SMART FARMER - IOT ENABLED SMART FARMING APPLICATION

NALAIYA THIRAN PROJECT

Submitted by

CHANDHURU A (TEAM LEAD) -921319106038

MURUGARAJ K -921319106302

BAVANESSHVAR B -921319106033

DHANUSH KUMAR B -921319106045

of

BACHELOR OF ENGINEERING

in

ELECTRONICS AND COMMUNICATION ENGINEERING

Team ID: PNT2022TMID05165

TABLE OF CONTENTS

PROJECT REPORT

CHAPTER 1 - INTRODUCTION

1.1 Project Overview

Agriculture has always been the backbone of any economic development. To promote further growth of agriculture, it must be integrated with modern practices and technologies. With the wide spread acceptance of technology, it can be used in farming to make farmers perform their activity with ease. Electronics and IoT has found its application in many of the personal assistant devices. This can be extended to many vital fields like agriculture where their assistants can help solve many issues faced. Electronics can help devices get physically connected with their operational environment and analyze and collect data. IoT can help analyze and transfer the data to the user. The combination of these gives rise to an all-in-one device capable of carrying out a task.

1.2 Purpose

In recent times, the erratic weather and climatic changes have caused issues for farmers in predicting the perfect conditions to initiate farming. Though on a superficial scale it seems unpredictable, it can be determined with certain parameters with which crop planning can be done. Maintenance of farm fields during and after cultivation are also important. These can be performed by measuring soil moisture, humidity and temperature.

Measurement of these parameters are performed using physical sensors. This system is in turn connected to IoT system which can provide a easy to access interface for farmers to read, analyze and take action based on the presented condition. Taking it a step ahead, the system can also gain access to motors and other electrical equipment used in farming and automate their operation. This can help with unsupervised operation ensuring accuracy and lesser response time.

CHAPTER 2 - LITERATURE SURVEY

2.1 Existing problem

There has been several attempts and solution to help farmers adopt technological practices. Few solutions restricted their performance with just suggestions and alerts. While few employed IoT independent electronics. Few of the cases of previous attempts and researches are described below.

i. "IoT based smart sensors agriculture stick for live temperature and moisture monitoring using Arduino, cloud computing & solar technology". This work was performed using Cloud computing platform (Things Speak) for data acquisition. The circuit was designed using Arduino and DHT 11 sensors.

ii. "Smart Farming using IoT, a solution for optimally monitoring farming conditions". This work used ESP-32 based IoT platform and Blynk mobile application.

iii. "Smart farming using IoT". The automation and interface part made use of water pump and HTTP protocol for parameters monitoring using website.

The above stated prior works lacked one or two features, which when included could have enhanced the performance. In the first work, including a Raspberry Pi based controller in place of Arduino can help reduce the design area while also providing microcontroller with additional UI and IoT interfaces. In the second stated work, going with MIT app inventor instead of Blynk application can improve the possibility of feature expansion. Farmers or developers won't need to go for a paid version of the app to include new features. In the third work, control of water pump can be enhanced with the use of servo-based water valves to direct and control the flow of water rather than using a bi-stated logic.

2.2 References

The following were the source of references:

i. https://www.researchgate.net/publication/313804002_Smart_farming_IoT_based_smart_sensors_agriculture_stick_for_live_temperature_and_moisture_monitoring_using_Arduino_cloud_computing_solar_technology.

ii. https://www.sciencedirect.com/science/article/pii/S1877050919317168

iii. *"Smart farming: IoT based smart sensors agriculture stick for live temperature and moisture monitoring using Arduino, cloud computing & solar technology",* Anand Nayyar Assistant Professor, Department of Computer Applications & IT KCL Institute of Management and Technology, Jalandhar, Punjab Er. Vikram Puri M.Tech(ECE) Student, G.N.D.U Regional Center, Ladewali Campus, Jalandhar iv. *"Smart Farming using IoT, a solution for optimally monitoring farming conditions",* Jash Doshi; Tirth kumar ; Patel Santosh kumar Bharati.

v. *"Smart Farming Using IOT"*, CH Nishanthi; Dekonda Naveen, Chiramdasu Sai Ram , Kommineni Divya , Rachuri Ajay Kumar; ECE Dept., Teegala Krishna Reddy Engineering College, Hyderabad, India 2,3,4,5student, ECE Dept., Teegala Krishna Reddy Engineering College, Hyderabad, India.

