, microcontrollers, Smart phones. Technology used is Node MCU

2018 IEEE/ACIS 17th International Conference on Computer and Information Science (ICIS)

The aim of this research is to propose a traceability system, summarising and presenting observed data from the smart farm. The Internet of Things (IoT) has been introduced in this research, using several sensors to detect the environmental data in the smart farm. Tools used are temperature sensors, Agricultural products, Temperature measurement, Intelligent sensors, Humidity sensor, QR codes. Technology used is Raspberry Pi.

Smart Agriculture: IOT based smart sensors agricultureby Anand Nayyar and Er. Vikram Puri, November 2016

A Novel Smart IOT based Agriculture assisting farmers in getting Live Data(Temperature, Soil Moisture) for efficient environment monitoring which will enable them to do smart farming and increase their overall yield and quality of products. Tools used are Water level sensor, Buzzer, LCD, Moisture sensor. Technology used is Arduino UNO.

2.2 References

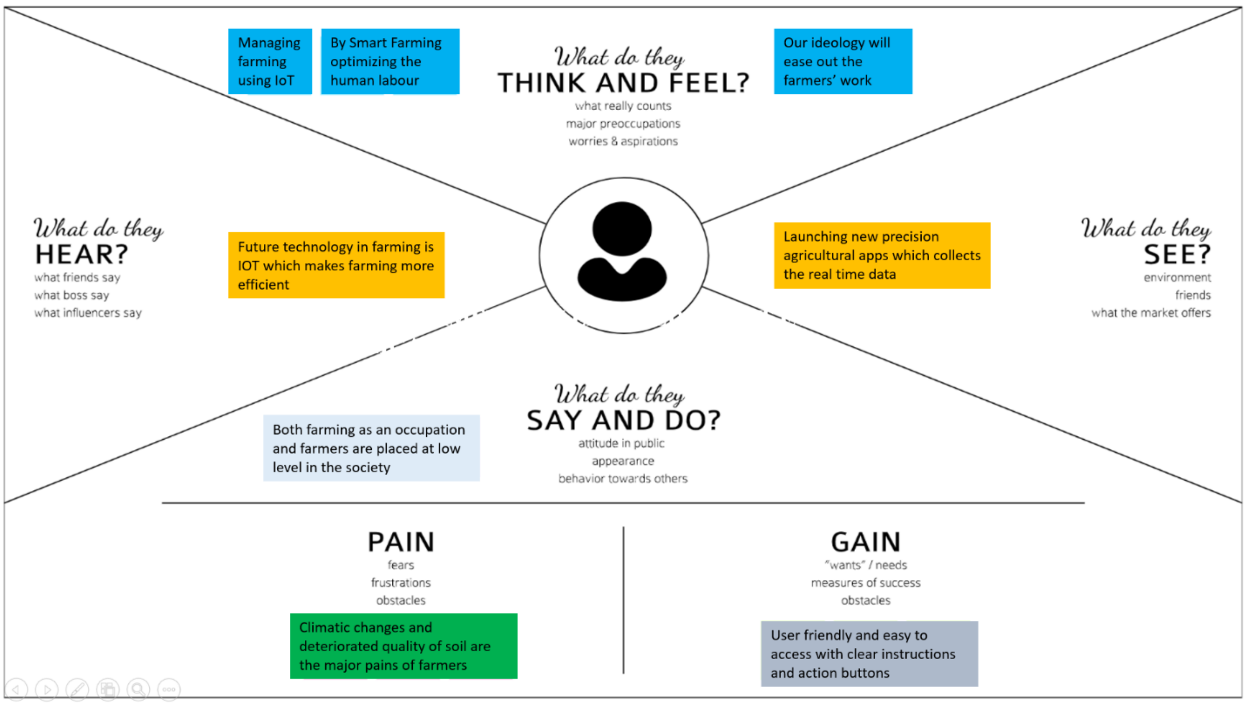
- Farooq, M.S.; Riaz, S.; Abid, A.; Abid, K.; Naeem, M.A. A Survey on the Role of IoT in Agriculture for the Implementation of Smart Farming. IEEE Access 2019, 7, 156237–156271.
- Kassim, M.R.M. IoT Applications in Smart Agriculture: Issues and Challenges. In Proceedings of the IEEE Conference on Open Systems (ICOS), Kota Kinabalu, Malaysia, 17–19 November 2020; pp. 19–24.
- Boursianis, A.D.; Papadopoulou, M.S.; Gotsis, A.; Wan, S.; Sarigiannidis, P.; Nikolaidis, S.; Goudos, S.K. Smart Irrigation System for Precision Agriculture—The AREThOU5A IoT Platform. IEEE Sens. J. 2020, 21, 17539–17547.
- N Putjaika, S Phusae, A Chen-Im, P Phunchongharn, K .A control system in an intelligent farming by using arduino technology 2016 Fifth ICT International Student Project Conference (ICT-ISPC), p. 53 - 56

2.3 Problem Statement Definition

Our objective is to design a IoT Enabled Smart Farming Application which generates messages on different platforms to notify farmers. Our product will assist farmers by obtaining the realtime data from the farmland to take necessary steps during unfavourable conditions. Our proposed product uses NodeMCU, DHT11 Temperature and Humidity Sensor, Soil Moisture Sensor, Relay Coil, AC Motor Pump, Buzzer. Farmers can monitor all the sensor parameters by using a web / mobile application / dashboard even if the farmer is not near his field. Watering the crop is one of the important tasks for the farmers. They can make the decision whether to water the crop or postpone it by monitoring the sensor parameters and control the motor pumps from the mobile application itself.

3. IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas



3.2 Ideation & Brainstorming

- Temperature and Humidity sensor to detect the temperature and humidity of the soil
- Moisture sensor to detect moisture content of soil
- Trigger the motor to pump water if threshold of moisture sensor is low, through the website
- Using a buzzer to give an alarming sound to indicate danger
- Connecting NodeMCU and IBM Watson cloud to reflect real time values in dashboard that is the cloud
- Send SMS during emergency

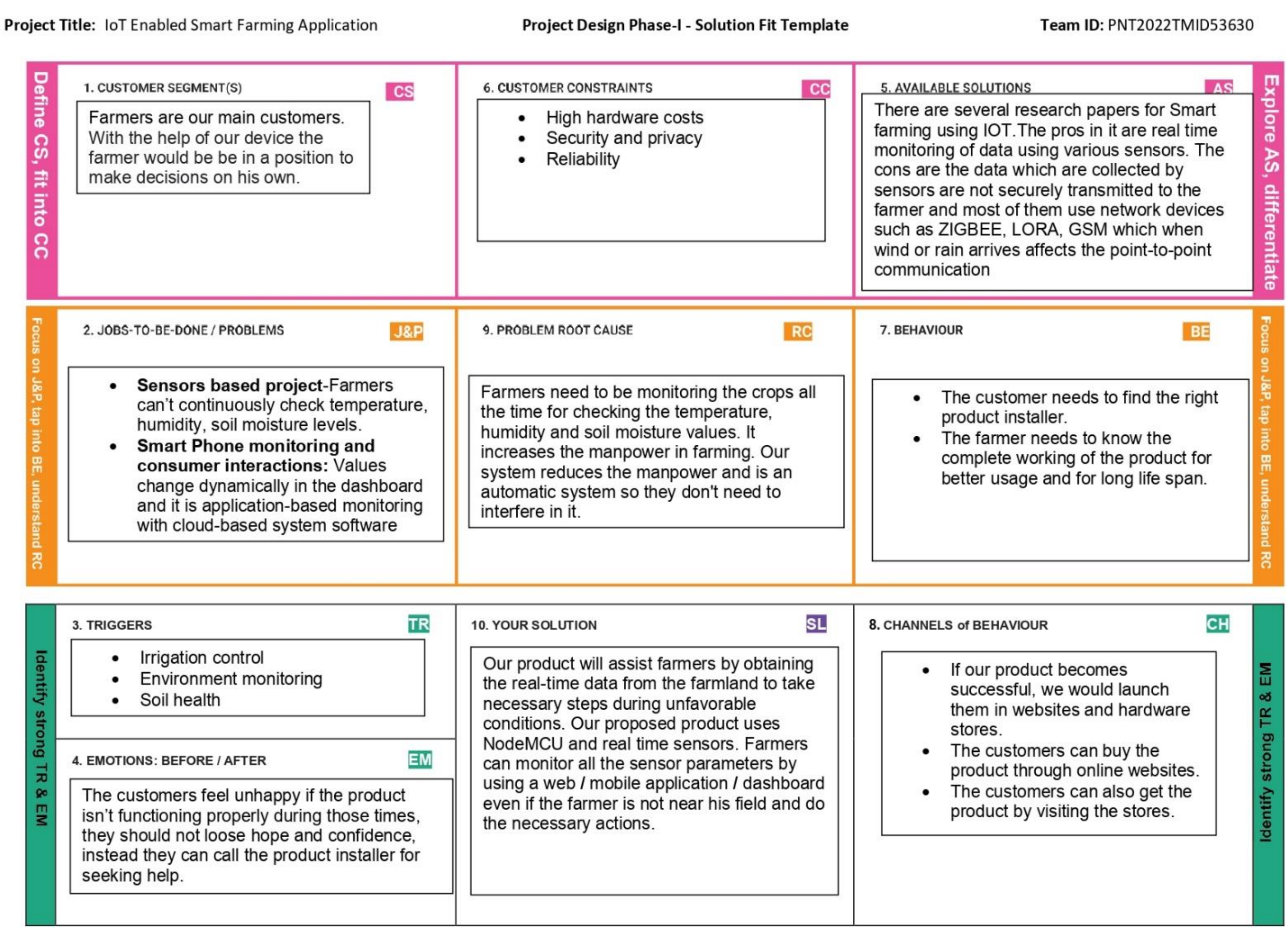
  PRIORITIES:
- Interfacing all the sensors with the microcontroller

- Controlling the water pump
- Produce an alarming sound during emergency

3.3 Proposed Solution

Our proposed system provides a solution for secure transmission of the real time data obtained from the sensors to the IBM cloud rather than using the networking devices like Zigbee, LORA, GSM modules which causes the interference of data obtained from multiple users. Our product is cost effective, since for communication to farmers we have a web dashboard rather using hardware devices. Our product enables automatic real time decision-making in an environment composed of dozens of thousands of sensors continuously transmitting data through the web dashboard without causing any interference All the IOT end devices are controlled using standalone rechargeable batteries so that the product would last for a long span. The farmer can control his farm irrespective of his place/location

3.4 Problem Solution fit



Project Title: IoT Enabled Smart Farming Application | **Project Design Phase-I - Solution Fit Template** | **Team ID:** PNT2022TMID53630

Define CS, fit into CC

1. CUSTOMER SEGMENT(S) — CS

Farmers are our main customers. With the help of our device the farmer would be be in a position to make decisions on his own.

6. CUSTOMER CONSTRAINTS — CC

- High hardware costs
- Security and privacy
- Reliability

5. AVAILABLE SOLUTIONS — AS

There are several research papers for Smart farming using IOT.The pros in it are real time monitoring of data using various sensors. The cons are the data which are collected by sensors are not securely transmitted to the farmer and most of them use network devices such as ZIGBEE, LORA, GSM which when wind or rain arrives affects the point-to-point communication

Explore AS, differentiate

Focus on J&P, tap into BE, understand RC

2. JOBS-TO-BE-DONE / PROBLEMS — J&P

- **Sensors based project**-Farmers can't continuously check temperature, humidity, soil moisture levels.
- **Smart Phone monitoring and consumer interactions:** Values change dynamically in the dashboard and it is application-based monitoring with cloud-based system software

9. PROBLEM ROOT CAUSE — RC

Farmers need to be monitoring the crops all the time for checking the temperature, humidity and soil moisture values. It increases the manpower in farming. Our system reduces the manpower and is an automatic system so they don't need to interfere in it.

