Smart Farmer

IoT Enabled Smart Farming Application

Team ID: PNT2022TMID12911

Bachelor of Engineering

Electronics and Communication Engineering

PSG College Of Technology

Coimbatore – 641004

Faculty Evaluator : Dr. Manoharan v k

Faculty Mentor : Dr. G. Srivatsun

Team Members:

718019L231 – Pavithra M

718019L252 - Sona S

718019L237 – Prikshit singh

718020L432 - Pradeip B

1: INTRODUCTION

The main objective of this project is to design a IoT based Smart farming system which helps farmers to monitor their fields by monitoring the field parameters such as soil moisture, temperature and humidity etc. Monitoring systems helps to enhance the crop productivity. IoT technology is an evolving technology in recent times. Conventional farming requires manual labors to monitor the field condition which was the time-consuming process. To overcome this downside, smart farming concept was introduced. Through smart farming, farmers can automate the process of farming through the IoT based Mobile/Web application.

1:1: Project Overview

Temperature, Humidity are the important factors which affects the quality and productivity of the plant growth. Continuous monitoring of these parameters helps to provide valuable information to the farmers which in term helps to automate the irrigation process. This IoT based Smart farmer system will continuously monitor the temperature, humidity of the field update those value to the IoT based cloud application. Farmer can monitor their fields through the IoT based application. They can also control the end devices like pump motors to supply water to their fields through IoT based application.

1:2: Purpose

The purpose of smart farmer project is to help farmers in the irrigation process. The system provides various parameters like temperature, humidity etc. to monitor the condition of the fields and to protect the crops. Based on the temperature, soil moisture, water level of the field etc., and system will take necessary action and the entire operation can be controlled by the IoT application.

2: LITERATURE SURVEY

2:1 Existing Problem

The main problem in the conventional farming is wastage of water, use of fertilizers and use of human resource. To overcome these problems a smart farming system has been proposed. In this project irrigation process will be done automatically using different sensors like Temperature sensor, Humidity sensor etc. This project helps to replace the manual work. The proposed system will monitor crop-field using Temperature sensor, Humidity sensor, Soil moisture sensor etc. By monitoring these parameters the irrigation process can be automated.

2:2:References

S.NO	Paper Title	Author	Journal name& year of publication	Description
1	IoT Enabled Smart Farming And Irrigation System	M. Rohith, R Sainivedhana, Dr. N. Sabiyath Fatima	IEEE 2021	In this paper, authors have demonstrated a IoT enabled smart farming and irrigation system to automate the process of watering to plants. This system helps to measure the values of various parameters such as humidity, moisture and temperature of plants and water them accordingly. This system consists of three sensors which will sense the values of humidity, moisture and temperature of plants. If any of the sensor values decreases the motor automatically turns on the water for plants. The ultimate significance of the paper is that most of the manual work is reduced and watering process is automated with the help of IoT enabled devices as a result of which healthy plants can be grown.

2	A Multi-collective, IoT-enabled, Adaptive Smart Farming Architecture	G.Kakamoukas, P. Sariciannidis, G.Livanos, M.Zervakis, D.Ramnalis, V.Polychrnos, T.Karamitsou, A.Folinas, N. Tsitsiokas	IEEE 2019	In this paper, authors have proposed a precision architecture for Smart Farming in order to use precise and efficient approaches for monitoring and processing information from farms, crops, forestry, and livestock aiming at more productive and sustainable rural development. This proposed architecture encloses wireless sensor networks, meteorological stations and unmanned aerial vehicles along with an information processing system that leverages machine learning and computing technologies. The innovation of the proposed architecture lies in the creation of an integrated monitoring and decision support system for efficient allocation of resources and protection of plant capital from the diseases.
3	A Systematic Review of IoT Solutions for Smart Farming	Emerson Navarro, Nuno Costa, and Antonio Pereira	MDPI 2020	In this work, authors have presented a systematic review of the state-of-the-art of IoT adoption in smart agriculture and identified the main components and applicability of IoT solutions. In this particular work it was observed that the use of artificial intelligence and image processing techniques has become more common to improve the management of smart farming. From the identified applications of IoT for smart farming it was observed that the most common application

				is the monitoring of crops. Here, authors showed that different network protocols may be simultaneously used in IoT solutions for smart farming.
4	Internet of Things and LoRaWAN–Enabled Future Smart Farming	Bruno Citoni, Francesco Fioranelli, Muhammad A. Imran,Qammer H. Abbasi		In this paper authors have explained about LoRaWAN which is been under the spotlight in recent years due to its suitability to be the standard communication protocol for IoT deployments. It provides long communication range and low energy consumption by drastically reducing the available data rate. They also explained about the development of LoRaWAN enabled smart agriculture test to improve the understanding about the impact of the limitations using experimental test data, and moving towards building predictive models and adaptive network management algorithms for smart farming using the data collected.
5	A Survey on the Role of IoT in Agriculture for the Implementation of Smart Farming	Muhammad Shoaib Farooq, Shamyla Riaz, Adnan Abid, Kamran Abid, Muhammad Azhar Naeem	IEEE 2019	In this paper, authors have explained the aspects of technologies involved in the domain of IoT in agriculture. They explained about the major components and technologies, network architecture, network layers, network topologies and protocols involved in developing IoT based smart farming system. They also explained about the connection of IoT based agriculture systems with relevant technologies

				including cloud computing, big data storage and analytics and they highlighted the security issues.
6	A Revisit of Internet of Things Technologies for Monitoring and Control Strategies in Smart Agriculture	Amjad Rehman, Tanzila Saba, Muhammad Kashif, Suliman Mohamed Fati, Saeed Ali Bahaj, Huma Chaudhry	MDPI 2021	IoT, in particular, can improve the efficiency of agriculture and farming processes by eliminating human intervention through automation. The fast rise of Internet of Things (IoT)-based tools has changed nearly all life sectors, including business, agriculture, surveillance, etc. These radical developments are upending traditional agricultural practices and presenting new options in the face of various obstacles. The goal of this research is to evaluate smart agriculture using IoT approaches in depth. The paper demonstrates IoT applications, benefits, current obstacles, and potential solutions in smart agriculture. This smart agricultural system aims to find existing techniques that may be used to boost crop yield and save time, such as water, pesticides, irrigation, crop, and fertilizer management.
7	Traffic-Aware Secured Cooperative Framework for IoT-Based Smart Monitoring in Precision Agriculture	Ibrahim Abunadi, Amjad Rehman, Khalid Haseeb, Lorena Parra, Jamie Lloret	MDPI 2022	This study proposes a framework for a system that combines fog computing with smart farming and effectively controls network traffic. Firstly, the proposed framework efficiently monitors redundant information and avoids the inefficient use of

				communication bandwidth. It also controls the number of re-transmissions in the case of malicious actions and efficiently utilizes the network's resources. Second, a trustworthy chain is built between agricultural sensors by utilizing the fog nodes to address security issues and increase reliability by preventing malicious communication. Through extensive simulation-based experiments, the proposed framework revealed an improved performance for energy efficiency, security, and network connectivity in comparison to other related works.

2:3: Problem Statement Definition

Most important factors for the quality and productivity of plant growth are temperature, humidity and light. Continuous monitoring of these environmental variables provides valuable information to the grower to better understand, how each factor affects growth and how to maximize crop productiveness [The optimal greenhouse micro climate adjustment can enable us to improve productivity and to achieve remarkable energy savings especially during the winter in northern countries. WSN composed of hundreds of nodes which have ability of sensing, actuation and communicating, has great advantages in terms of high accuracy, fault tolerance, flexibility, cost, autonomy and robustness compared to wired ones. Moreover, with the onset of IoT and M2M communications, it is poised to become a very significant enabling technology in many sectors, like military, environment, health, home and other commercial areas.

IoT is a general term, covering a number of technologies that allows devices to communicate with each other, with or without human intervention. This paper presents a novel approach to implement wireless greenhouse automation and monitoring system which in a timely manner provides a possibility for screen monitoring of detailed data about the conditions of the greenhouse.

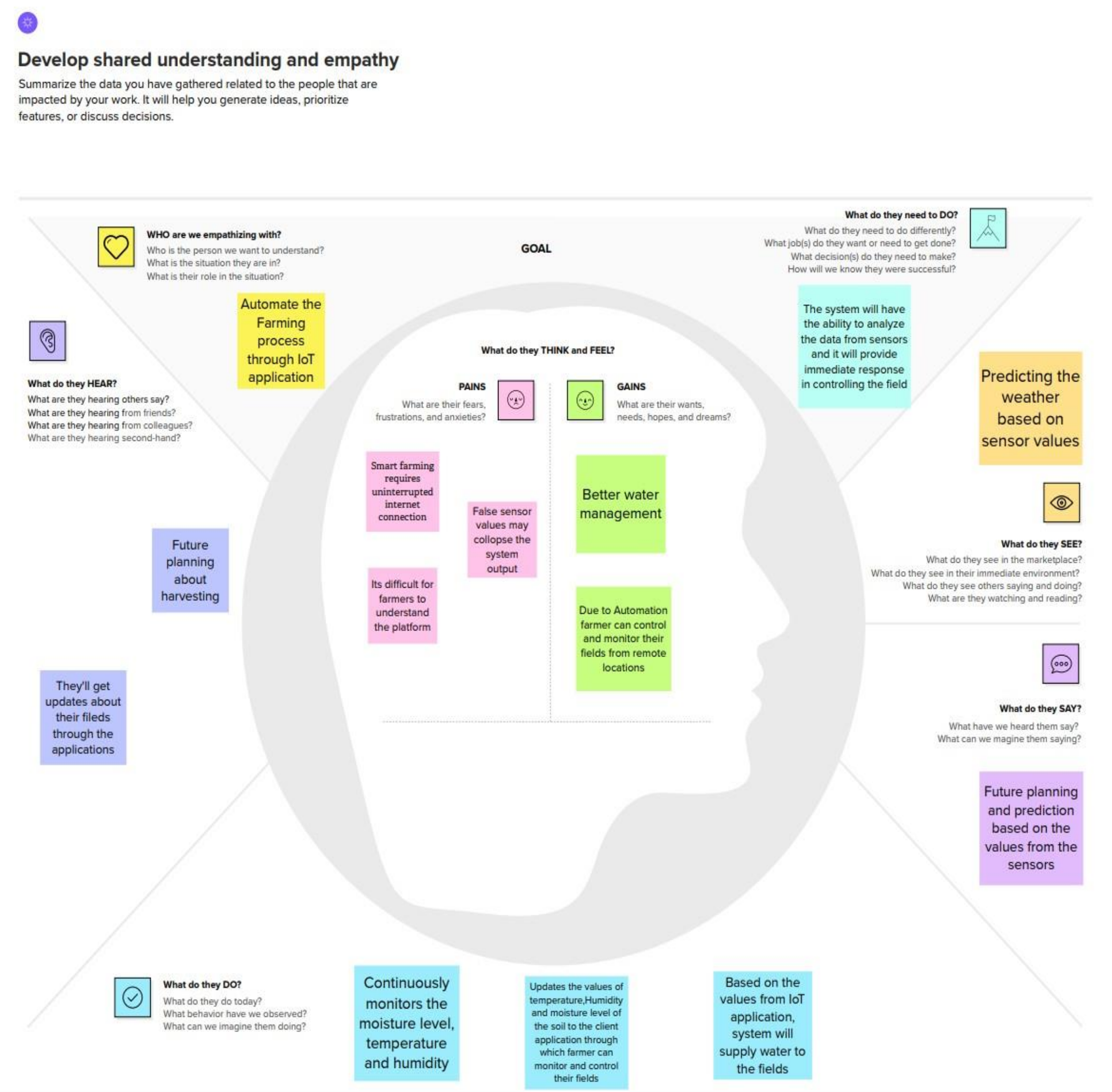
Furthermore, the suggested setup can be incorporated with other internet and messaging services (i.e. Web, WAP, SMS) to provide communication for farmers.

The wireless sensor network (WSN) is one of the most significant technologies in the 21st century and they are very suitable for distributed data collecting and monitoring in tough environments such as greenhouses. The other most significant technologies in the 21st century is the Internet of Things (IoT)which has rapidly developed covering hundreds of applications in the civil, health, military and agriculture areas.