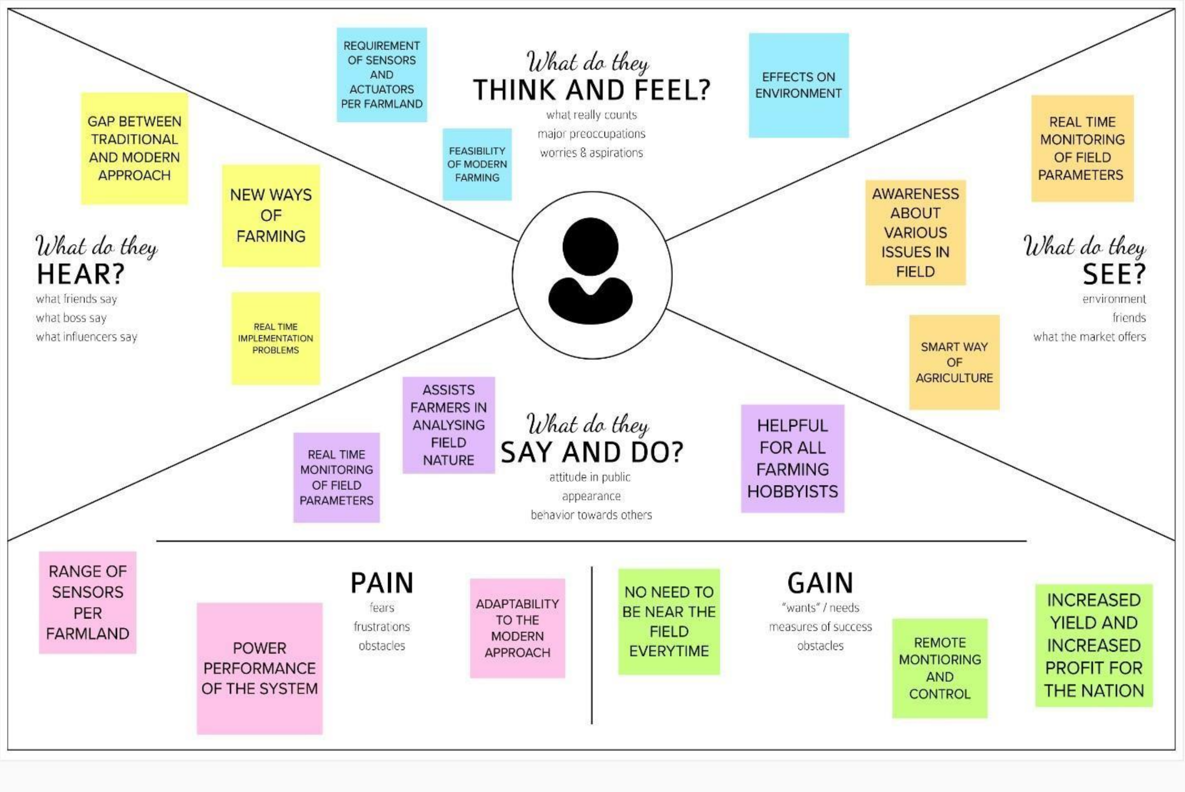
2.3 Problem Statement Definition

The problem statement in a nutshell covers all the possible technical aspects that can be included by farmer to convert farming in to smart and efficient farming. IoT enabled smart farming, on a wider perspective, concentrates on connecting all the independently operating sub-systems in farming automation into a single entity. IoT-based agriculture system helps the farmer in monitoring different parameters of his field like soil moisture, temperature, and humidity using some sensors.

The idea of IoT is further extended with the help of mobile and web application where farmers can monitor all the sensor parameters 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.

CHAPTER 3 - IDEATION AND PROPOSED SOLUTION

3.1 Empathy Map Canvas



3.2 Ideation & Brainstorming

Top 3 ideas:

Top 1st:

Name: CHANDHURU A

Idea name: User friendly application for farmland parameters

Description: A complete application with sophisticated features to monitor all the field parameters and making it user friendly so that every farmer can benefit from that.

Top 2nd:

Name: BAVANESSHVAR B

Idea name: A website guide about the product and features
Description: A website that describes the features of the application, also provides important advices in farming regarding optimum conditions, crop health, use of resources etc. With this, along with farmers any hobbyist who is interested in farming can start cultivating in an efficient way with this guide.

Top 3rd:

Name: MURUGARAJ K

Idea name: usage of raspberry pi over other processor for IoT applications

Description: for real time monitoring and high processing power, usage of raspberry pi is a better choice over Arduino and other microcontrollers. And to utilize IoT related applications, raspberry pi platform is the best choice.

16 ideas from the brain storming session

CHANDHURU A

Idea 1:	User friendly application for farmland parameters
Idea 2:	Awareness about IoT in agricultural domain through various applications
Idea 3:	Computer vision for detecting crop diseases
Idea 4:	Automating watering process to save water

BAVANESSHVAR B

Idea 1:	Usage of raspberry pi over other processor for IoT applications.

Idea 2: Deciding the specification of sensors to be deployed based on the range of operation per square feet of farmlands.

Idea 3: Protection case for sensors to avoid wear and tear during adverse conditions.

Idea 4: Using RF based communication along with IoT protocols to deliver data.

MURUGARAJ K

Idea 1: A website guide about the product and features

Idea 2: Provision through application to remotely control agricultural instruments

Idea 3: Data collection about various field parameters

Idea 4: Features in website to control agricultural actuators

DHANUSH KUMAR B

Idea 1: Various protocols used in IoT.

Idea 2: Application with simple UI but efficient usage.

Idea 3: Interface between website, application and sensors.

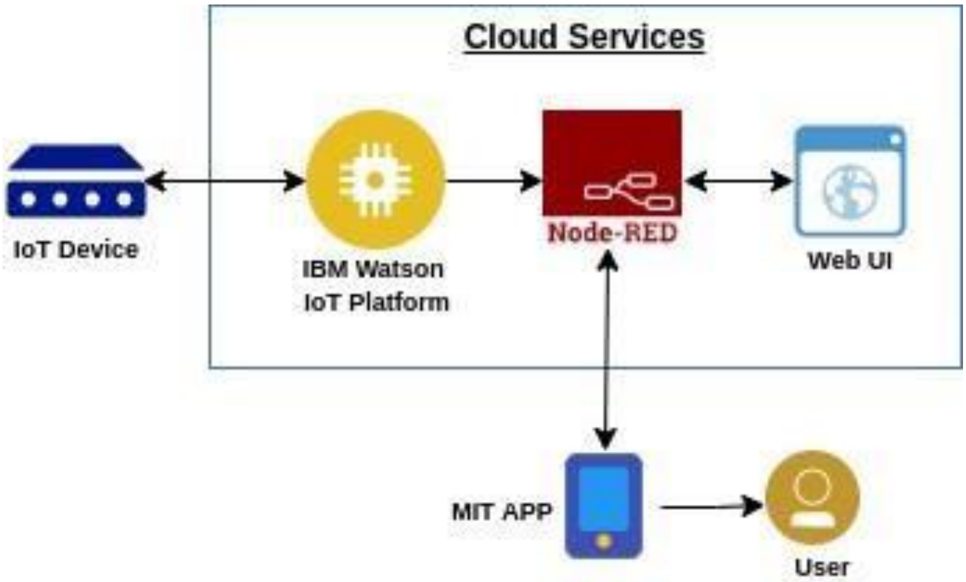
Idea 4: Utilizing ai to improvise accuracy.