7. BEHAVIOUR — BE

- The customer needs to find the right product installer.
- The farmer needs to know the complete working of the product for better usage and for long life span.

Focus on J&P, tap into BE, understand RC

Identify strong TR & EM

3. TRIGGERS — TR

- Irrigation control
- Environment monitoring
- Soil health

4. EMOTIONS: BEFORE / AFTER — EM

The customers feel unhappy if the product isn't functioning properly during those times, they should not loose hope and confidence, instead they can call the product installer for seeking help.

10. YOUR SOLUTION — SL

Our product will assist farmers by obtaining the real-time data from the farmland to take necessary steps during unfavorable conditions. Our proposed product uses NodeMCU and real time sensors. Farmers can monitor all the sensor parameters by using a web / mobile application / dashboard even if the farmer is not near his field and do the necessary actions.

8. CHANNELS of BEHAVIOUR — CH

- If our product becomes successful, we would launch them in websites and hardware stores.
- The customers can buy the product through online websites.
- The customers can also get the product by visiting the stores.

Identify strong TR & EM

4. REQUIREMENT ANALYSIS

4.1 Functional requirement

Following are the functional requirements of the proposed solution

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration through Form Registration through Gmail Registration through LinkedIN
FR-2	User Confirmation	Confirmation via EmailConfirmation via OTP
FR-3	User Login	Creating username Creating password Accessing the website
FR-4	Reset Password	Changing the password when user forgot the old password Receiving a link to confirmed mail address or phone number Entering new password
FR-5	User Authentication	Changing password occasionally Adding security questions
FR-6	User logout	Confirmation for logging out Resetting view withgeneric data

4.2 Non-Functional requirements

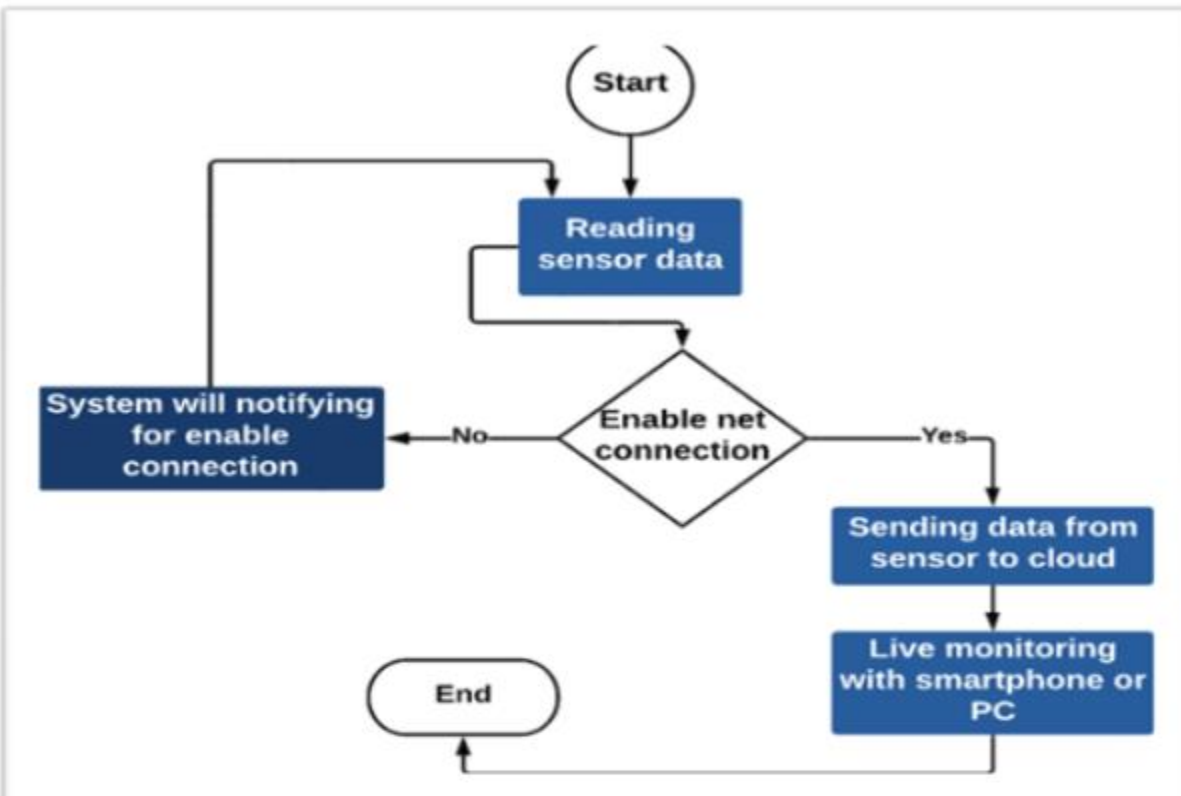
Following are the non-functional requirements of the proposed solution.

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	Our product provides the ease at which the users operate the system andmake productive use of it since the software and hardware part is easily understandable.
NFR-2	**Security**	Our product assures that all data inside the system orits part will be protected against malware attacks or unauthorized access by having authentication keys and tokens.