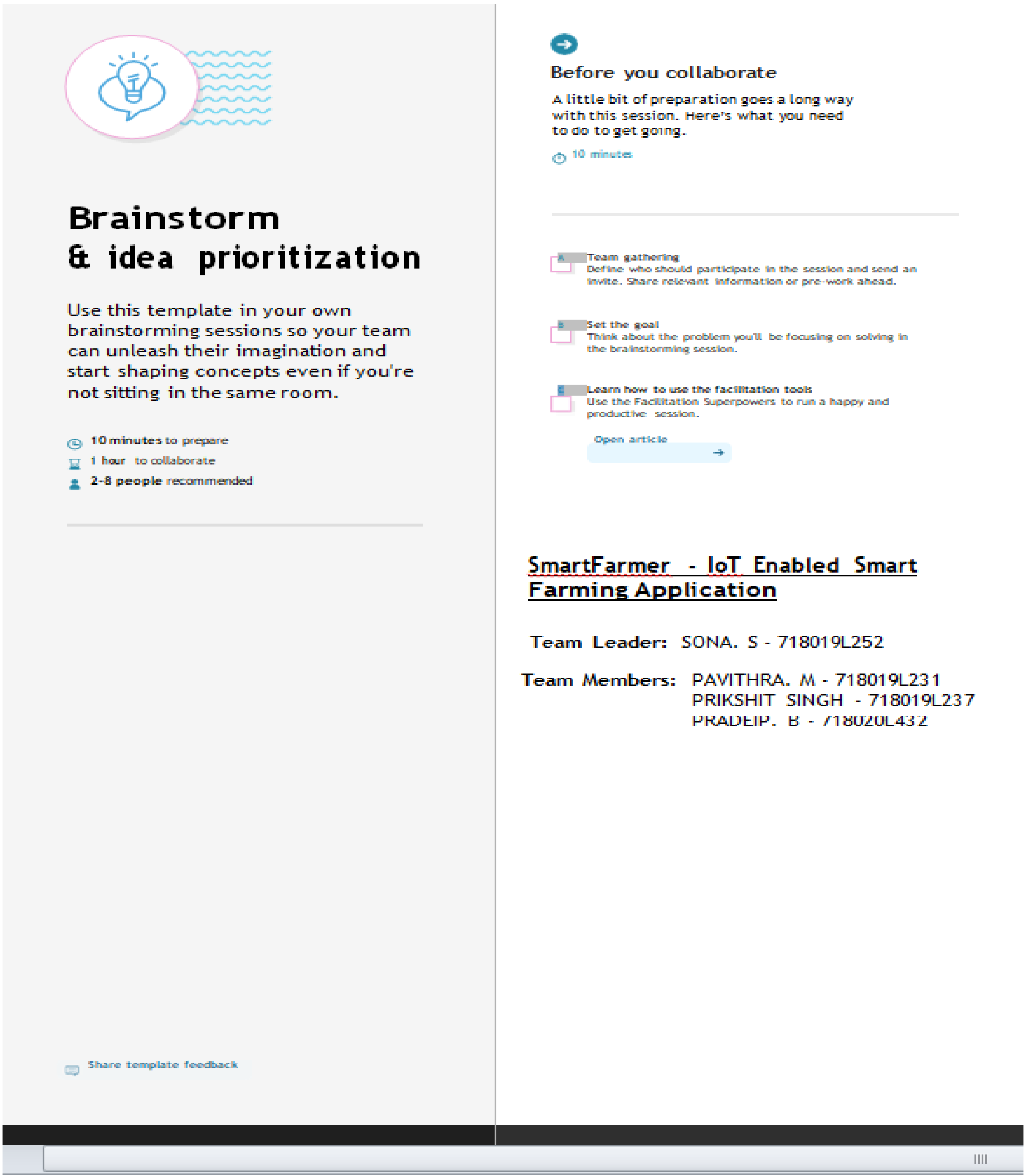
In modern greenhouses, several measurement points are required to trace down the local climate parameters in different parts of a large-scale greenhouse in order to ensure proper operation of the greenhouse automation system. Cabling would make the measurement system expensive, vulnerable and also difficult to relocate once installed. This paper presents a WSN prototype consisting of MicaZ nodes which are used to measure greenhouses' temperature, light, pressure and humidity. Measurement data have been shared with the help of IoT. With this system farmers can control their greenhouse from their mobile phones or computers which have internet connection

3: IDEATION AND PROPOSED SOLUTION

3:1: Empathy Map Canvas



3:2: Ideation And Brainstorming



1 Define your problem statement

What problem are you trying to solve? Frame your problem as a How Might We statement. This will be the focus of your brainstorm.

5 minutes

PROBLEM

Monitoring and supplying water to the field is time consuming process for the farmers and sometimes it might be difficult for them when they are away from their fields. So to overcome this problem, we need a smart irrigation system which helps farmer to monitor their fields

Key rules of brainstorming

To run an smooth and productive session

- Stay in topic.
- Encourage wild ideas.
- Defer judgment.
- Listen to others.
- Go for volume.
- If possible, be visual.

2 Brainstorm

Write down any ideas that come to mind that address your problem statement.

10 minutes

TIP

You can select a sticky note and hit the pencil [switch to sketch] icon to start drawing!

Person 1

- Easy to understand the hardware and software interface
- They will get instant alert about their field condition
- Better control over the process

Person 2

- Sometimes IoT application automatically monitor the fields
- Field activities will be automatically monitored with the help of IoT device
- Basically the interface will be user friendly, anyone with basic knowledge can easily work with the device

Person 3

- Farmers can control the device from anywhere
- The data from the remote devices are getting stored in the secured cloud server
- It simplifies the process of cultivation and irrigation

Person 4

- Farmers can easily monitor their fields
- The device will notify the status of the soil moisture, humidity and temperature to the farmers
- Easy to manage and interface sensors with the IoT environment

Group ideas

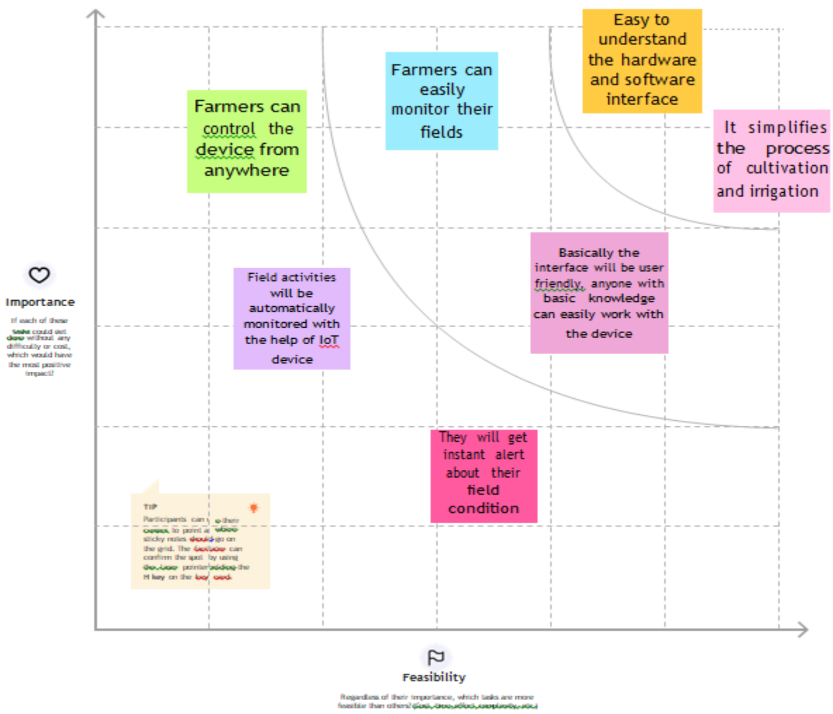
Take turns sharing your ideas while clustering similar or related notes as you go. Once all sticky notes have been grouped, give each cluster a sentence-like label. If a cluster is bigger than six sticky notes, try and see if you and break it up into smaller sub-groups.

20 minutes

Prioritize

Your team should all be on the same page about what's important moving forward. Place your ideas on this grid to determine which ideas are important and which are feasible.

20 minutes



3:3: Proposed Solution

S.No.	Parameter	Description
1.	Problem Statement (Problemto be solved)	• Monitoring and supplying water to the field is time consumingprocess for the farmers. • It is difficult for them to monitor their field when they are in remote place. • Major challenges faced by the IoT in the Agricultural sector are Lack of Information, High Adoption, Security.
2.	Idea/Solution Description	This IoT enabled smart farming application willhelp farmers to monitor and control their fields based on the sensor values such as humidity,moisture and temperature.
3.	Novelty/Uniqueness	**ALERT MESSAGE –** IoT sensor nodes and edge devices collect information from the fields such as soil moisture, temperature and humidity andthen it will transmit the collected data to the IoT cloud application. **REMOTE ACCESS –** Edge devices can be accessed from anywhere.

4.	Social Impact/Customer Satisfaction	The system will help the users in time conservation by automated process. IoT device helps the customer by reducing the labor cost and Running cost of the plant. IoT can also help e-commerce businesses thrive and increase sales.
5.	Scalability of the Solution	Here Scalability refers to the adaptability i.e., a system can increase the capacity in terms of number of edge devices etc.,

3:4:Problem Solution Fit

Define CS, fit into CC

1. Customer Segment(S) CS

Who is your customer?
i.e. working parents of 0-5 y.o. kids

The customer for this product is a farmer who grows crops. Our goal is to help them, monitor field parameters remotely. This product saves agriculture from extinction.

6. Customer Constrains CC

What constraints prevent your customers from taking action or limit their choices of solutions?
i.e. spending power, budget, no cash, network connection, available devices

Using many sensors is difficult. An unlimited or continuous internet connection is required for success.

5. AVAILABLE SOLUTIONS AS

Which solutions are available to the customers when they face the problem. or need to get the job done? What have they tried in the past? What pros & cons do these solutions have? i.e. pen and paper

The irrigation process is automated using IoT. Meteorological data and field parameters were collected and processed to automate the irrigation process. Disadvantages are efficiency only over short distances, and difficult data storage.

Explore AS, differentiate

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

2. JOBS-TO-BE-DONE / PROBLEMS J&P

Which jobs-to-be-done (or problems) do you address for your customers? There could be more than one; explore different sides.

The purpose of this product is to use sensors to acquire various field parameters and process them using a central processing system. The cloud is used to store and transmit data using IoT. The Weather API is used to help farmers make decisions. Farmers can make decisions through mobile applications.

9.PROBLEM ROOT CAUSE RC

What is the real reason that this problem exists? What is the back story behind the need to do this job?

Frequent changes and unpredictable weather and climate made it difficult for farmers to engage in agriculture. These factors play an important role in deciding whether to water your plants. Fields are difficult to monitor when the farmer is not at the field, leading to crop damage.

7. BEHAVIOUR BE

What does your customer do to address the problem and get the job done?
i.e. Directly related: find the right solar panel installer, calculate usage and benefits; indirectly associated: customers spend free time on volunteering work (i.e. Greenpeace)

Use a proper drainage system to overcome the effects of excess water from heavy rain. Use of hybrid plants that are resistant to pests.

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

3. TRIGGERS TR

What triggers customers to act? i.e., seeing their neighbor installing solar panels, reading about a more efficient solution in the news.

Farmers struggle to provide adequate irrigation. Inadequate water supply reduces yields and affects farmers' profit levels. Farmers have a hard time predicting the weather.

4. EMOTION'S: BEFORE / AFTER EM

How do customers feel when they face a problem of a job and afterwards?
i.e. lost, insecure > confident, in control - use it in your communication strategy & design.

BEFORE: Lack of knowledge in weather forecasting → Random decisions → low yield.

AFTER: Data from reliable source → correct decision → high yield.

10. YOUR SOLUTION SL

If you are working on an existing business, write down your current solution first, fill in the canvas, and check how much it fits reality.
If you are working on a new business proposition, then keep it blank until you fill in the canvas and come up with a solution that fits within customer limitations, solves a problem and matches customer behavior.

Our product collects data from various types of sensors and sends the values to our main server. It also collects weather data from the Weather API. The final decision to irrigate the crop is made by the farmer using a mobile application.

8.CHANNELS OF BEHAVIOUR CH

8.1 ONLINE
What kind of actions do customers take online? Extract online channels from #7

8.2 OFFLINE
What kind of actions do customers take offline? Extract offline channels from #7 and use them for customer development.