3.3 Proposed Solution

S. No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	To overcome the lack of awareness and control of soil parameters such as temperature, moisture, humidity thereby improving quality of crops and plants, by implementing automated watering of plants.
	Idea / Solution description	To provide clear awareness about the

2.	soil, crop, weather parameters and improving controllability of the farming process through remote monitoring using sensors and controlling using an application.	
3.	Novelty / Uniqueness	• Usage of Raspberry Pi for increased processing power and user-friendly programming using Python. • Usage of Servo motors to properly direct the water flow according to the needs.
4.	Social Impact / Customer Satisfaction	• Improvisation in control of farming which ultimately leads to increased number of plants and trees. • Effective reduction of greenhouse effect and global warming.
5.	Business Model (Revenue Model)	Based on the scale of application and the sophistication of the motors, the cost of the model will vary.
6.	Scalability of the Solution	Variables of the entire field can be monitored using a single cloud account.

Small scale farming (gardening) applications for domestic purposes can use small scale model and largescale farming can include more sophisticated sensors such as rain sensor, TDS sensor, etc.



3.4 Problem Solution fit

PNT2022TMID05165

Project Title:Smart Farmer-IOT Enabled Smart Farming Application **Project Design Phase-I - Solution Fit Template**

Define CS, fit into CC

1. CUSTOMER SEGMENT(S) CS

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

- Farmers
- Plant hobbyists
- House gardeners
- Terrace gardening hobbyists

6. CUSTOMER CONSTRAINTS 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.

- Lack of Real-Time Monitoring system.
- Adaptability to Modern Agricultural Methods.
- Lack of awareness about farmland parameters.

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 is an alternative to digital notetaking

- Computer Vision based monitoring but it provides only images no real time monitoring.
- Individual sensors available for monitoring but not integrated together as integration all parameters only can provide better accuracy.

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.

- Range of sensors per farmland.
- Power Performance
- Adaptability to modern approach.

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? i.e. customers have to do it because of the change in regulations.

- Adverse climatic conditions.
- Lack of knowledge and awareness about environmental factors.

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)

- Surveys on different agricultural fields.
- Feedback about the existing solutions.

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

Identify strong TR & EM

3. TRIGGERS TR

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

- **Technological advancements in other countries.**
- **Getting proper awareness about field parameters.**
- **Efficient Real-Time Monitoring.**

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 behaviour.

- To provide clear awareness about the soil, crop, weather parameters and improving controllability of the farming process through remote mentoring using sensors and controlling using an application.
- A website manual for customer reference.

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

- Surveys and polls about different agricultural fields.

OFFLINE

- Testing and feedback about the products.

Identify strong TR & EM

4. EMOTIONS: BEFORE / AFTER EM

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

BEFORE

- **Additional care for monitoring.**
- **Worried over wilting and drying of crops and plants**

AFTER

- **Feeling Relieved due to real- time monitoring**
- **Promotes everyone to practice small scale farming.**

CHAPTER 4 - REQUIREMENT ANALYSIS

4.1 Functional Requirements:

Functional requirements involve the hardware and software components needed to design the system. They are:

- ***Sensors***: Rain sensor, DHT11–Temperature and Humidity sensor, Soil Moisture sensor.
- ***Actuators***: Water pumps, Motors, Servos.
- ***MCUs (Microcontroller Units)***: Raspberry Pi, ESP-8266.
- ***Software Components***: Web UI, Node red, IBM Watson as the cloud platform, Mobile application using MIT App inventor.

4.2 Non-functional Requirements:

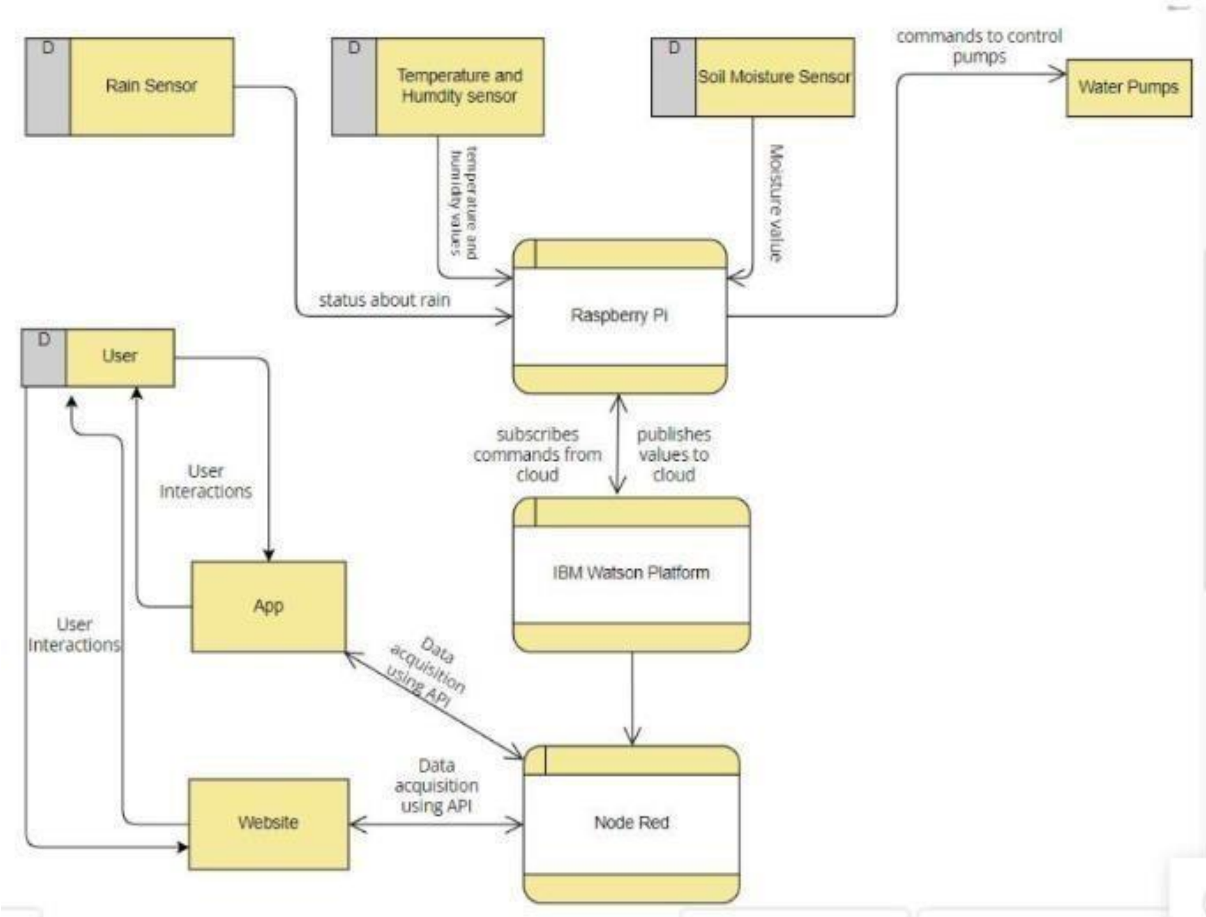
Non-functional requirements deal more of a customer or business model point of view. These requirements play a major role when the project is ready as a market product. Some of those non-technical requirements are:

- ***Usability***: Can be used for both large scale agricultural farms and domestic gardens for soil monitoring and watering of plants.
- ***Security***: Since the user uses his/her own cloud account to store and process sensor data, data privacy is maintained to a significant extent.
- ***Reliability***: Inclusion of real-time monitoring of sensor data and interactive mobile application makes the product more reliable.

- ***Performance***: Performance of the system is significantly high as MCUs with high processing capability such as Raspberry Pi are being used.
- ***Availability***: After successful completion of the design, the model will be available in the market, and people can purchase the product according to their requirements.
- ***Scalability***: The design can be scaled to be used for large sized farms by including sophisticated hardware components and sensors like TDS sensor, according to the requirements and physical parameters.

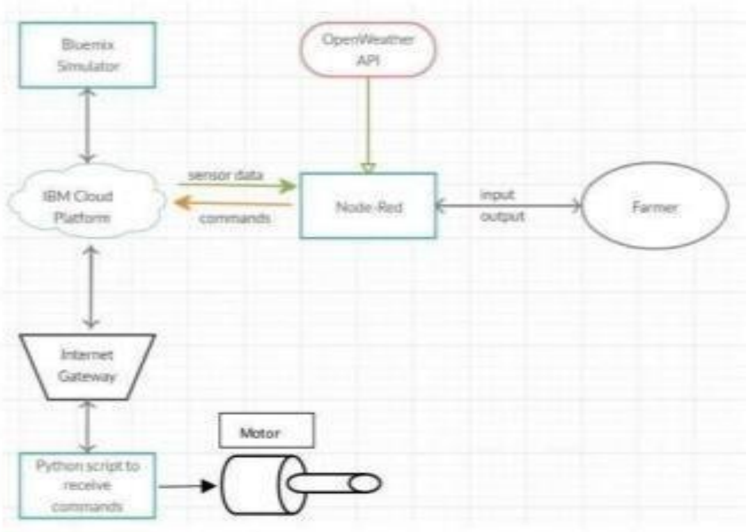
CHAPTER 5 - PROJECT DESIGN

5.1 Data Flow Diagrams



5.2 Solution and Technical Architecture

The technical architecture diagram is as follows:



<u>Guidelines</u>:

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)

- The different soil parameters temperature, soil moistures and humidity are sensed using different sensors and obtained value is stored in the IBM cloud.
- Here, instead of using Raspberry Pi processor unit, random values are generated for various soil parameters using Python.
- NODE-RED is used as a programming tool to write the hardware, software, and APIs. The MQTT protocol is followed for the communication.
- All the collected data are provided to the user through a mobile application that was developed using the MIT app inventor. The user could decide through an app, weather to water the crop or not

depending upon the sensor values. By using the app, they can remotely operate the motor switch.

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
	Login	USN-3	As a user, I can log into the application by entering email & password		High	Sprint-1
	Dashboard	USN-4	As a user, I can have access to all the sensor data on my dashboard		Low	Sprint-2
	Control	USN-5	As a user, I can control the agricultural devices connected over internet	I can control using user buttons	Low	Sprint-2
Customer (App user)	App - Control	USN-6	As a user, I can control the agricultural devices connected over internet	I can control using user buttons	Medium	Sprint-2
	App – monitor	USN-7	As a user, I can have access to all the sensor data on my app - dashboard		Medium	Sprint-2
Administrator	Setting defaults	USN-8	As a administrator, I can set default conditions to trigger an event		High	Sprint-1

CHAPTER 6 - PROJECT PLANNING AND SCHEDULING

6.1 Sprint Planning and Estimation

6.2 Sprint Delivery and Schedule

The Sprint schedule is as follows:

Sprint	Functional requirement (epic)	User story number	User story/task	Story points	priority	Team members
Sprint-1	Registration	USN-1	As a user the farmer hast to register the user authentication	20	high	Chandhuru A

			details to the app			
Sprint-1	Registration	USN-2	Then he/she will get conformation mail for the authentication	20	High	Murugaraj K
Sprint-2	Login	USN-3	He/she can monitor the field whether the moisture level is down	10	Low	Bavanesshvar B
Sprint-3	Dashboard	USN-4	If moisture level is down thermistor sensor detect it and send the message through cloud	15	Medium	Dhanush kumar B
Sprint-4	Dashboard	USN-5	Then they will get message from the app	20	high	Chandhuru A

Project Tracker, Burndown chart:

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

Velocity:

Imagine we have a 10-day sprint duration, and the velocity of the team is 20 (points per sprint). Let us calculate the team's average velocity (AV) per iteration unit (storage points per day).