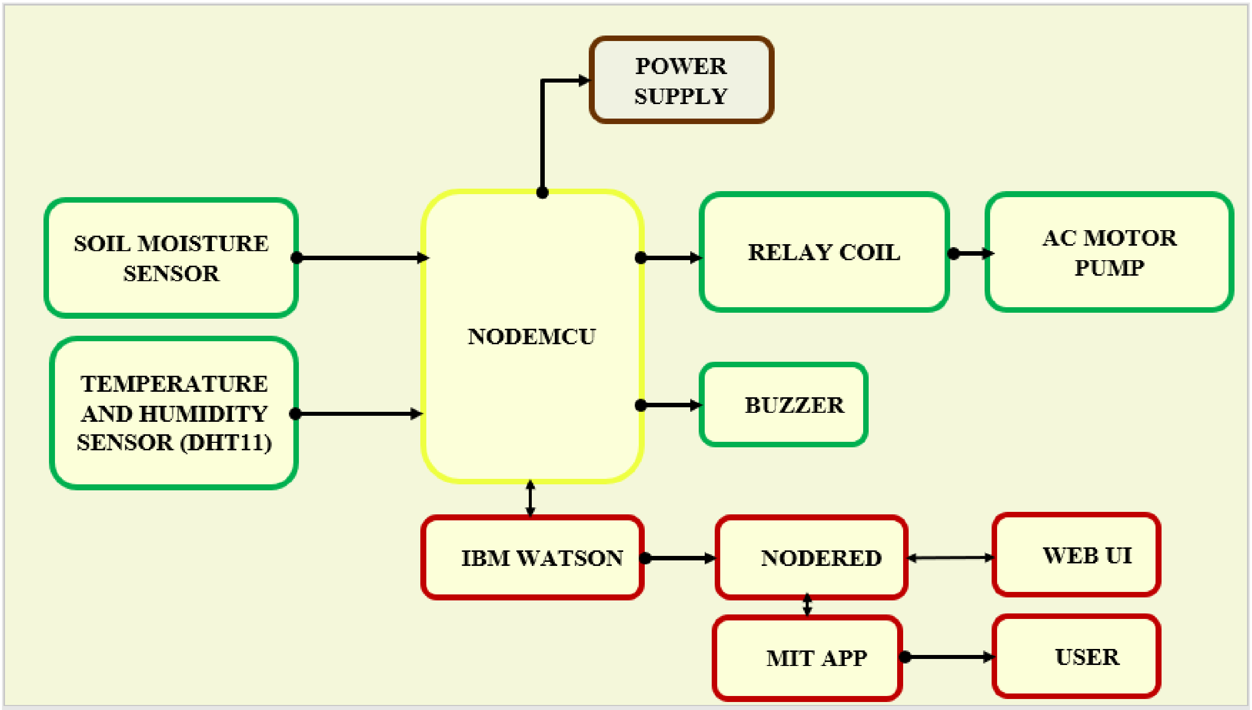
NFR-3	**Reliability**	Our product is more reliable because our software system consistently performs the specified functionswithout any failure
NFR-4	**Performance**	Our product is capable to provide the necessary functionalities to the users
NFR-5	**Availability**	Our system is accessible to the user at a given point intime
NFR-6	**Scalability**	Our product enables continuously transmitting datathrough web dashboard without causing any interference

5. PROJECT DESIGN

5.1 Data Flow Diagrams



5.2 Solution & Technical Architecture



5.3 User Stories

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user)	Registration	USN-1	As a user, I can register for the application by entering my, email password , and confirming my password.	I can access my account / dashboard	High	Sprint-1

		USN-2	As a user, I will receive confirmation email once I have registered for the application	I can receive confirmation email & click confirm	High	Sprint-1
		USN-3	As a user, I can register for the application through Facebook	I can register & access the dashboard with Facebook Login	Low	Sprint-2
		USN-4	As a user, I can register for the application through Gmail	I can register & access the dashboard with Gmail Login	Medium	Sprint-1
	Login	USN-5	As a user, I can log into the applicationby entering email & password	I can access dashboard with email login	High	Sprint-1
	Dashboard	USN-6	As a user I can enter into dashboard by using navigation panel	I can access the dashboardby using navigation panel	High	Sprint-1
Customer (Web user)	Registration	USN-1	As a user, I can register for the web application by entering my email, password, and confirming my password.	I can access my account / dashboard	High	Sprint-1
		USN-2	As a user, I will receive confirmation email once I have registered for the web application	I can receive confirmation email & click confirm	High	Sprint-1
	Login	USN-3	As a user, I can log into the web application by entering email & password	I can access dashboard with email login	High	Sprint-1

	Dashboard	USN-4	As a user I can enter into web dashboardby using navigation panel	I can access into dashboardby using navigation panel	High	Sprint-1
Customer Care Executive	Registration	USN-1	As a user I can contact the customer care service through phone or mail medium	I can receive confirmation SMS or email	High	Sprint-1
		USN-2	As a user I want customer care to answer the questions related to product andservices	I can get the problem solved within a day	High	Sprint-1
		USN-3	As a user I want customer care toregister my complaints	I can receive a confirmation message stating my complaint is registered	High	Sprint-1
		USN-4	As a user I want customer care to collect and analyze consumer feedback	I can get the status of my feedback	High	Sprint-1
		USN-5	As a user I want customer care to troubleshoot technical problems	I can get the problemsolved within a day	High	Sprint-1
Administrator		USN-1	As a user I want the administrator to usegood working hardware	I can get a guarantee and warranty card	High	Sprint-1
		USN-2	As a user I want the administrator to sellthe product in a reasonable rate	I can get the cost of bill of materials	High	Sprint-1
		USN-3	As a user I want the administrator to refund my amount if I am not satisfiedwith the product	I can get an assurance stating I will ge tmy amountback	High	Sprint-1

6. PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning & Estimation

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team members
Sprint-1	**Registration**	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	2	High	**Revilla Jyosthna, Pannave K, Iyswarya S, Pritha R**
Sprint-1	**User confirmation**	USN-2	As a user, I will receive confirmation email once I have registered for the application	1	High	
Sprint-1	**Login**	USN-3	As a user, I can log into the application by entering email & password	1	High	
Sprint-1	**Simulation creation**	USN-4	Connect hardware devices with esp8266	4	High	
Sprint-2	**Dashboard**	USN-5	Real time sensor values are sent to IBM Watson IoT platform and sent to Node-red	4	High	
Sprint-3	**Software**	USN-6	To develop a mobile application using MIT app	4	High	
Sprint-3	**Software**	USN-7	Connecting application with Node-Red and further application development	3	High	
Sprint-4	**Testing**	USN-8	Testing developed application and working model	2	High	