ONLINE: Providing online assistance to the farmer, in providing knowledge regarding the pH and moisture level of the soil. Online assistance to be provided to the user in using the product.

OFFLINE: Awareness camps to be organized to teach the importance and advantages of the automation and IoT in the development of agriculture.

4: REQUIREMENT ANALYSIS

4:1:Functional Requirements

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 Gmail
FR-2	User Confirmation	Confirmation via Email Confirmation via OTP
FR-3	Log in to system	Check Credentials Check Roles of Access.
FR-4	Manage Modules	Manage System Admins Manage Roles of User Manage User permission
FR-5	Check Weather details	Temperature details Humidity details
FR-6	Log out	Exit

4:2:Non-Functional Requirements

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

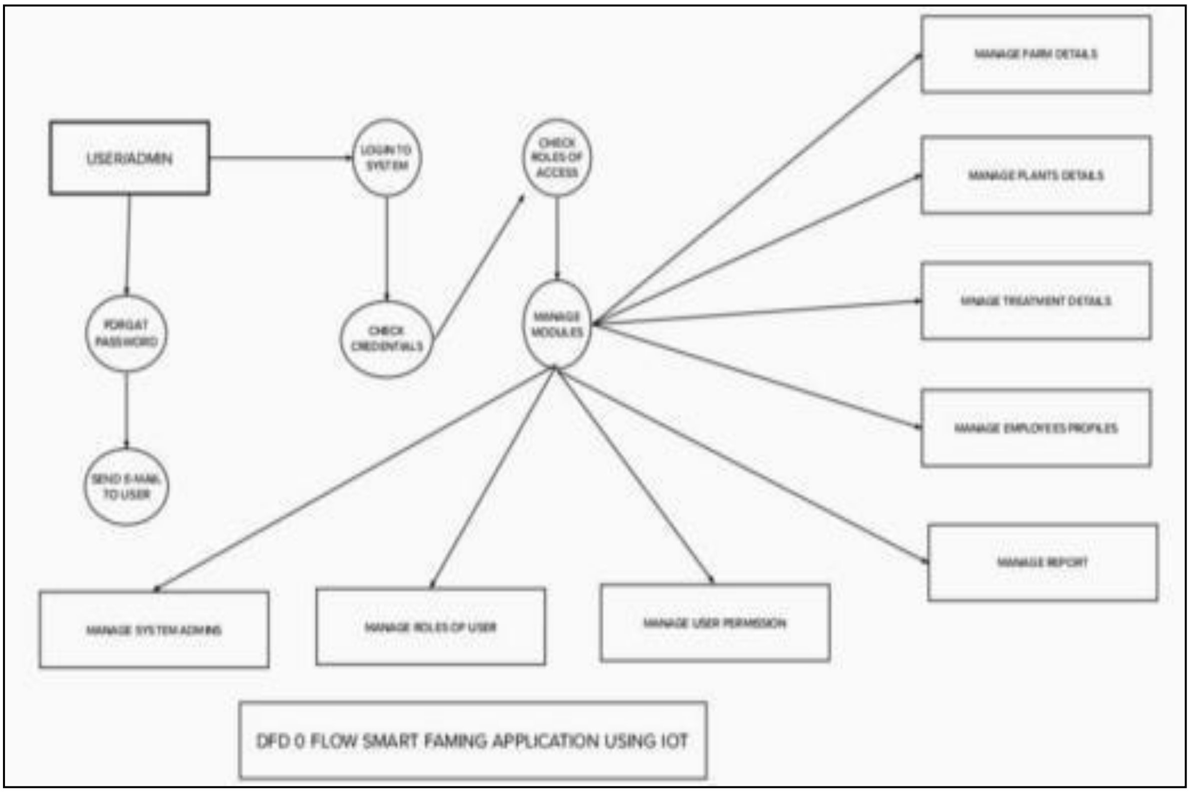
NFR No.	Non-Functional Requirement	Description
NFR-1	Usability	Usability refers to efficiency in use, remember ability, lack of errors in operation and subjective pleasure.
NFR-2	Reliability	The shared projection achieves a better trade-off between costs and reliability.
NFR-3	Scalability	Scalability is a major concern for IoT platforms. It has shown that different architectural choices of IoT platforms affect system scalability and that automatic real time decision-making isfeasible in an environment.
NFR-4	Security	Sensitive and private data must be protected from their production until the decision making and storage stages.

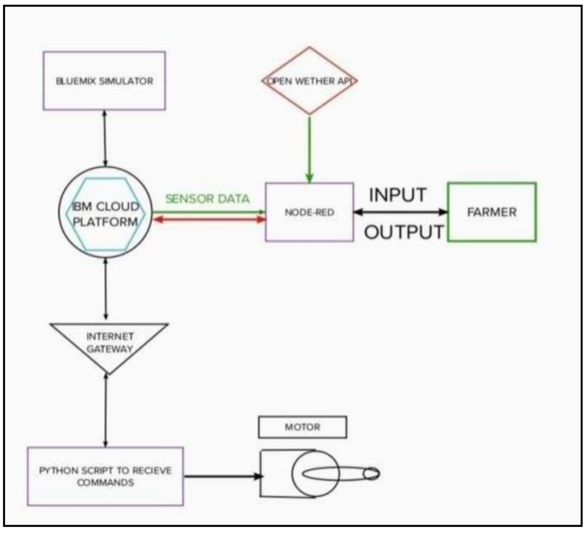
NFR-5	Performance	The idea of implementing integrated sensors with sensing soil and environmental or ambient parameters in farming will be more efficient for overall monitoring.
NFR-6	Availability	Automatic adjustment of farming equipment made possible by linking information like crops/weather and equipment to auto-adjust temperature, humidity, etc

5: PROJECT DESIGN

5:1:Data Flow Diagrams

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirementgraphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.



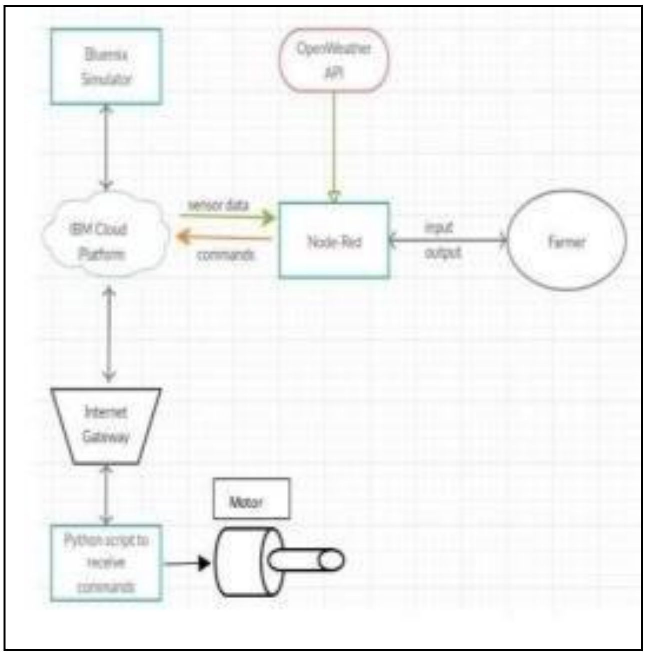


Description:

- The parameters from the farming environment such as temperature, humidity, soil moisture is sensed using different sensors and the obtained value is stored in the IBM cloud.
- Arduino UNO board is used as a processing unit that processes the data obtained from sensors and weather data from weather API.
- Node-Red is used as a programming tool to wire the hardware, software, and API's.
- The MQTT protocol is used for communication.
- The data collected from the sensors is given to the mobile application through IBM IoTCloud. The mobile application was developed using MIT app inventor.
- User can take decisions based on the parameters displayed in the mobile application.
- User can monitor and control the process of their field/plant through the mobile application itself.

5:2:solution & technical architechture

The deliverable will include the architectural diagram as below and the information as per the table 1 and table 2.



Guidelines:

1. Include all the processes (As an application logic/Technology Block)
2. Provide Infrastructural demarcation (Local/Cloud)
3. Indicate external interfaces (third party API's etc.,)
4. Indicate Data Storage components/services
5. Indicate interface to machine learning models (if applicable).

Description:

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Table -1: Components and Technologies

S.No	Component	Description	Technology
1.	User Interface	User interaction with application such as UI and Mobile app	HTML, CSS, JavaScript/ Angular Js/React Js etc.
2.	Application Logic -1	Logic for a process in the Application	Python
3.	Application Logic -2	Logic for a process in the Application	IBM Watson IoT Service
4.	Application Logic -3	Logic for a process in the Application	IBM Watson Assistant
5.	Database	Data Type, Configurations etc.	MySQL, NoSQL, etc.
6.	Cloud Database	Database Service on Cloud	IBM Cloud
7.	File Storage	File storage requirements	IBM Block storage or other storage service or local Filesystem
8.	External API – 1	Purpose of External API used in the application	IBM Weather API, etc.,
9.	Machine Learning Model	Purpose of Machine learning model	Object recognition model, etc.,
10.	Infrastructure (Server/Cloud)	Application Deployment on Local system/Cloud local server configuration	Local, Cloud Foundry, Kubernetes, etc.,

Table -2: Application Characteristics:

S.No	Characteristics	Description	Technology
1.	Open-Source Frameworks	List the open-source frameworks used	Technology of Opensource Framework
2.	Security Implementation	Sensitive and private data must be protected from their production until the decision-making an dstorage stages	e.g. Node-Red, Open weather AppAPI, MIT App Inventor, etc.
3.	Scalable Architecture	scalability is a major concern for IoT platforms. It has been shown that different architectural choices of IoT platforms affect system scalability and that automatic real time decision-making is feasible in an environment composed of dozens of thousand	Technology used
4.	Availability	Automatic adjustment of farming equipment madepossible by linking information lik e crops/weather an d equipment to auto-adjust temperature, humidity, etc.	Technology used
5.	Performance	The idea of implementing integrated sensors with sensing soil and Environmental or ambient parameters in farming will be more efficient for overall monitoring.	Technology used

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 emailonce 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 applicationthrough Facebook	I can register & access the dashboard with Facebook Login	Low	Sprint-2
		USN-4	As a user, I can register for the applicationthrough Gmail		Medium	Sprint-1
	Login	USN-5	As a user, I can log into the application byentering email & password		High	Sprint-1
	Dashboard					
Customer (Webuser)						
Customer Care Executive						
Administrator						

6: PROJECT PLANNING AND SCHEDULING

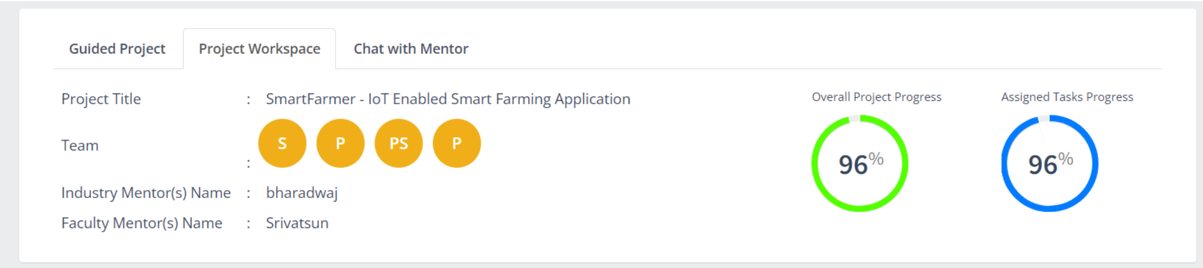
6.1 Sprint Planning and Estimation

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task
Sprint-1	Mobile/web user Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.
Sprint-1		USN-2	As a user, I will receive confirmation email once I have registered for the application
Sprint-2	Mobile/web user Login	USN-3	As a user, I can login to the application by entering the email and password
Sprint-2		USN-4	As a user, I can login to the application by entering the phone number
Sprint-3	Monitoring and Controlling	USN-5	As a user, I need a application which is smart enough to control and monitor the fields
Sprint-3		USN-6	As a user, I want to know about the temperature and humidity level in order to water the fields
Sprint-3		USN-7	As a user, I want to control the field devices(motors)
Sprint-4	Software	USN-8	As a admin, I need to authorize the data transferred by the end device to the IBM Cloud
Sprint-4		USN-9	As a admin, I need an application (node red, IBM Watson) in order the simulate the values and I want to test the application