$$AV = \frac{sprint\ duration}{velocity} = \frac{20}{10} = 2$$

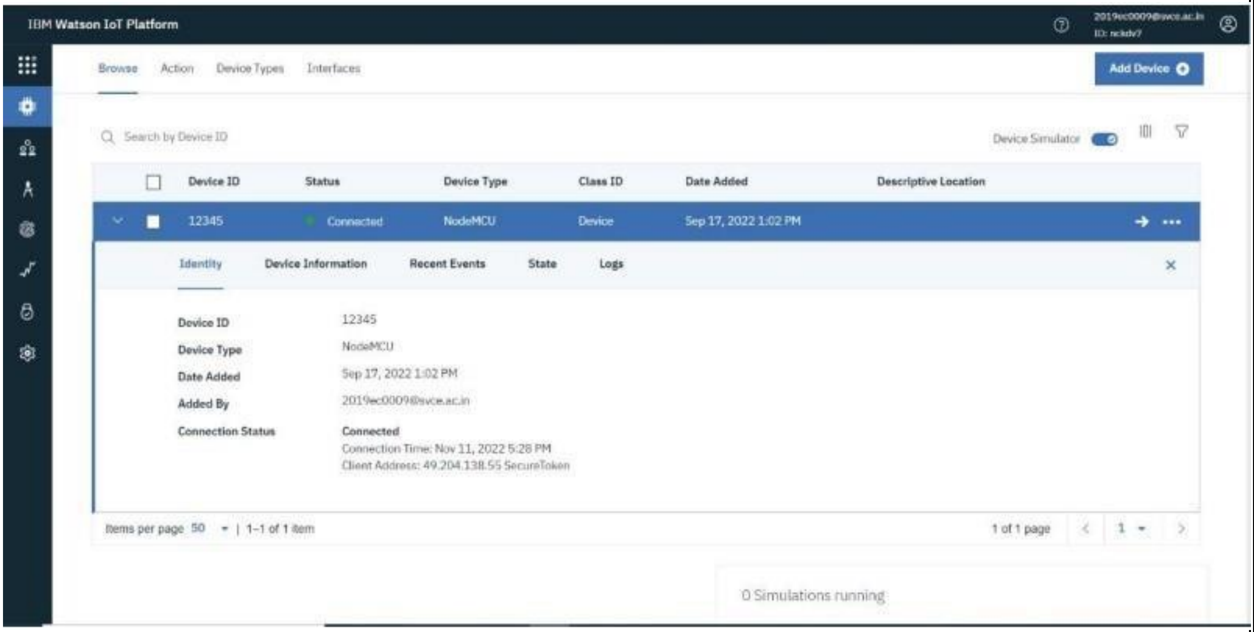
Burndown Chart:

A burndown chart is the graphical representation of work left to be done versus time. It is often used in agile software development methodologies such as Scrum. However, burn down charts can be applied to any project containing measurable progress over time.

CHAPTER 7 - CODING AND SOLUTIONING

- **Configuration of the IBM Watson IOT Platform and a device:**

In the IBM Watson IOT Platform, under the catalog list, under the Internet of Things platform, a device has been created. From that the device credentials such as Device ID, Device Type, Organization ID, Authentication token were obtained.



- **Development of Python Script to publish data to IBM Watson IOT platform:**

<u>Code</u>: import time

import sys import

ibmiotf.application

import ibmiotf.device

import random

#Provide your IBM

Watson Device

Credentials

organization =

"nckdv7" deviceType

=

"NodeMCU"

deviceId = "12345" authMethod = "token" authToken = "12345678" # Initialize GPIO try: deviceOptions = {"org": organization, "type": deviceType, "id": deviceId, "auth-method": authMethod, "auth-token": authToken}

deviceCli = ibmiotf.device.Client(deviceOptions)

#... except Exception as e:

print("Caught exception connecting device: %s" % str(e)) sys.exit()

Connect and send a datapoint "hello" with value "world" into the cloud as # an event of type "greeting" 10 times deviceCli.connect() while True: #Get Sensor Data from DHT11 temp=random.randint(0,100) pulse=random.randint(0,100) moisture= random.randint(0,100) humidity=random.randint(0,100); lat = 17 lon = 18 data = { 'temperature' : temp, 'humidity' : humidity, 'Moisture' :

moisture} #print

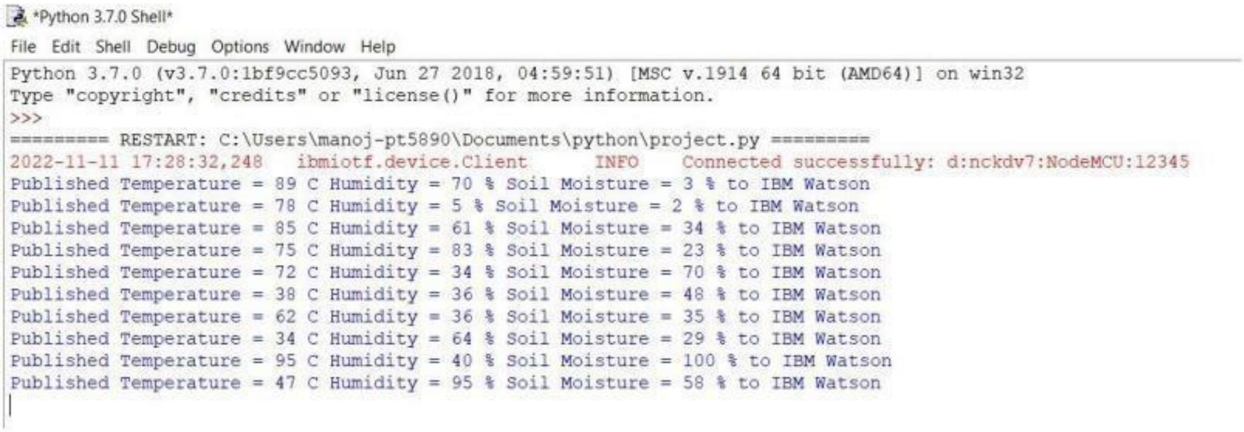
data

def myOnPublishCallback():