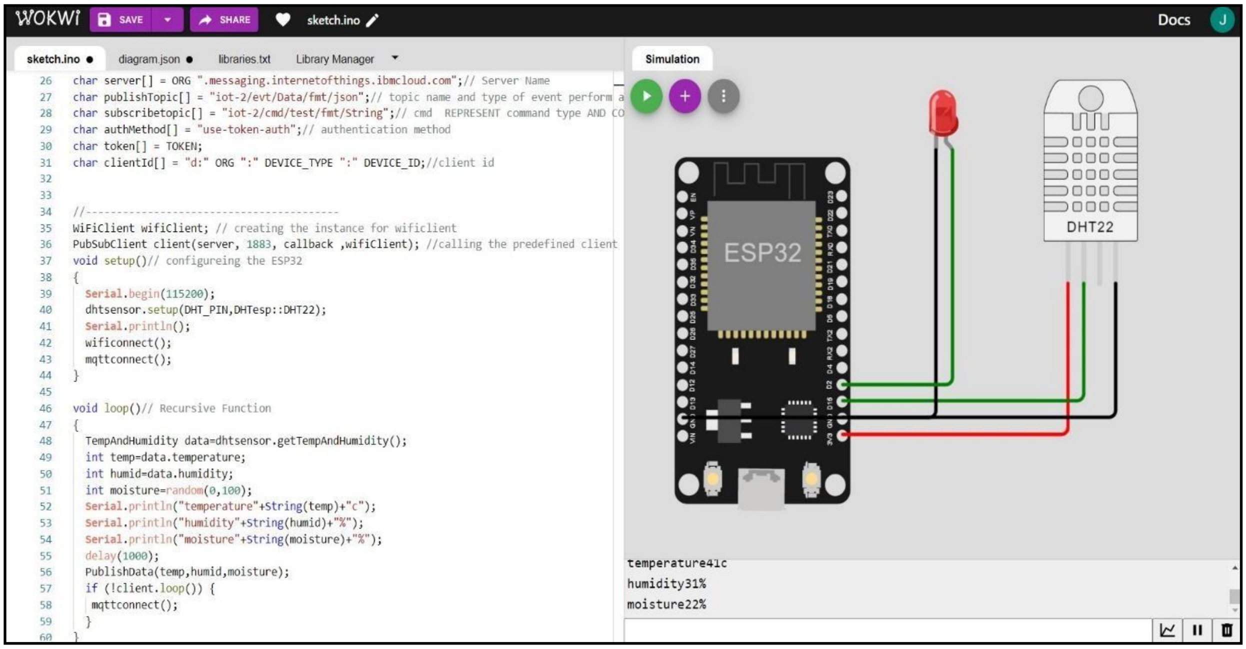
6.2 Sprint Delivery Schedule

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date(Actual)
Sprint-1	20	6 Days	24 Oct 2022	29 Oct 2022	20	29 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	08 Nov 2022

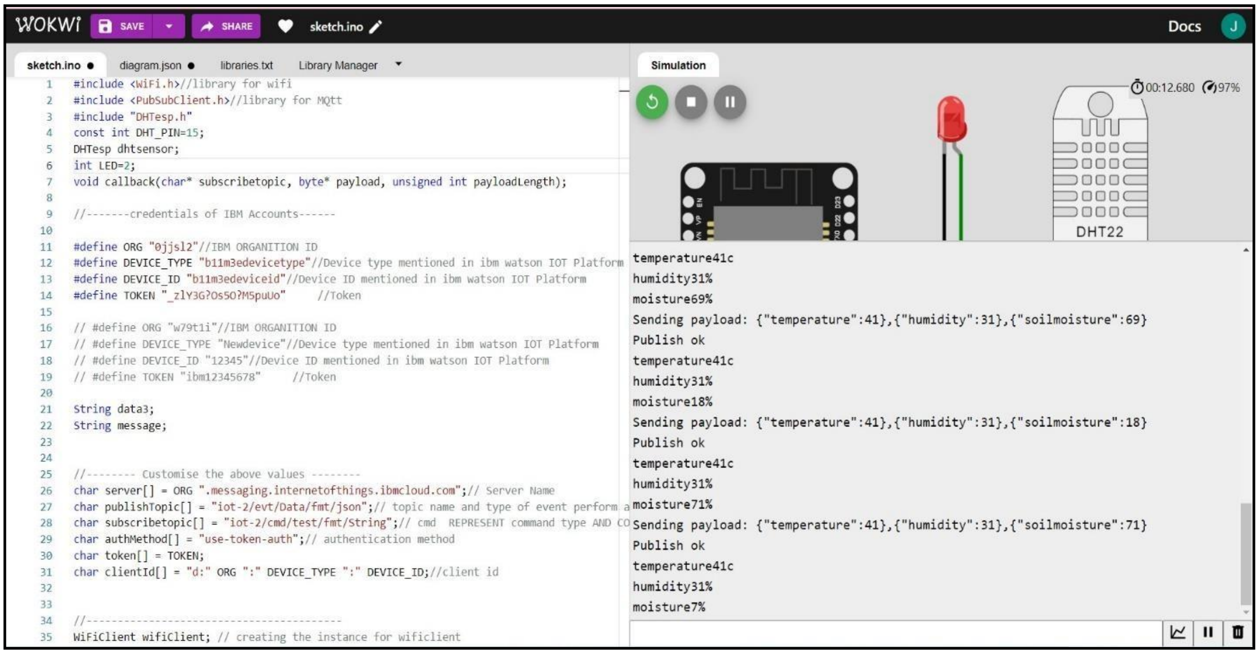
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	14 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	18-19 Nov 2022