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	05 NOV 2022
Sprint-3	20	6 Days	07Nov 2022	12 Nov 2022	20	15 NOV 2022
Sprint-4	20	6 Days	14Nov 2022	19 Nov 2022	20	19 NOV 2022

6:3: Reports from JIRA

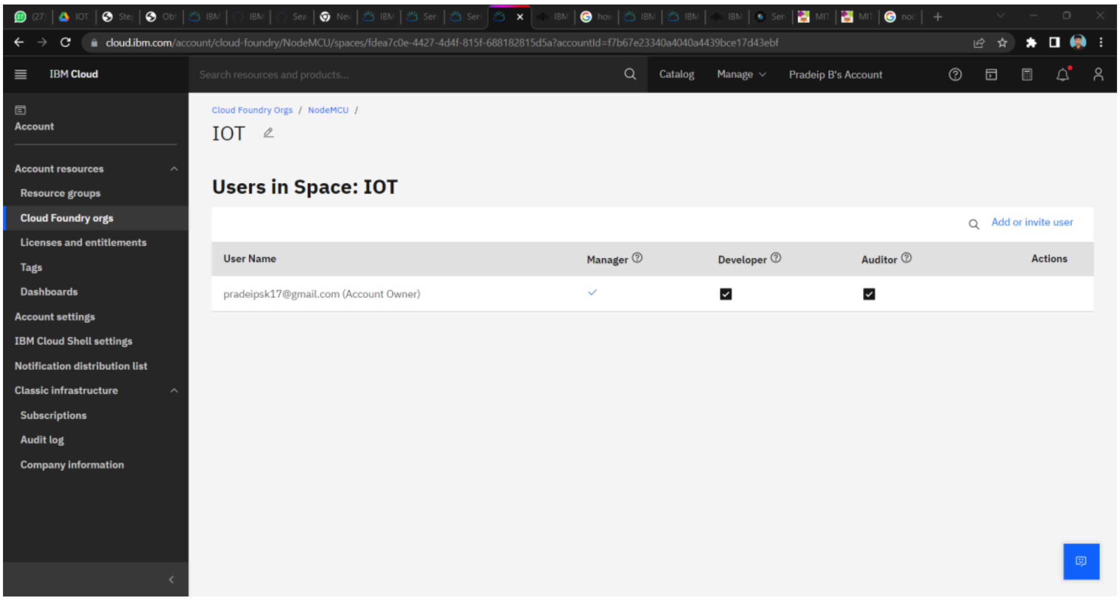


7: CODING AND SOLUTIONING

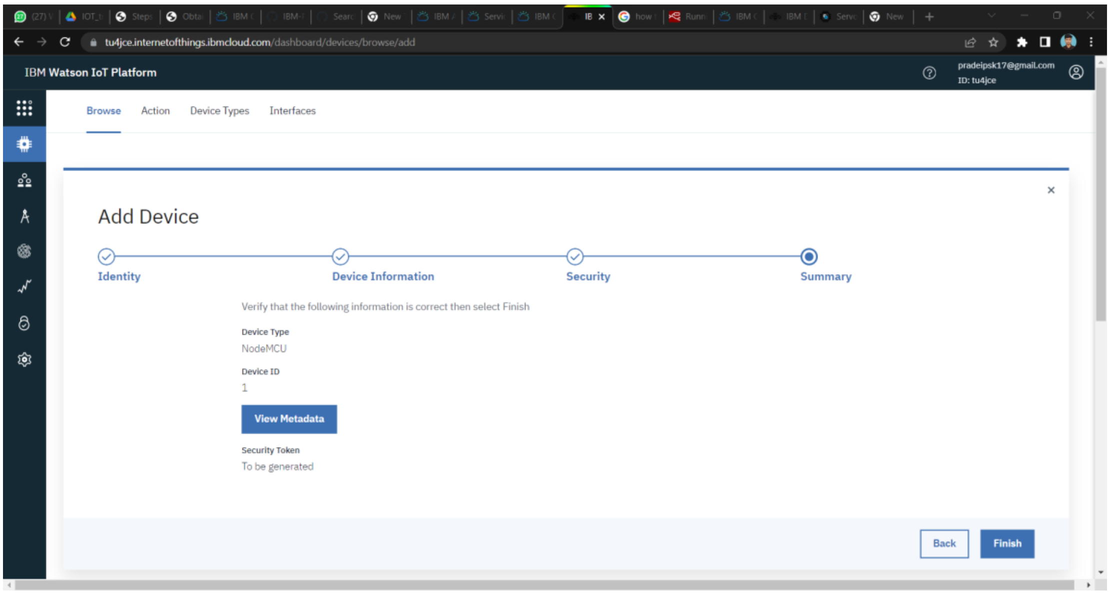
7:1: Feature 1

An account has been created on the respective platforms like IBM Cloud, IBM Watson, Node-Red, MIT App Inventor.

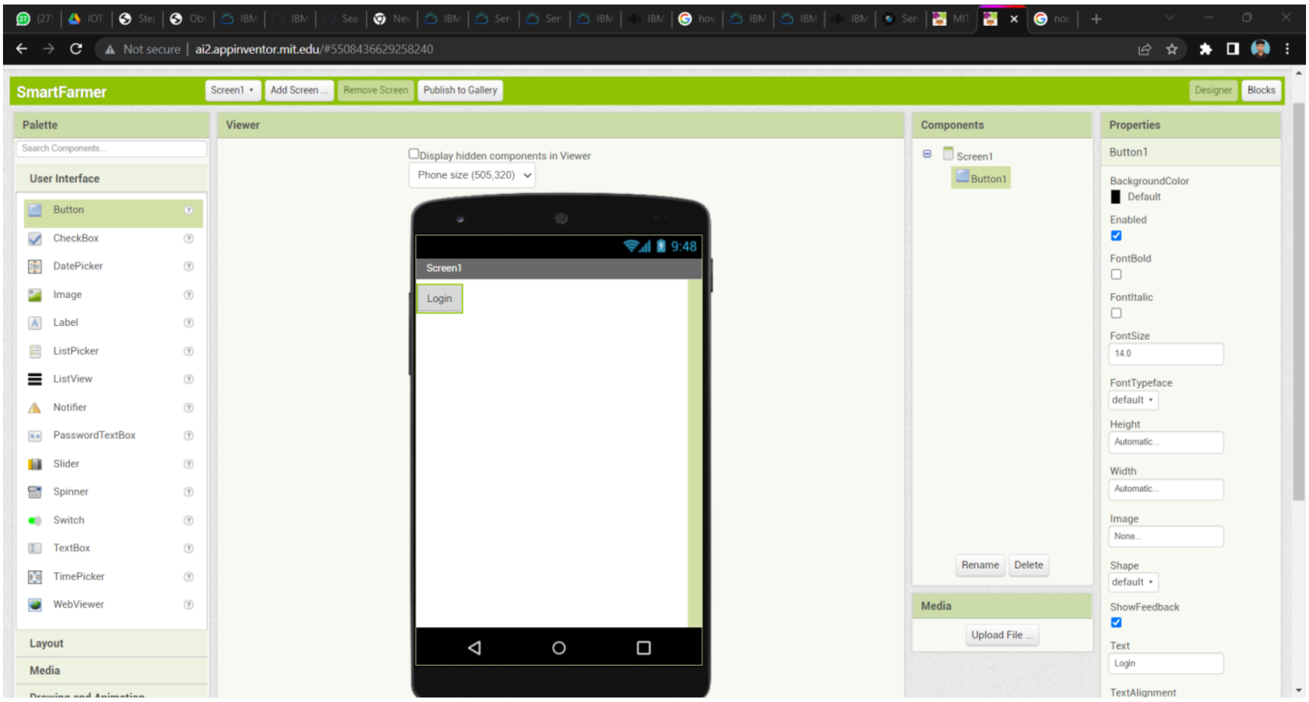
IBM CLOUD DASHBOARD:



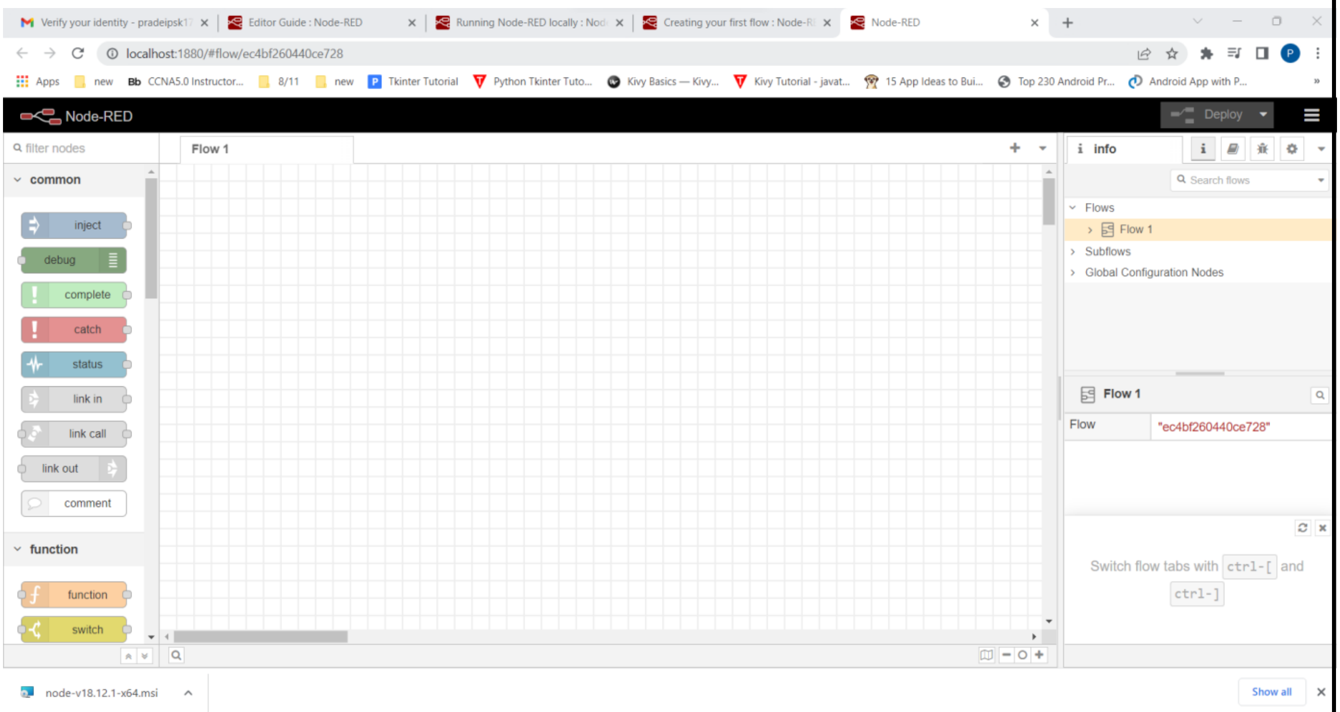
IBM WATSON IOT PLATFORM:



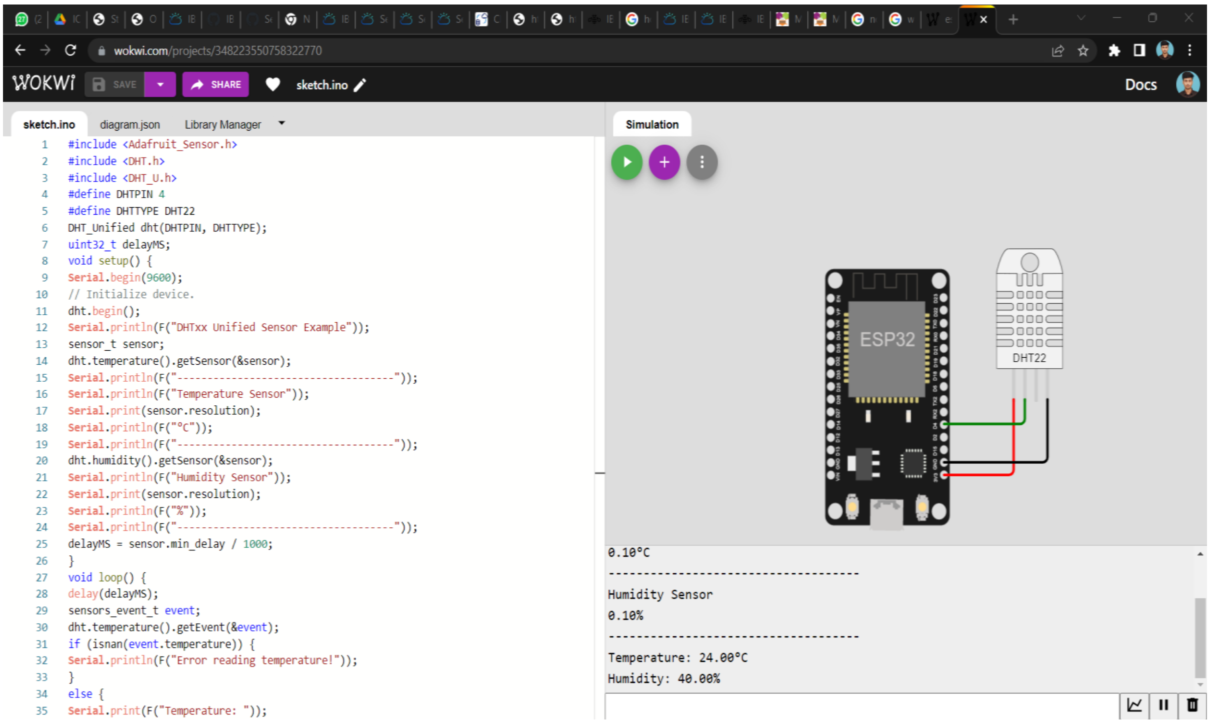
MIT APP INVENTOR:



NODE-RED:



MEASURING TEMPERATURE AND HUMIDITY VALUES WITH ESP 32:



Program:

```
#include <Adafruit_Sensor.h>
#include <DHT.h>
#include <DHT_U.h>
#define DHTPIN 4
#define DHTTYPE DHT22
DHT_Unified dht(DHTPIN, DHTTYPE);
uint32_t delayMS;
void setup() {
Serial.begin(9600);
// Initialize device.
dht.begin();
Serial.println(F("DHTxx Unified Sensor Example"));
sensor_t sensor;
dht.temperature().getSensor(&sensor);
Serial.println(F("------------------------------------"));
Serial.println(F("Temperature Sensor"));
Serial.print(sensor.resolution);
Serial.println(F("°C"));
Serial.println(F("------------------------------------"));
dht.humidity().getSensor(&sensor);
Serial.println(F("Humidity Sensor"));
Serial.print(sensor.resolution);
Serial.println(F("%"));
Serial.println(F("------------------------------------"));
delayMS = sensor.min_delay / 1000;
```

```
}
void loop() {
delay(delayMS);
sensors_event_t event;
dht.temperature().getEvent(&event);
if (isnan(event.temperature)) {
Serial.println(F("Error reading temperature!"));
}
else {
Serial.print(F("Temperature: "));
Serial.print(event.temperature);
Serial.println(F("°C"));
}
dht.humidity().getEvent(&event);
if (isnan(event.relative_humidity)) {
Serial.println(F("Error reading humidity!"));
}
else {
Serial.print(F("Humidity: "));
Serial.print(event.relative_humidity);
Serial.println(F("%"));
}
}
```

Wokwi editor window link:

https://wokwi.com/projects/348223550758322770

Sensor Interfacing:

Program:

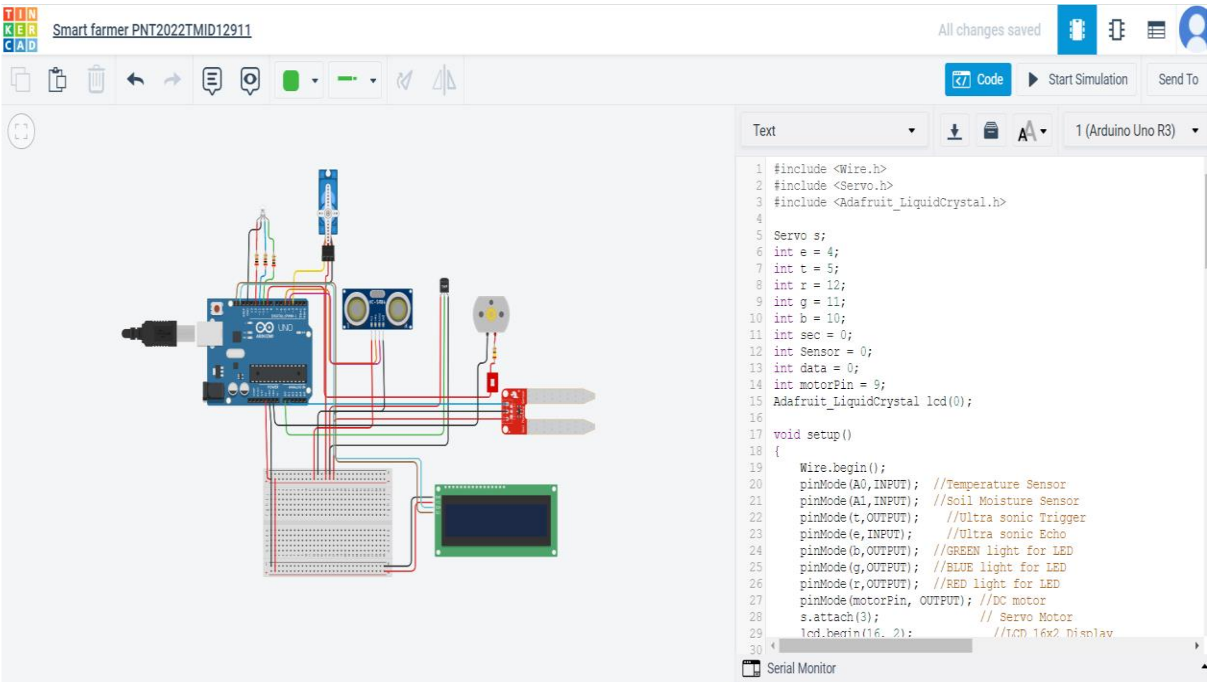
```
#include <Wire.h>
#include <Servo.h>
#include <Adafruit_LiquidCrystal.h>
Servo s;
int e = 4;
int t = 5;
int r = 12;
int g = 11;
int b = 10;
int sec = 0;
int Sensor = 0;
int data = 0;
int motorPin = 9;
Adafruit_LiquidCrystal lcd(0);
```

```
void setup()
{
    Wire.begin();
    pinMode(A0,INPUT);   //Temperature Sensor
    pinMode(A1,INPUT);   //Soil Moisture Sensor
    pinMode(t,OUTPUT);    //Ultra sonic Trigger
    pinMode(e,INPUT);     //Ultra sonic Echo
    pinMode(b,OUTPUT);   //GREEN light for LED
    pinMode(g,OUTPUT);   //BLUE light for LED
    pinMode(r,OUTPUT);   //RED light for LED
    pinMode(motorPin, OUTPUT); //DC motor
    s.attach(3);               // Servo Motor
    lcd.begin(16, 2);               //LCD 16x2 Display
    lcd.setBacklight(0);
    Serial.begin(9600);
}

float readDistanceCM(){
    digitalWrite(t, LOW);
    delayMicroseconds(2);
    digitalWrite(t, HIGH);
    delayMicroseconds(10);
    digitalWrite(t, LOW);
    int duration = pulseIn(e, HIGH);
    return duration * 0.034 / 2;
}

void loop(){
    //Soil Moisture:
    Sensor = analogRead(A1);          //Reads data from Soil
Moisture sensor
    data = map(Sensor,0, 1023, 0, 100); //Low analog value
indicates HIGH moisture level and High analog value indicates
LOW moisture level
    //data = map(analogValue,fromLOW,fromHIGH,toLOW,toHIGH)
    Serial.print("Soil Moisture value:");
    Serial.println(data);
    //'data = 0' indicates wet and 'data = 100' indicates dry

    //Temperature:
    double a = analogRead (A0);    //Reads data from
Temperature sensor
    double t = (((a/1024)*5)-0.5)*100;
    Serial.print("Temperature value:");
    Serial.println(t);

    //Ultrasonic sensor:
    float distance = readDistanceCM();
    Serial.print("Measured distance: ");
    Serial.println(readDistanceCM());
```

```
 //LCD Display:
 lcd.setBacklight(1);
 lcd.clear();

//Conditions:
if (t>40 & t<50){
    digitalWrite(b,0);
    digitalWrite(g,1);
    digitalWrite(r,0);
    s.write(90);
    digitalWrite(motorPin, HIGH);
    Serial.println("Water Partially Flows");
}

else if (t>50){
    digitalWrite(b,1);
    digitalWrite(g,1);
    digitalWrite(r,0);
    s.write(180);
    digitalWrite(motorPin, HIGH);
    Serial.println("Water Fully Flows");
}

else if (t>30 & data<30){
    digitalWrite(b,1);
    digitalWrite(g,1);
    digitalWrite(r,0);
     s.write(90);
    digitalWrite(motorPin, HIGH);
    Serial.println("Water Partially Flows");
}

else if (data<50){
    digitalWrite(b,0);
    digitalWrite(g,0);
    digitalWrite(r,1);
    s.write(90);
    digitalWrite(motorPin, HIGH);
    Serial.println("Water Partially Flows");
}

else if (distance < 10){
    digitalWrite(b, 0);
    digitalWrite(g, 0);
    digitalWrite(r, 1);
    s.write(0);
    digitalWrite(motorPin, LOW);
    Serial.println("Water Does Not Flow");
    lcd.clear();
      lcd.println("Drain the water");
}
```

```
    else{
         digitalWrite(b,1);
         digitalWrite(g,0);
         digitalWrite(r,0);
         s.write(0);
         digitalWrite(motorPin, LOW);
         Serial.println("Water Does Not Flow");
     }
      lcd.setCursor(0,0);
      lcd.print("Temp:");
     lcd.println(t);
      lcd.println("degree");
      lcd.setCursor(0,1);
      lcd.print("Soil Moisture:");
     lcd.println(data);
      lcd.println("%");
     Serial.println("------------------------------------------
-----------");
     delay(1000);
}
```

TinkerCad Circuit:



TinkerCAD Link: https://www.tinkercad.com/things/aF7C9bG6Ofi-fabulous-lahdi/editel?sharecode=vOnjCKw6mFQOyxSB6cjizeDp-Be0dJRz5kqGyS42m-8

7:2:Feature 2

SENDING SENSOR DATA FROM WOKWI TO IBM WATSON IOT PLATFORM:

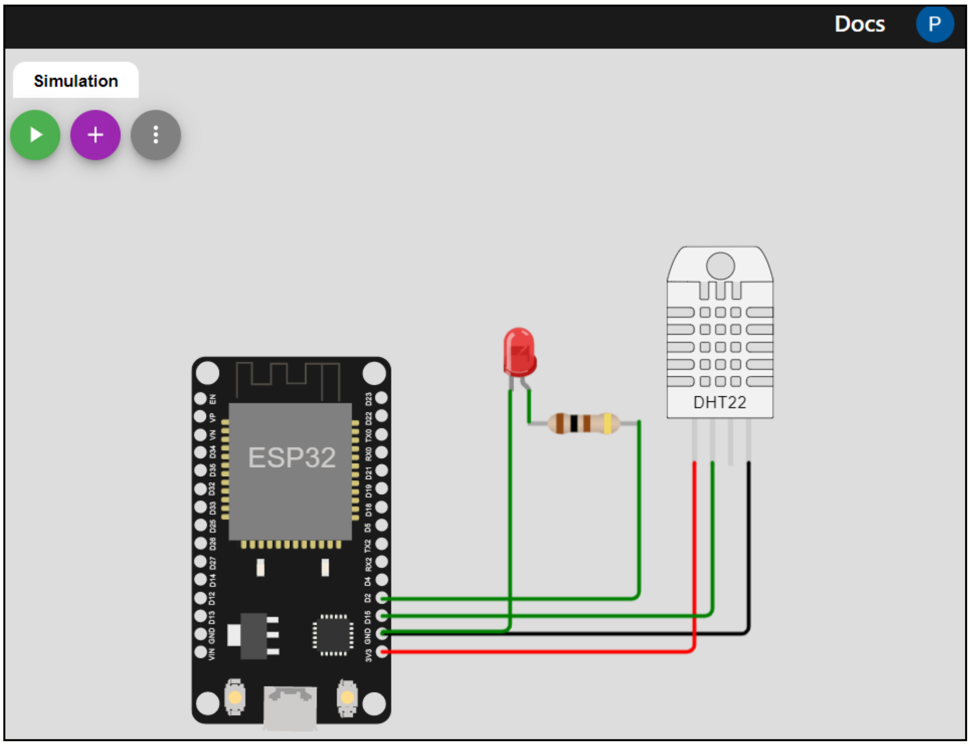
PROGRAM FOR SENDING TEMPERATURE AND HUMIDITY VALUES USING MQTT PROTOCOL:

```
#include <WiFi.h>
#include <PubSubClient.h>
#include "DHT.h"
#define DHTPIN 15
#define DHTTYPE DHT22
#define LED 2

DHT dht (DHTPIN, DHTTYPE);
void callback(char* subscribetopic, byte* payload, unsigned
int payloadLength);
#define ORG "tu4jce"//IBM ORGANITION ID
#define DEVICE_TYPE "NodeMCU"//Device type
#define DEVICE_ID "12345"//Device ID
#define TOKEN "2W?*d5U83t+ICiNhyJ"     //Token
String data3;
float h, t;
char server[] = ORG
".messaging.internetofthings.ibmcloud.com";
char publishTopic[] = "iot-2/evt/Data/fmt/json";
char subscribetopic[] = "iot-2/cmd/command/fmt/String";
char authMethod[] = "use-token-auth";
char token[] = TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;
//-----------------------------------------
WiFiClient wifiClient;
PubSubClient client(server, 1883, callback ,wifiClient);
void setup()
{
  Serial.begin(115200);
  dht.begin();
  pinMode(LED,OUTPUT);
  delay(10);
  Serial.println();
  wificonnect();
  mqttconnect();
}


void loop()
{
```

```
  h = dht.readHumidity();
  t = dht.readTemperature();
  Serial.print("temp:");
  Serial.println(t);
  Serial.print("Humid:");
  Serial.println(h);

  PublishData(t, h);
  delay(1000);
  if (!client.loop()) {
    mqttconnect();
  }
}
void PublishData(float temp, float humid) {
  mqttconnect();
  String payload = "{\"temp\":";
  payload += temp;
  payload += "," "\"Humid\":";
  payload += humid;
  payload += "}";

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

  if (client.publish(publishTopic, (char*) payload.c_str())) {
    Serial.println("Publish ok");
  } 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()
{
  Serial.println();
```

```
  Serial.print("Connecting to ");

  WiFi.begin("Wokwi-GUEST", "", 6);
  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, unsigned
int 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=="lighton")
  {
Serial.println(data3);
digitalWrite(LED,HIGH);
  }
  else
  {
Serial.println(data3);
digitalWrite(LED,LOW);
  }
data3="";
}
```

Wokwi project link:
https://wokwi.com/projects/348379419871543890
CIRCUIT:



WOKWI SERIAL MONITOR:

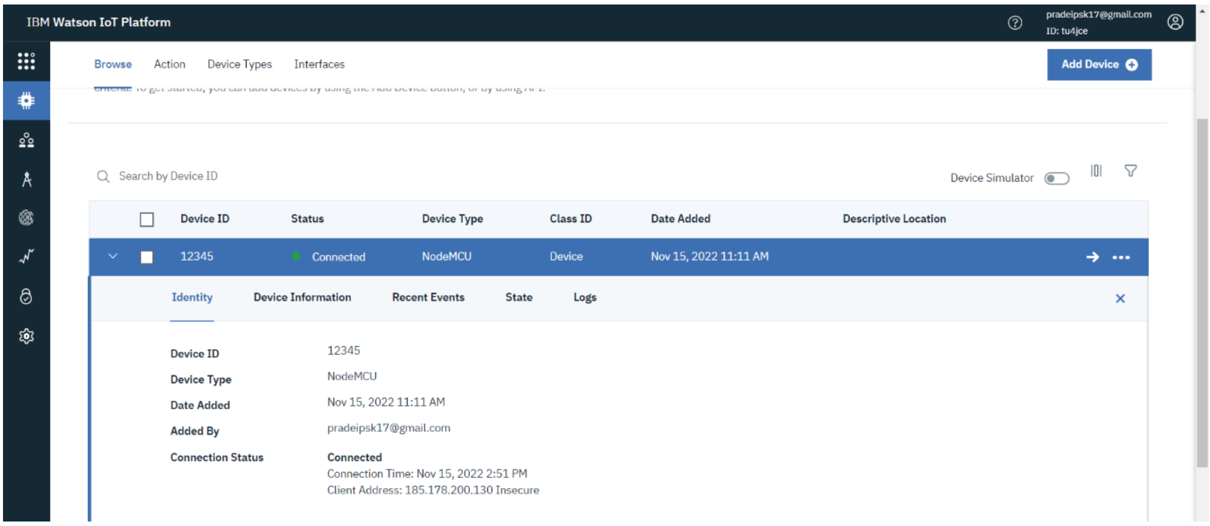
```
Connecting to ...
WiFi connected
IP address:
10.10.0.2
Reconnecting client to tu4jce.messaging.internetofthings.ibmcloud.com
iot-2/cmd/command/fmt/String
subscribe to cmd OK
```

Connecting to IBM Watson IoT platform

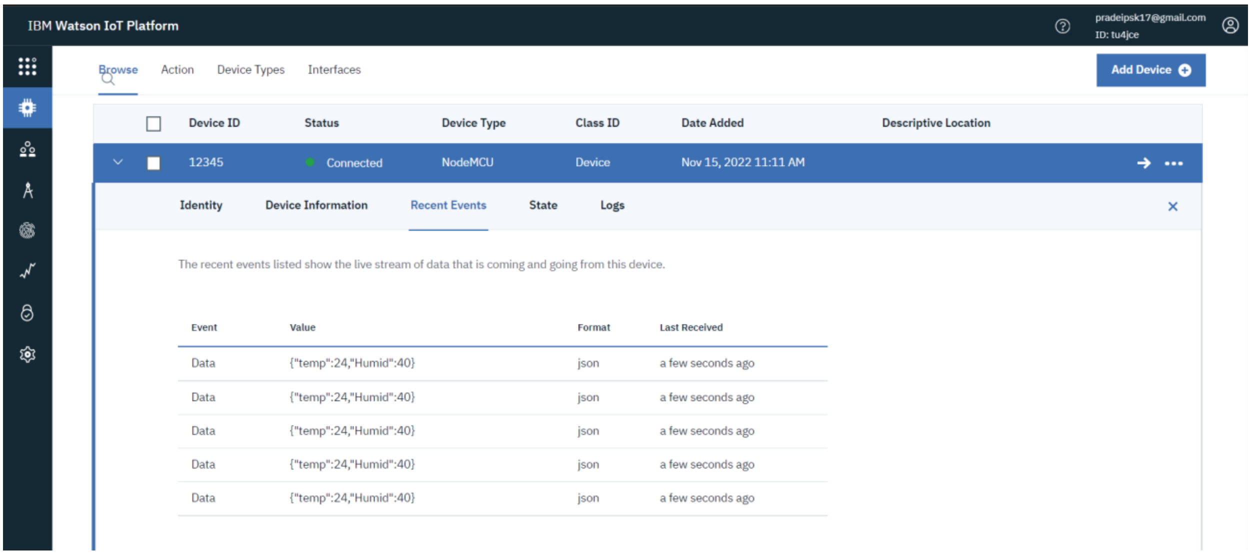
```
temp:24.00
Humid:40.00
Sending payload: {"temp":24.00,"Humid":40.00}
Publish ok
temp:24.00
Humid:40.00
Sending payload: {"temp":24.00,"Humid":40.00}
Publish ok
```

Publishing temperature and humidity values to the IBM Watson IoT platform

IBM Watson IoT platform:



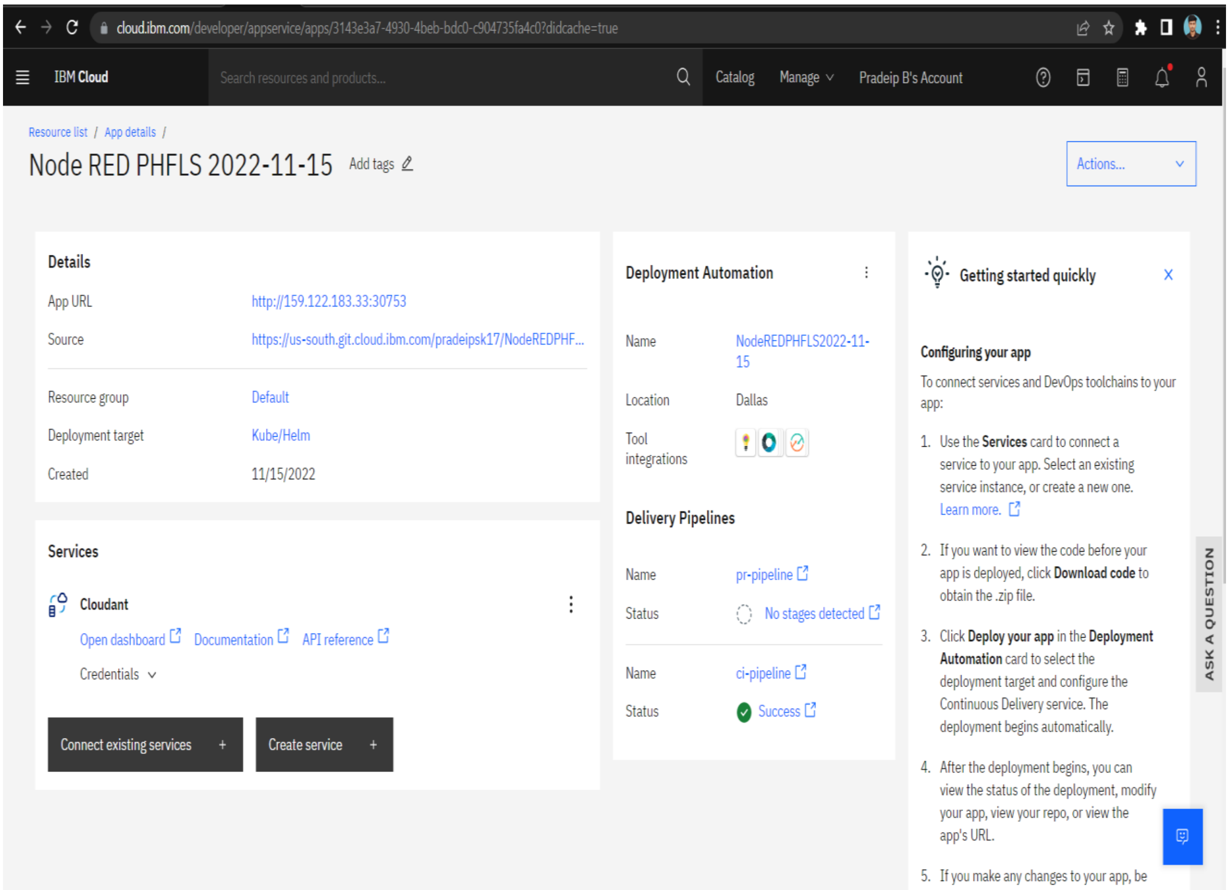
Connected Status in IBM Watson IoT platform