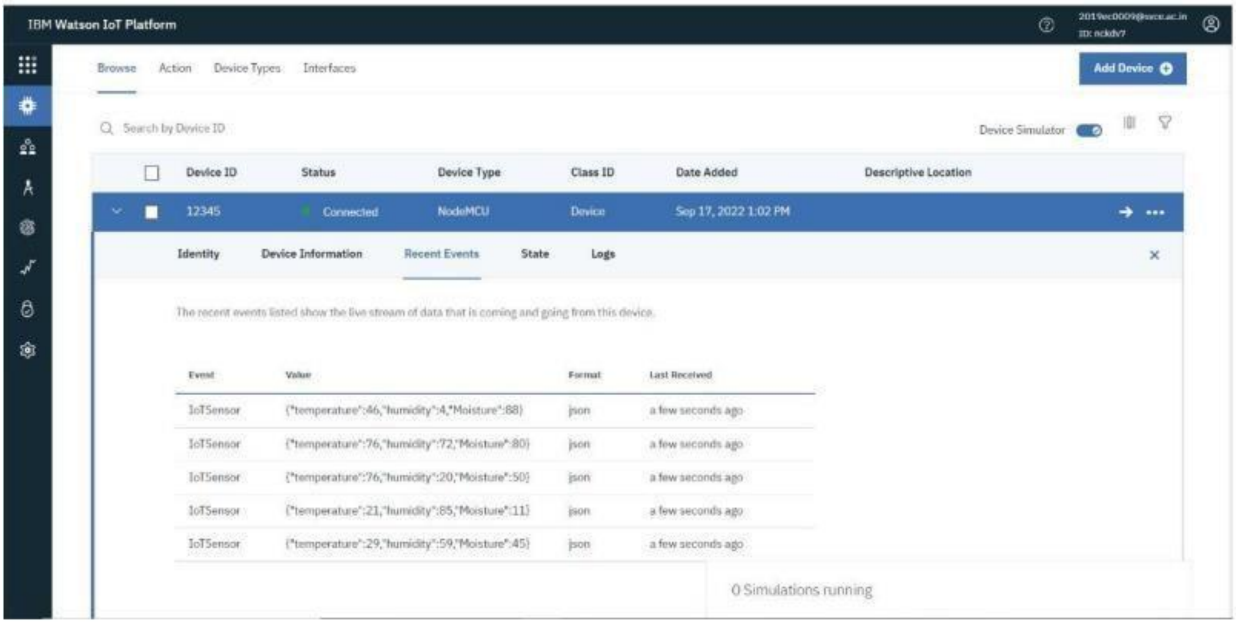
print ("Published Temperature = %s C" % temp, "Humidity = %s %%" % humidity, "Soil Moisture = %s %%" % moisture,"to IBM Watson") success = deviceCli.publishEvent("IoTSensor", "json", data, qos=0, on_publish=myOnPublishCallback) if not success: print("Not connected to IoTF")

time.sleep(1) deviceCli.commandCallback = myCommandCallback # Disconnect the device and application from the cloud deviceCli.disconnect()

Python Code Output:

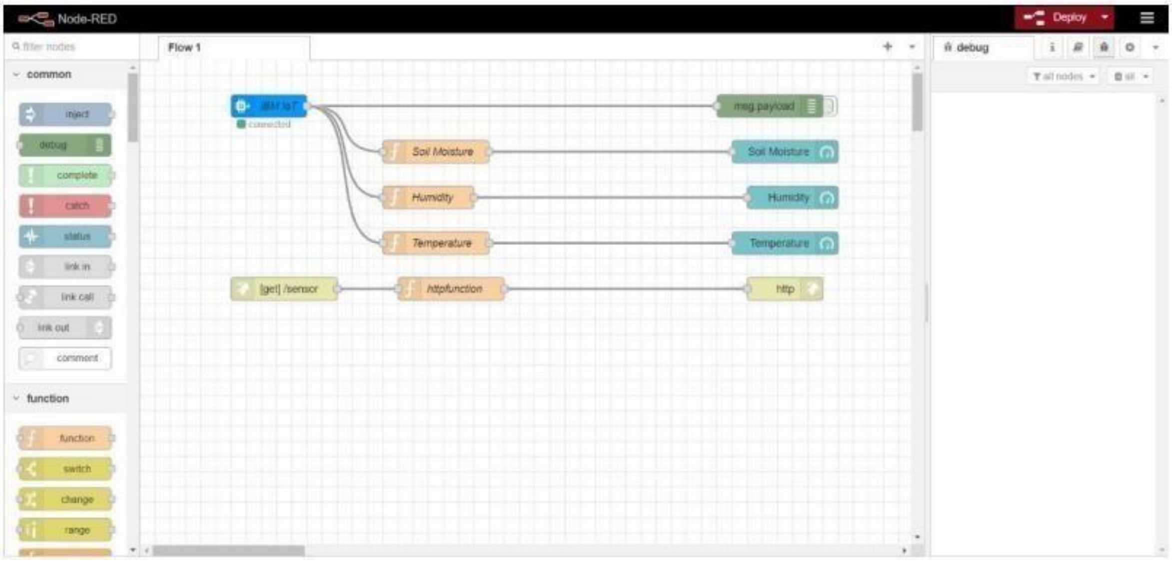


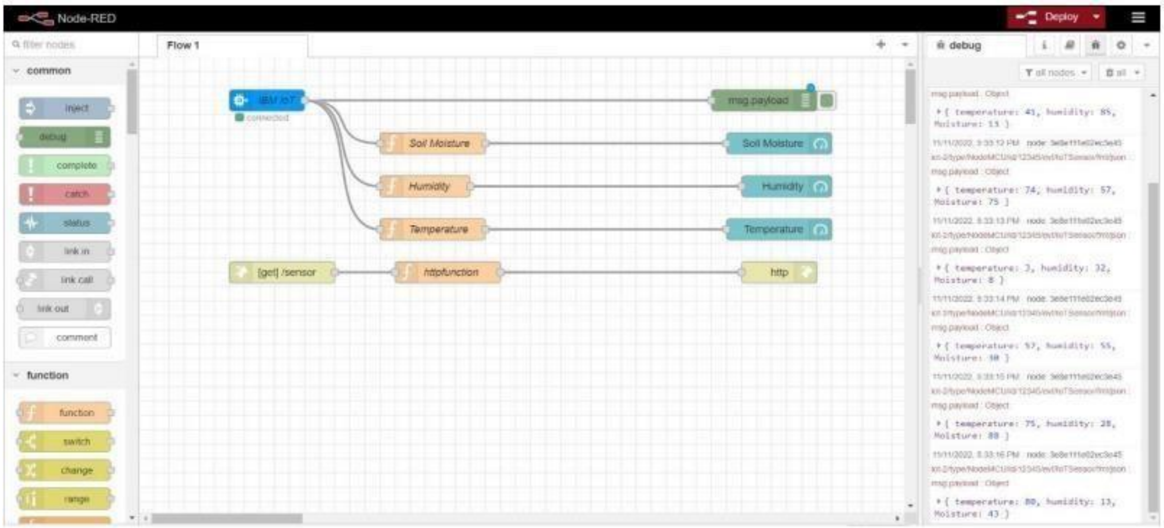
IBM Cloud after publishing data:



- **Creation of Node Red Service for device events:**

  In the IBM Watson IOT platform, under the catalog, under the Node Red app service, an application is deployed using cloud foundry. In the cloud foundry, a group has been created and using the ci pipeline, the app url is obtained. Using the URL, the Node red is launched. The IBM Watson IOT platform is connected to Node red using the IBM IoT palette. Using appropriate palettes, the data published in the IBM IoT platform is printed in the debug window of Node red.





Code block for the function palette:

1) **<u>Soil moisture</u>:**

Soil = msg.payload.Moisture   msg.payload = "Soil Moisture :

"   global.set('m',Soil)

msg.payload = Math.round(Soil)

return msg;

2) **<u>Humidity:</u>**

Humidity = msg.payload.humidity   msg.payload = "Humidity : "

global.set('h',Humidity)   msg.payload

= Math.round(Humidity)   return msg;   **3)**

Temperature:

Temperature = msg.payload.temperature msg.payload

= "Temperature : "

global.set('t',Temperature)   msg.payload

=Math.round(Temperature)   return msg;   **4)**

HTTP Function:

msg.payload = {"Temperature:": global.get('t'),"Humidity:": global.get('h'),"Soil Moisture:": global.get('m')} return msg;

- **Creation of Website dashboard:**

A website dashboard has been created using the gauge palette. It can be accessed by adding "/ui" in the main url of Node red. This dashboard displays the gauge representation of the data published in the IBM IOT platform.

Python code used: import

time import sys

import

ibmiotf.application

import ibmiotf.device

import random

#Provide your IBM Watson Device Credentials

organization = "nckdv7" deviceType =

"NodeMCU" deviceId = "12345" authMethod

= "token" authToken = "12345678" #

Initialize GPIO try:

deviceOptions = {"org": organization, "type": deviceType, "id": deviceId, "auth-method": authMethod, "auth-token": authToken} deviceCli = ibmiotf.device.Client(deviceOptions)

#.. except

Exception as e: print("Caught exception connecting device: %s" % str(e)) sys.exit()

Connect and send a datapoint "hello" with value "world" into the cloud as an event of type "greeting" 10 times deviceCli.connect() while True: #Get Sensor Data from DHT11 temp=random.randint(0,100) pulse=random.randint(0,100) moisture= random.randint(0,100)

humidity=random.randint(0,100); lat = 17 lon = 18 data = { 'temperature' : temp, 'humidity' : humidity, 'Moisture' : moisture}

#print data def

myOnPublishCallback():

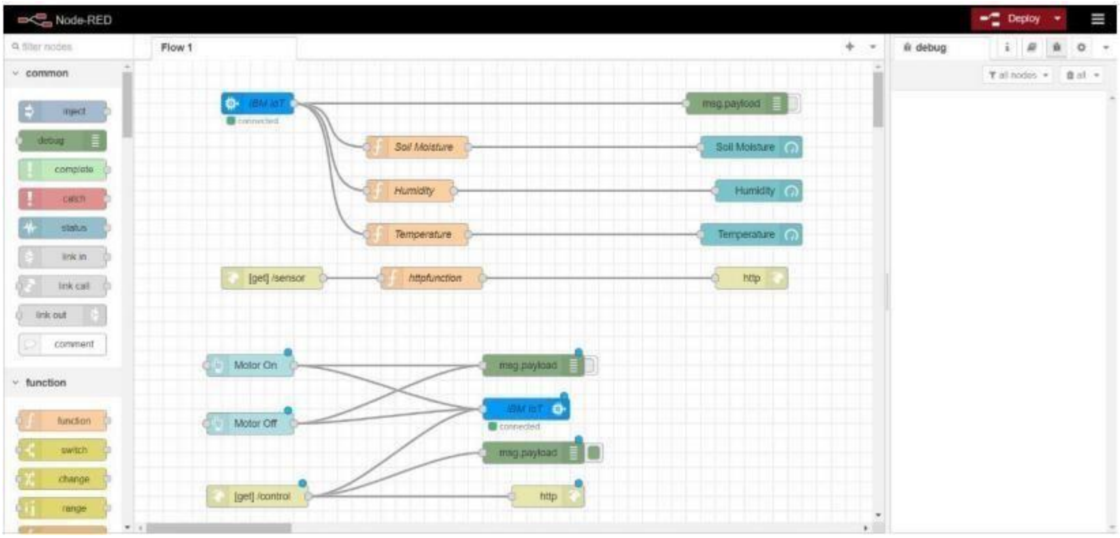
print ("Published Temperature = %s C" % temp, "Humidity = %s %%" % humidity, "Soil Moisture = %s %%" % moisture,"to IBM Watson")