7. CODING & SOLUTIONING

7.1 CIRCUIT DIAGRAM

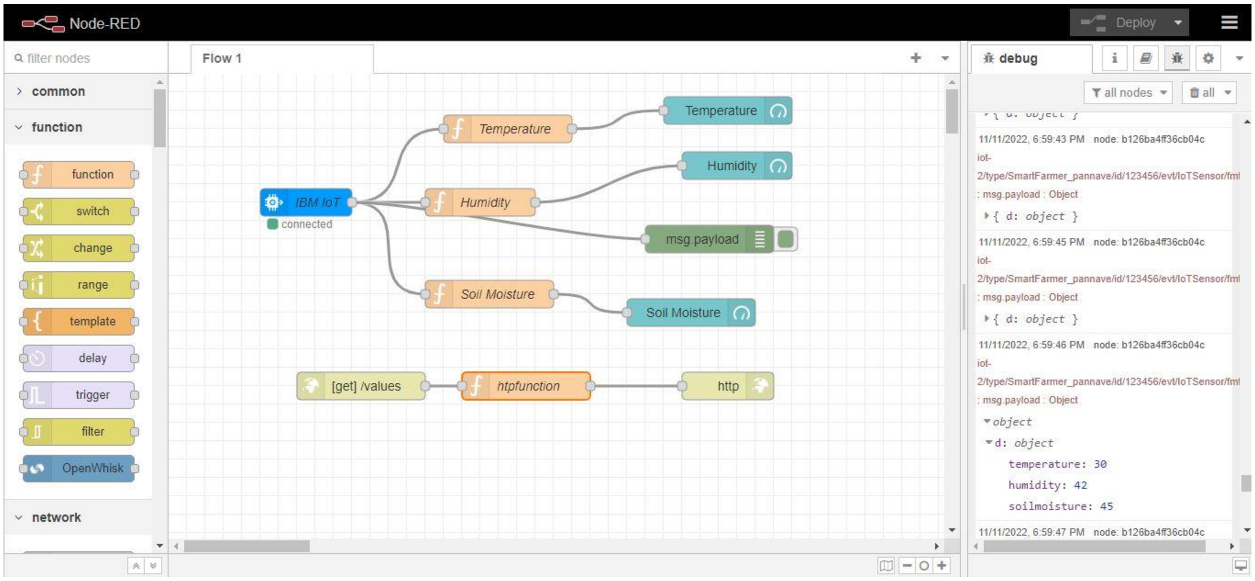


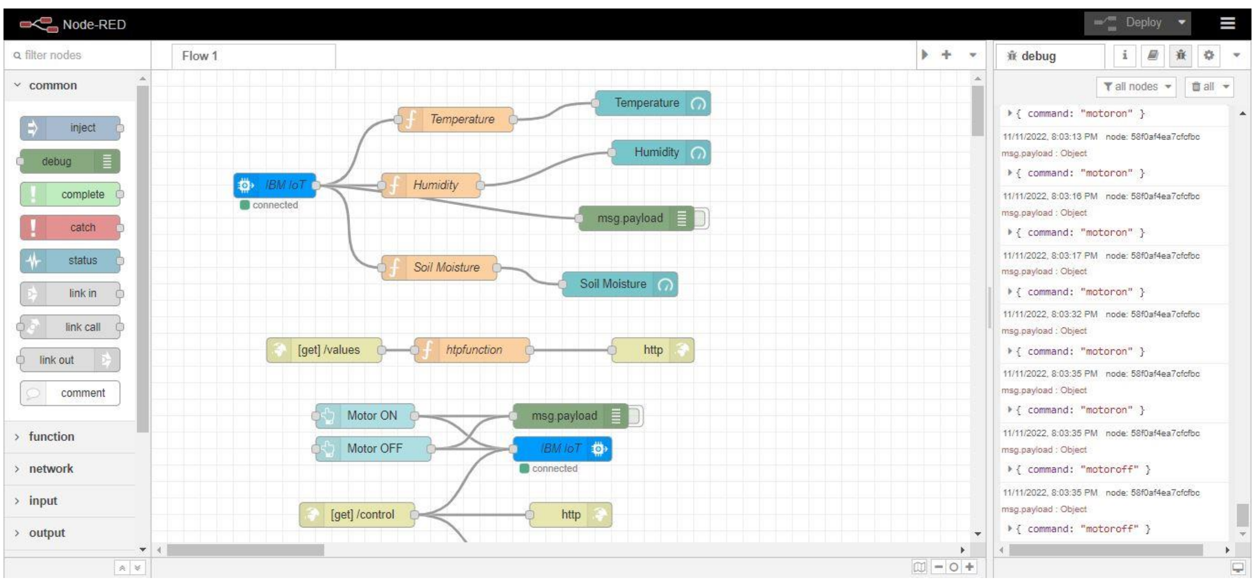
7.2 SENDING DATA TO IBM WATSON CLOUD



8. TESTING

8.1 Test Cases

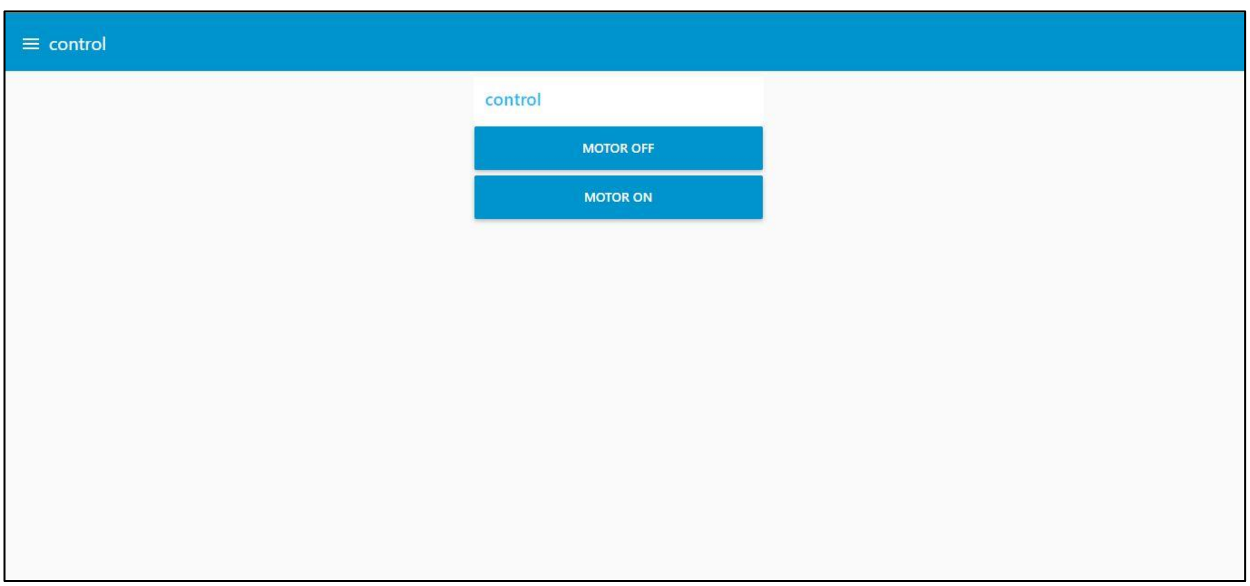




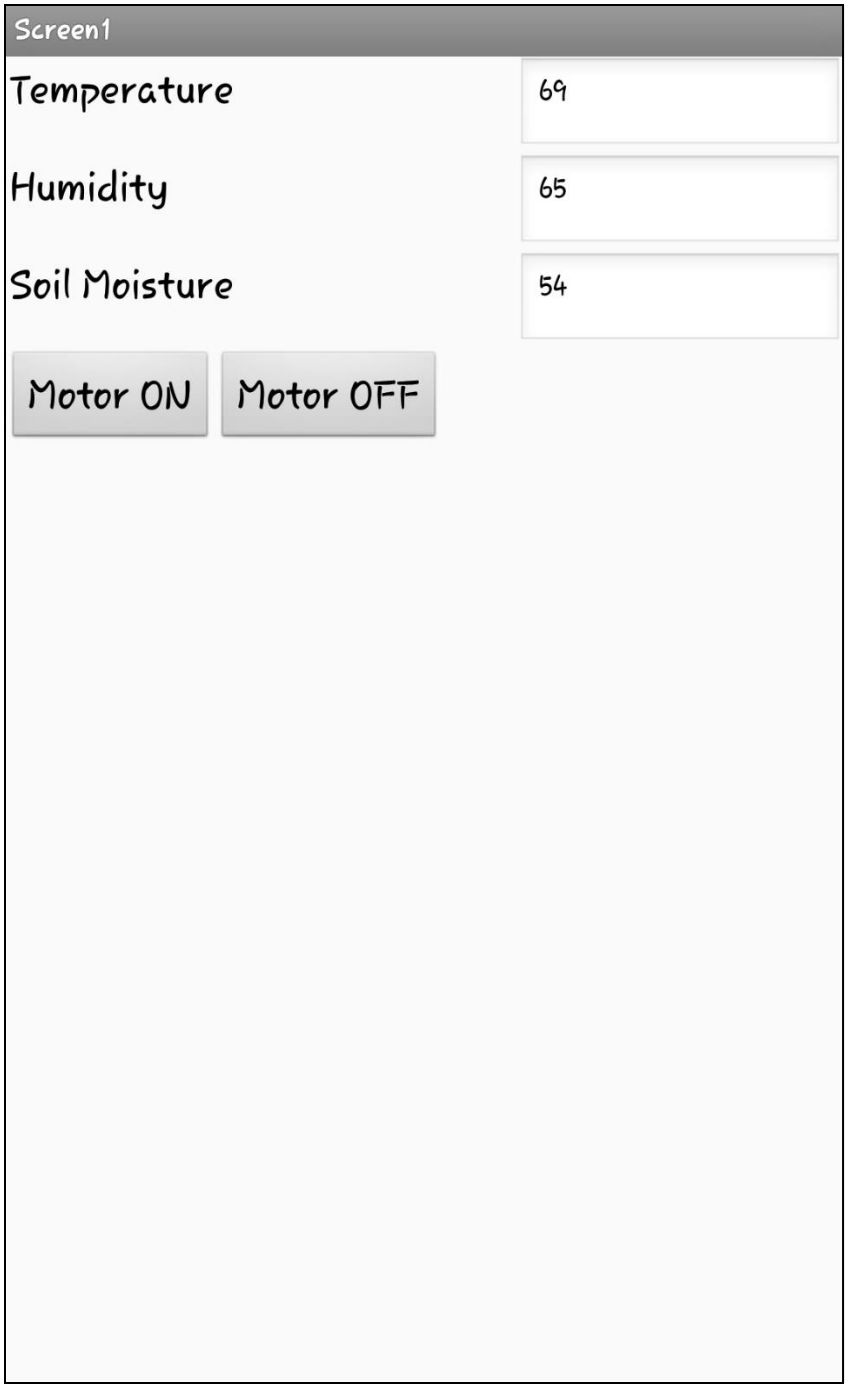
9. RESULTS

9.1 The user interface displaying the sensor values

9.2 The user interface displaying the control actions of user like motor on and motor off



9.3 The final APP which user can look in his/her mobile phone



10. ADVANTAGES & DISADVANTAGES

ADVANTAGES

- **Increased Production**

  Optimized crop treatment such as accurate planting, watering, pesticide application and harvesting directly affects production rates.

- **Water Conservation**

  Weather predictions and soil moisture sensors allow for water use only when and where needed.

- **Real-Time Data and Production Insight**

  Farmers can visualize production levels, soil moisture, sunlight intensity and more in real time and remotely to accelerate decision making process.

- **Lowered Operation Costs**

  Automating processes in planting, treatment and harvesting can reduce resource consumption, human error and overall cost.

- **Increased Quality of Production**

  Analyzing production quality and results in correlation to treatment can teach farmers to adjust processes to increase quality of the product.

- **Accurate Farm and Field Evaluation**

  Accurately tracking production rates by field over time allows for detailed predicting of future crop yield and value of a farm.

- **Improved Livestock Farming**

  Sensors and machines can be used to detect reproduction and health events earlier in animals. Geofencing location tracking can also improve livestock monitoring and management.

DISADVANTAGES

- The smart agriculture needs availability of internet continuously. Rural part of most of the developing countries do not fulfil this requirement. Moreover internet connection is slower.

- The smart farming based equipments require farmers to understand and learn the use of technology. This is major challange in adopting smart agriculture farming at large scale across the countries.