Recent Events in IBM Watson IoT platform

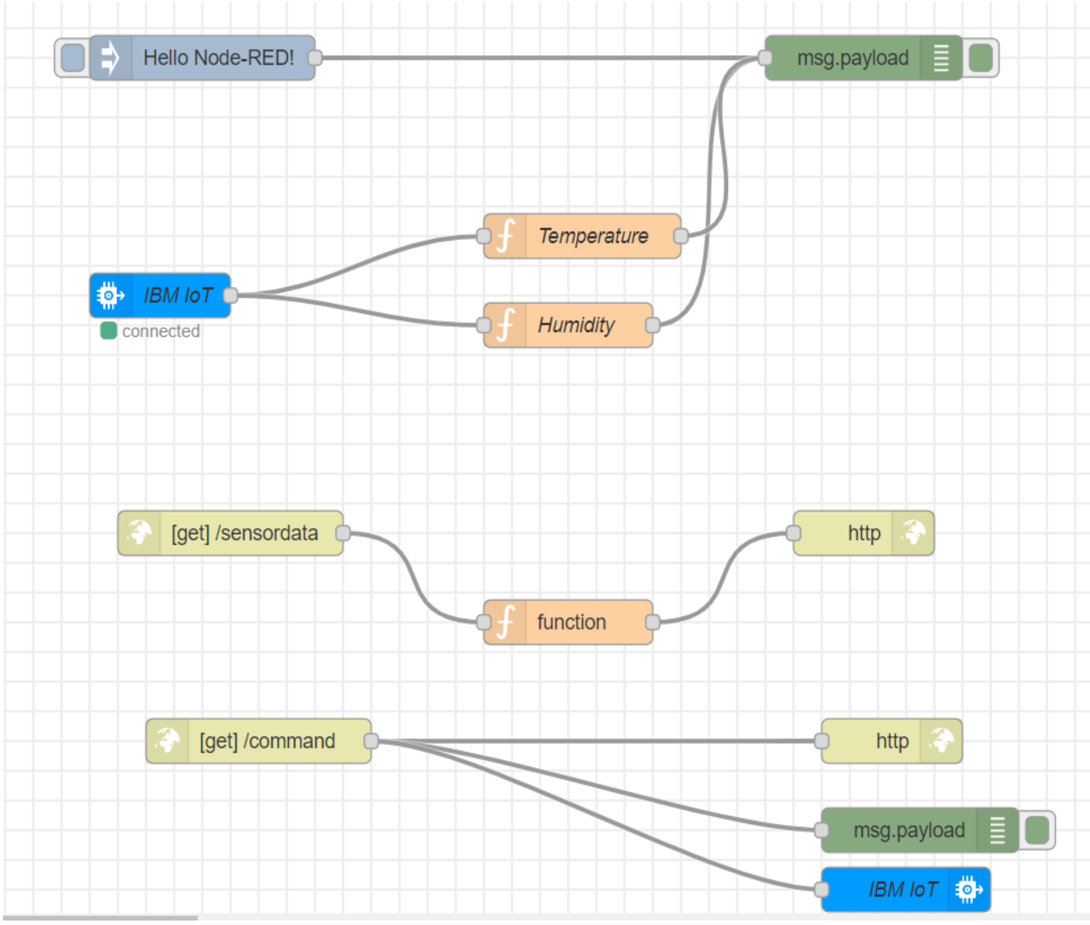
Once the sensor data like temperature and humidity gets updated in the IBM Watson IoT platform, those sensor data's will be available under recent events.

Node-RED Service Creation in IBM Cloud:



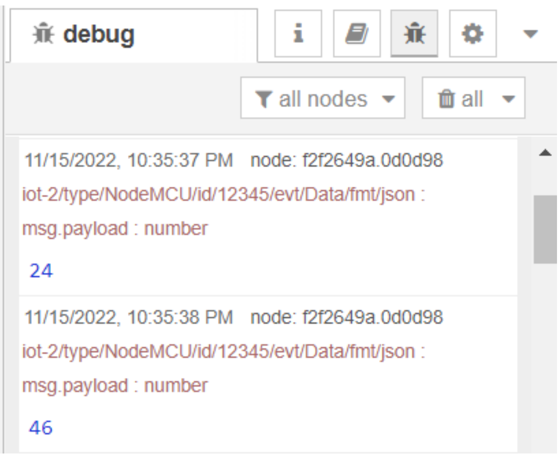
Node-RED service was created in the IBM cloud. After establishing Node-RED service, IBMIoT was installed in the Node-RED platform. Then, IBM Watson IoT platform was connected with Node-RED and the values in the IBM Watson IoT platform gets updated to the Node-RED in json file format.

Node-RED flow for getting sensor values from IBM Watson IoT Platform:



Node-RED Flow

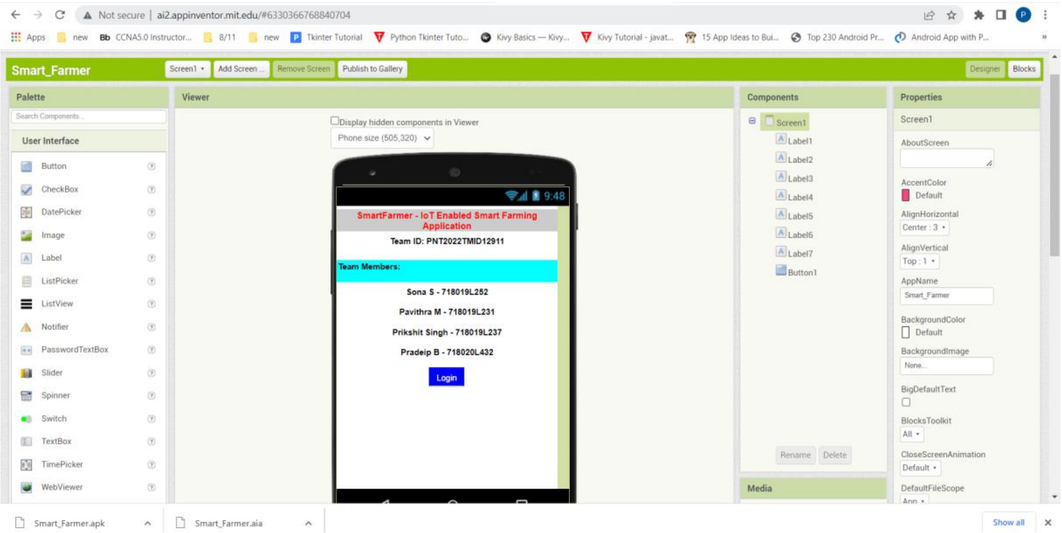
Node-RED debug window:



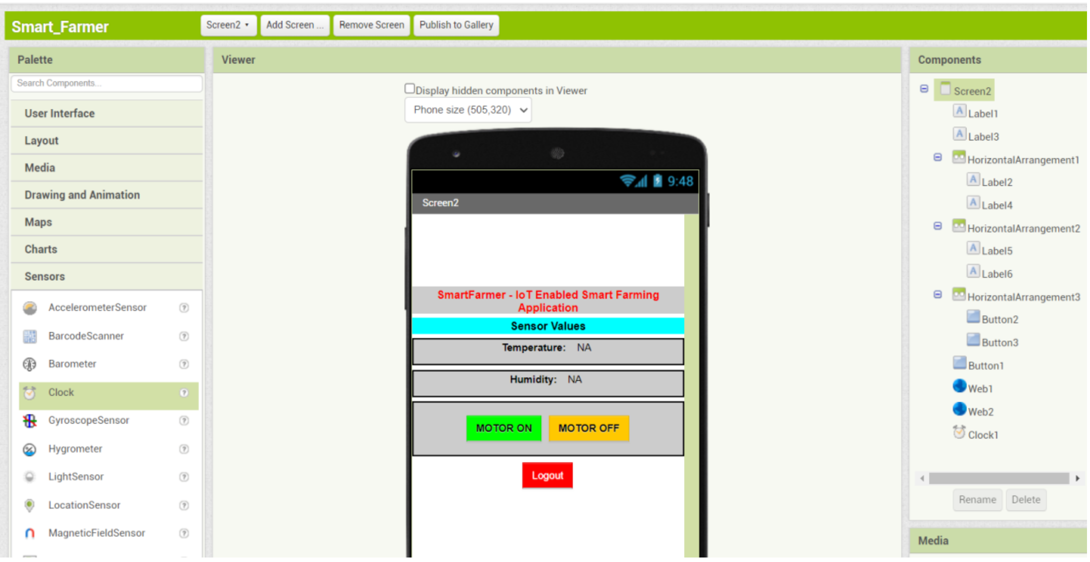
Temperature and Humidity values from the Wokwi simulator gets updated in the debug window of the Node-RED in the json file format.

Displaying Temperature and Humidity values over the URL using http response:

MIT App inventor Front End:

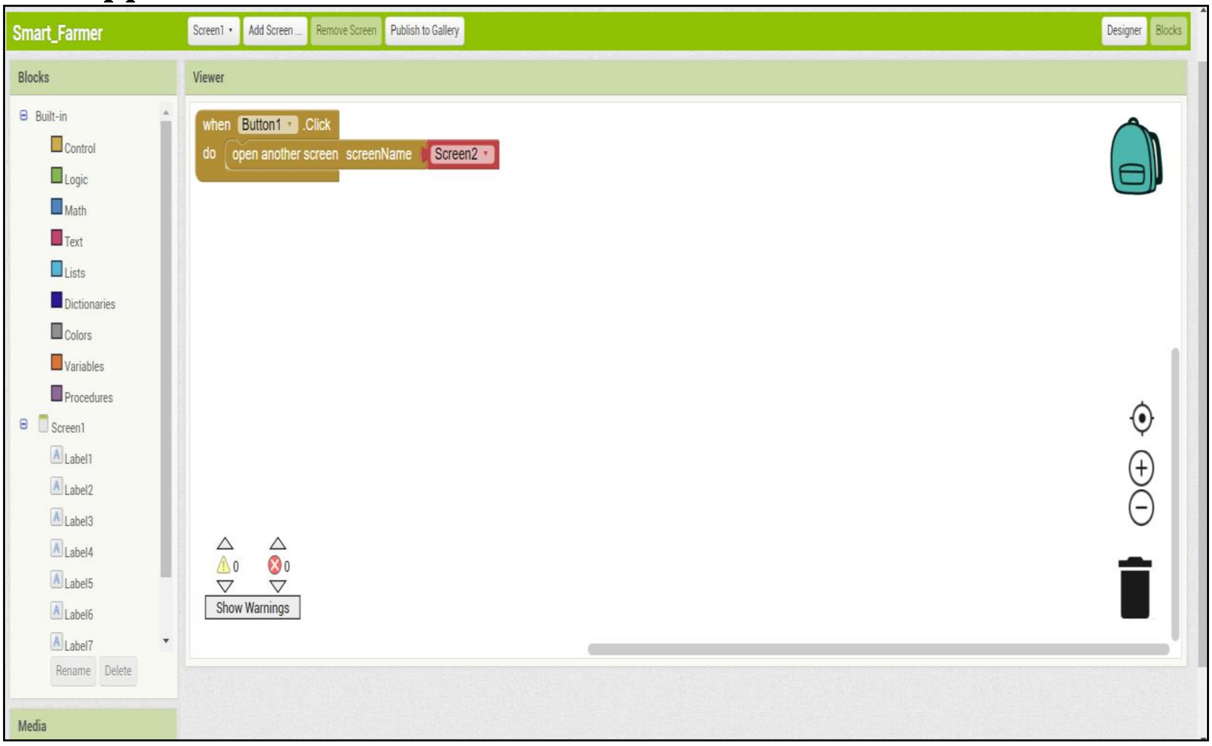


Screen 1

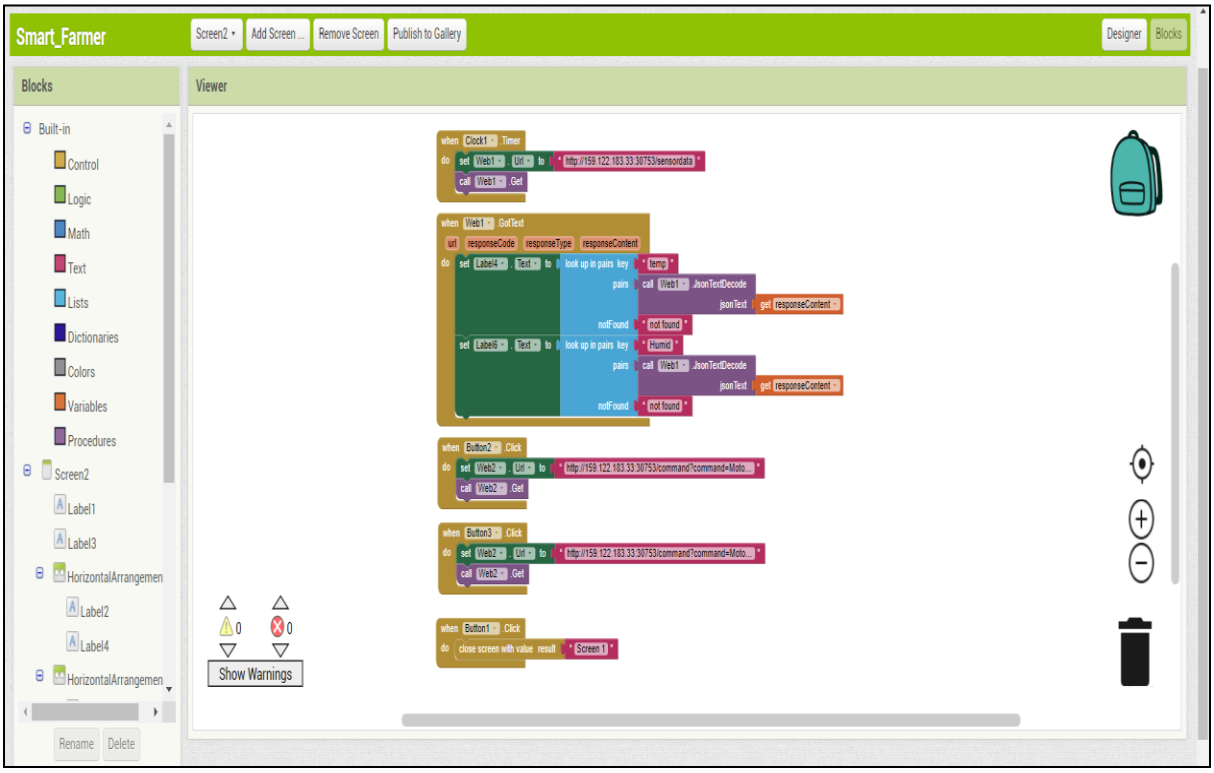


Screen 2

MIT App Inventor Back end:

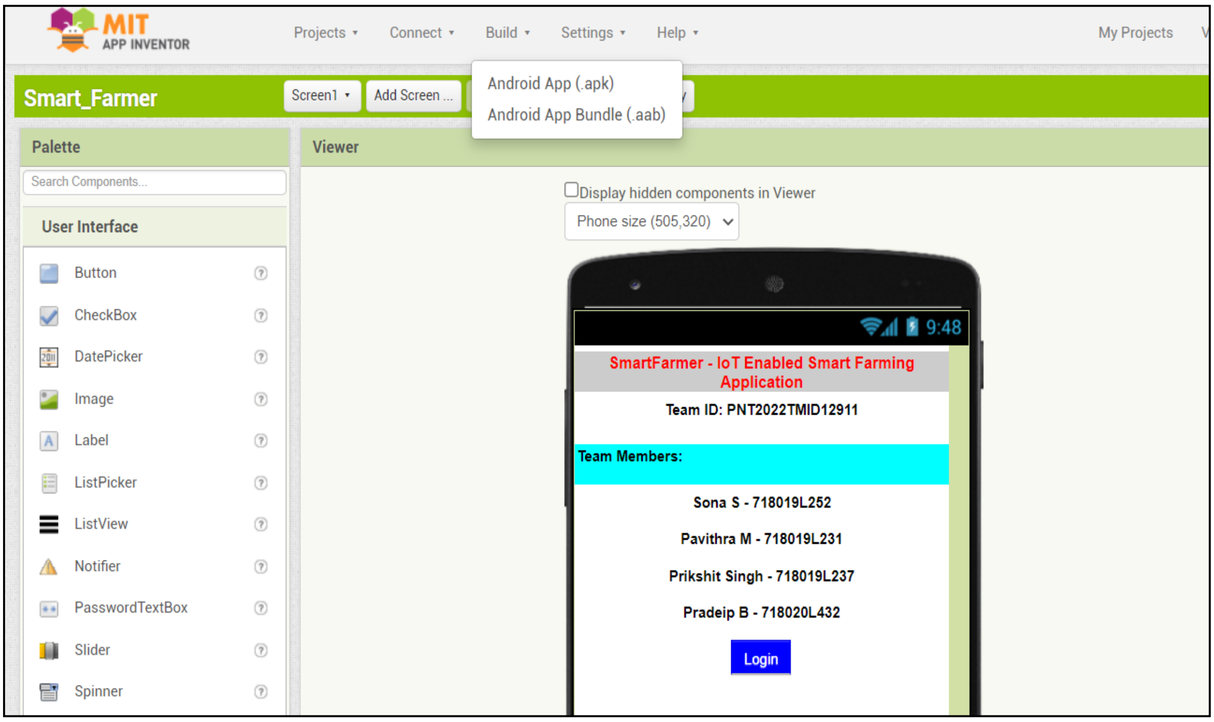


Screen 1

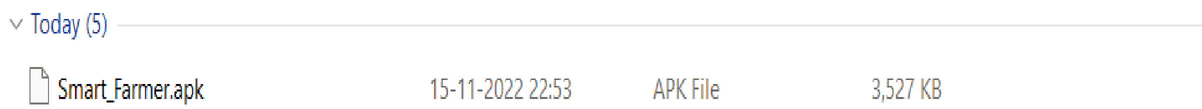


Screen 2

Exporting APK File:



Generated APK file:

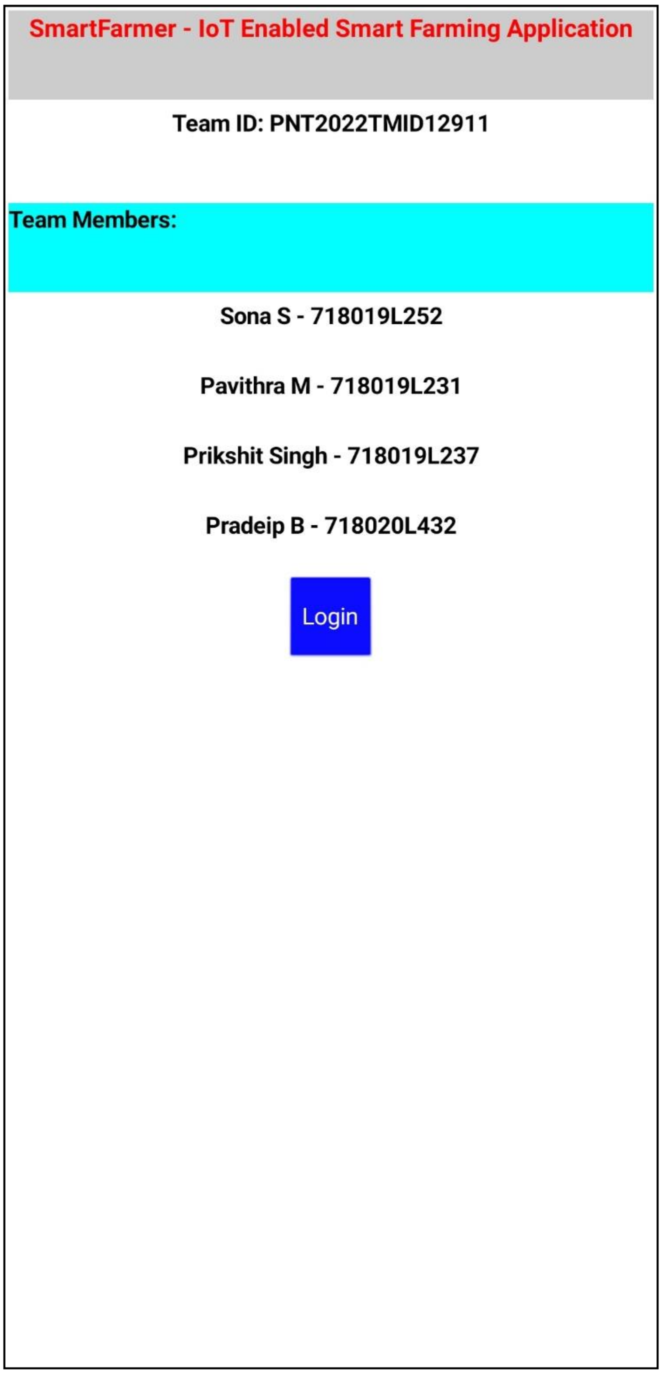


Size of the APK file: 3.5 MB

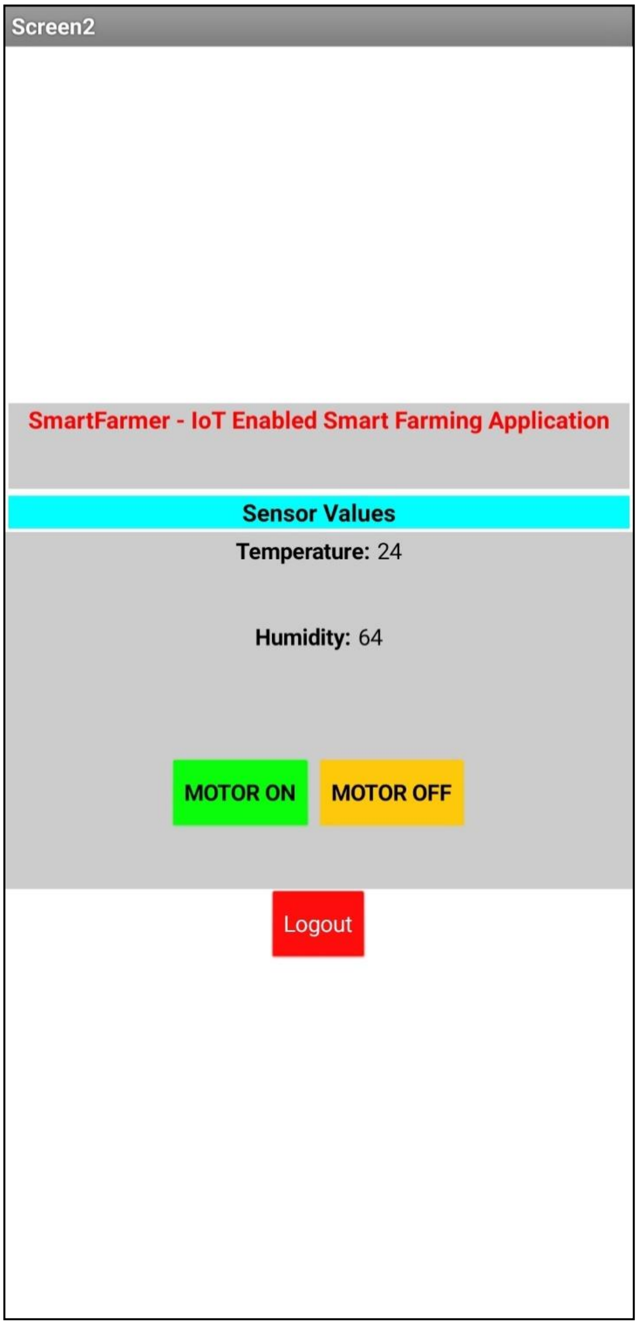
Once the apk file was generated, It can be installed in our mobile phones. After installing mobile application, senor data like temperature and humidity will be updated to the mobile phone dashboard through Node-RED http request method.

Based on the temperature and humidity value, user can switch on/off the motor using the Motor On/OFF button in the screen 2.

Mobile Application:



Screen 1


Screen2
SmartFarmer - IoT Enabled Smart Farming Application
Sensor Values
Temperature: 24
Humidity: 64
MOTOR ON
MOTOR OFF
Logout

Screen 2

Pressing Motor ON Switch:

11/15/2022, 11:05:59 PM node: 22d3da6f051a4672

msg.payload : Object

```
▶{ command: "Motor On" }
```

If Motor On switch is pressed by the user, Motor On message will be received by the Node-RED tool. Then, the message will be updated to the IBM Watson IoT Platform.

Pressing Motor OFF Switch:

11/15/2022, 11:06:27 PM node: 22d3da6f051a4672

msg.payload : Object

```
▶{ command: "Motor OFF" }
```

If Motor OFF switch is pressed by the user, Motor OFF message will be received by the Node-RED tool. Then, the message will be updated to the IBM Watson IoT Platform.

8: CONCLUSION

IoT based Smart farming system has been designed and mobile application was developed to control and monitor the field. The System has high efficiency and accuracy in fetching the live data of temperature and soil moisture. This IoT based smart farming System will assist farmers in increasing the agriculture yield and take efficient care of food production as the System will always provide helping hand to farmers for getting accurate live feed of environmental temperature and soil moisture with more than accurate results.

9: FUTURE WORKS

Crop predication plays a key role, it helps the farmer to decide future plan regarding the production of the crop, its storage, marketing techniques and risk management. To predict production rate of the crop artificial network use information collected by sensors from the farm. This information includes parameters such as soil, temperature, pressure, rainfall, and humidity. The farmers can get an accurate soil data either by the dashboard or a customized mobile application. Future work would be focused more on increasing sensors on this system to fetch more data especially with regard to Pest Control and by also integrating GPS module in this system to enhance this Agriculture IoT Technology to full-fledged Agriculture Precision ready product.