11. CONCLUSION

Thus the smart agriculture using IoT will revolutionized the world of farming and it will increase the productivity as well as improve the quality and can save lives of farmer. There is an urgent need for a system that makes the agricultural process easier and burden free from the farmer's side. With the recent advancement of technology it has become necessary to increase the annual crop production output of our country India, an entirely agro centric economy. The ability to conserve the natural resources as well as giving a splendid boost to the production of the crops is one of the main aims of incorporating such technology into the agricultural domain of the country. To save farmer's effort, water and time has been the most important consideration.

12. FUTURE SCOPE

The prospects are high that smart farming will change agriculture in a great way. Smart farming is expected to bridge the gap between large and small-scale farmers in both developing and developed countries. Technological advancement, growth in the internet of things, and the introduction of smartphones have contributed immensely to the adoption of technology in agriculture. Different countries understand the worth of these technologies, which explains why most countries are eager to promote the implementation of precision farming techniques.

There is no doubt that most agricultural operations that were practiced traditionally have changed significantly nowadays. This can be attributed to technological advancement the adoption of smart farming techniques and methodologies such as the use of machines, devices, sensors, and information technology. Presently, farmers make use of sophisticated technologies like aerial images, moisture and temperature sensors, GPS technology and robots. Such technology makes farming not only to be a profitable venture but also an environmentally friendly, safer, and efficient.

13.APPENDIX

Source Code

```
#include <WiFi.h>//library for wifi
#include <PubSubClient.h>//library for MQtt
#include "DHTesp.h"
const int DHT_PIN=15;
DHTesp dhtsensor;
int LED=9;
void callback(char* subscribetopic, byte* payload, unsignedintpayloadLength);

//-------credentials of IBM Accounts------

#define ORG "w79t1i"//IBM ORGANITION ID
#define DEVICE_TYPE "Newdevice"//Device type mentioned in ibm Watson IOT Platform
#define DEVICE_ID "12345"//Device ID mentioned in ibm watson IOTPlatform
#define TOKEN "ibm12345678"                //Token

String data3;
String message;

//-------- Customise the above values --------
char server[] = ORG ".messaging.internetofthings.ibmcloud.com";// ServerName
char publishTopic[] = "iot-2/evt/Data/fmt/json";// topic name and type of eventperform and format in
which data to be send


char subscribetopic[] = "iot-2/cmd/test/fmt/String";// cmd REPRESENTcommand type AND
COMMAND IS TEST OF FORMAT STRING
char authMethod[] = "use-token-auth";// authentication method
char token[] = TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;//client id

//_______________________________________
WiFiClient wifiClient; // creating the instance for wificlient
PubSubClient client(server, 1883, callback ,wifiClient); //calling the predefined client id by passing
parameter like server id,portand wificredential
void setup()// configuring the ESP32
{
   Serial.begin(115200);
   dhtsensor.setup(DHT_PIN,DHTesp::DHT22);
   Serial.println();
   wificonnect();
   mqttconnect();
}
```

```
void loop()// Recursive Function
{
    TempAndHumidity data=dhtsensor.getTempAndHumidity();
    int temp=data.temperature;
    int  humid=data.humidity;
     int  moisture=random(0,100);
    Serial.println("temperature"+String(temp)+"c");
    Serial.println("humidity"+String(humid)+"%");
    Serial.println("moisture"+String(moisture)+"%");
    delay(1000);
    PublishData(temp,humid,moisture);
    if (!client.loop()) {
     mqttconnect();
    }
}
/*...................................retrieving to Cloud......................................................*/

  void PublishData(int d,int a,int b) { mqttconnect();//function call
    for connecting to ibm
    /*
       creating the String in in form JSon to update the data to ibm cloud
    */
    String payload = "{\"temperature\":";payload += d;
    payload += "}";
    payload += "," "{\"humidity\":";
    payload += a;
    payload += "}";
    payload += "," "{\"soilmoisture\":";
    payload += b;
    payload += "}";

    Serial.print("Sending payload: ");
    Serial.println(payload);


    if (client.publish(publishTopic, (char*) payload.c_str())) {
     Serial.println("Publish ok");// if it sucessfully upload data on the cloud then itwill print publish ok
in Serial monitor or else it will print publish failed
    } else {
      Serial.println("Publish failed");
    }

}
```

```
void mqttconnect() {
    if (!client.connected())
    {
     Serial.print("Reconnecting client to ");
     Serial.println(server);
      while (!!!client.connect(clientId, authMethod, token)) {
        Serial.print(".");delay(500);
      }

       initManagedDevice();
            Serial.println();

    }
}
void wificonnect() //function defination for wificonnect
{
         Serial.println();
    Serial.print("Connecting to ");


  WiFi.begin("Wokwi-GUEST", "", 6);//passing the wifi credentials to establish the connection
    while (WiFi.status() != WL_CONNECTED) {delay(500);
           Serial.print(".");


    }
     Serial.println("");
     Serial.println("WiFi connected");
     Serial.println("IP address: ");
     Serial.println(WiFi.localIP());


void initManagedDevice() {
    if (client.subscribe(subscribetopic)) {
      Serial.println((subscribetopic)); Serial.println("subscribe to
      cmd OK");
    } else {
      Serial.println("subscribe to cmd FAILED");
    }
}

void callback(char* subscribetopic, byte* payload, unsignedint payloadLength)
{
```

```
    Serial.print("callback invoked for topic: ");
    Serial.println(subscribetopic);
    for (int i = 0; i < payloadLength; i++) {
      //Serial.print((char)payload[i]); data3 +=
      (char)payload[i];
    }

    Serial.println("data: "+ data3);if(data3=="motoron")
    {
Serial.println(data3);
digitalWrite(LED,HIGH);

    }

    else
    {
Serial.println(data3);
digitalWrite(LED,LOW);

    }
data3="";

}
```

GitHub Link

https://github.com/IBM-EPBL/IBM-Project-11040-1659255706

Project Demo Link

https://drive.google.com/file/d/1SXtlcMHm6jYEF3D6y3M3tKE6wxOmymJP/view?usp=sharing