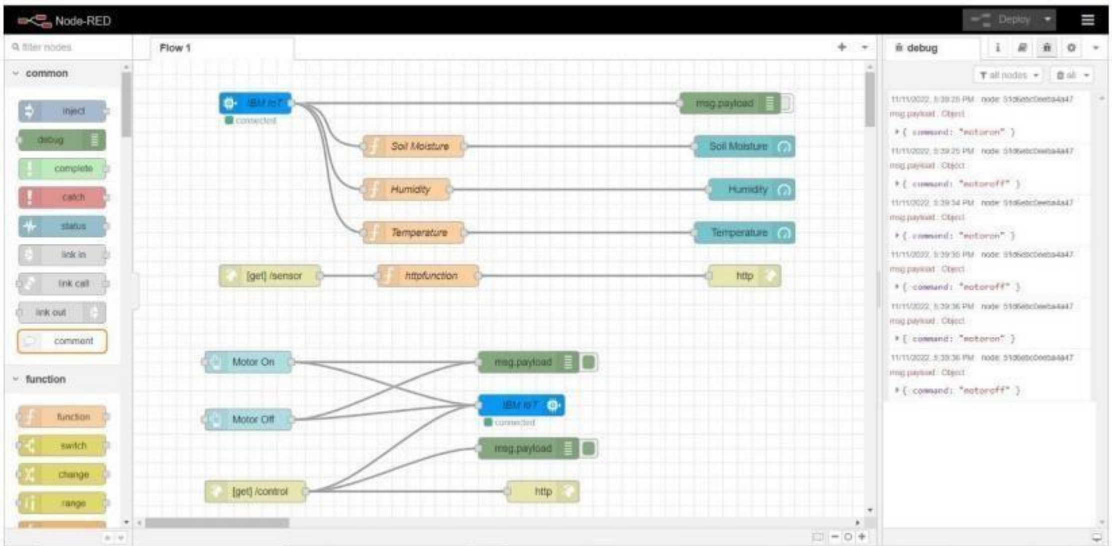
success = deviceCli.publishEvent("IoTSensor", "json", data, qos=0, on_publish=myOnPublishCallback) if not success:

print("Not connected to IoTF")

time.sleep(1) deviceCli.commandCallback = myCommandCallback # Disconnect the device and application from the cloud deviceCli.disconnect() **Creation of Node red service for device commands:**

In addition to the palettes used in the Sprint-2, additional palettes such as buttons have been included to control devices by giving commands and the output is printed in the debug whenever a specific command is given.





Development of Python script to subscribe command from the IBM IOT platform:

Code: import time

import sys import

ibmiotf.application

import ibmiotf.device

import random

#Provide your IBM Watson Device Credentials organization = "nckdv7" deviceType = "NodeMCU" deviceId = "12345" authMethod = "token" authToken = "12345678" # Initialize GPIO def myCommandCallback(cmd): print("Command received: %s" % cmd.data['command']) status=cmd.data['command'] if status=="motoron":

print("Motor is ON") else:

print("Motor is OFF")

#print(cmd) try: deviceOptions = {"org": organization, "type": deviceType, "id": deviceId, "authmethod": authMethod, "auth-token": authToken} deviceCli = ibmiotf.device.Client(deviceOptions)

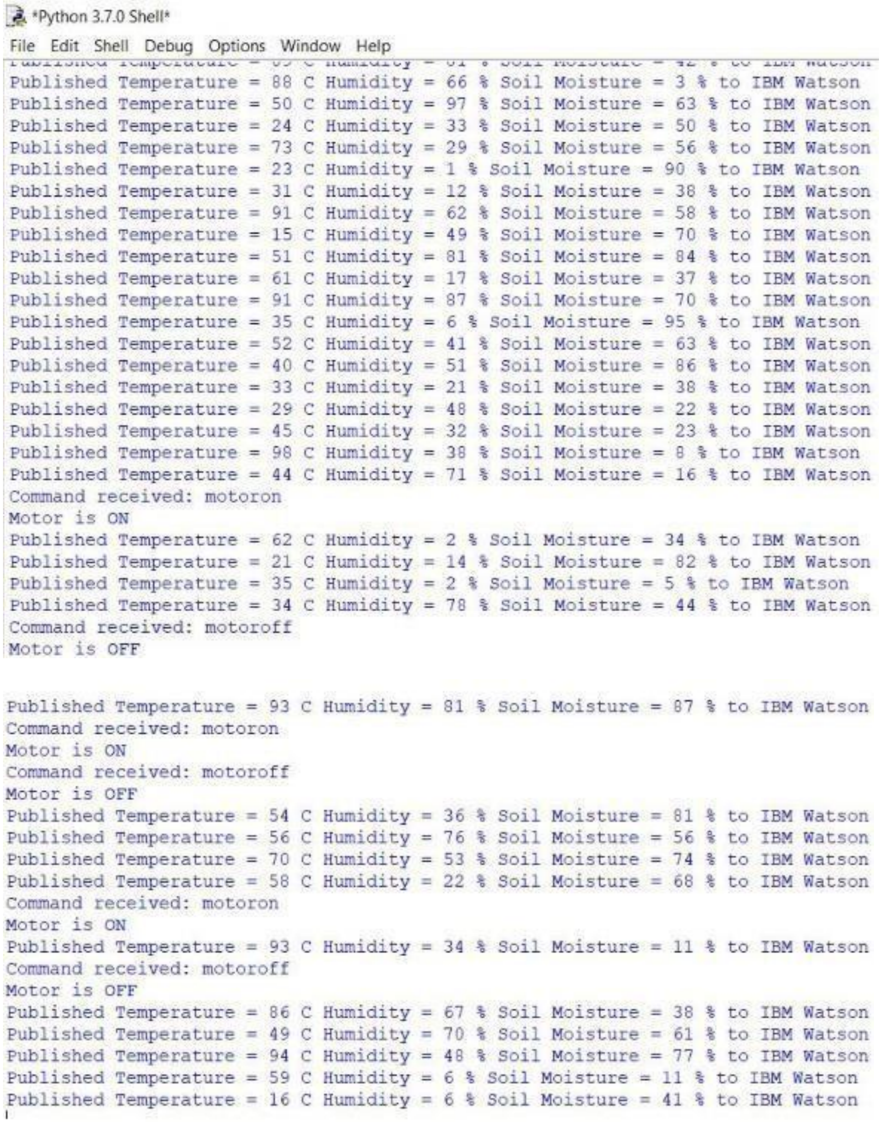
#.. except Exception as e:

print("Caught exception connecting device: %s" % str(e)) sys.exit()

Connect and send a datapoint "hello" with value "world" into the cloud as # an event of type "greeting" 10 times deviceCli.connect() while True: #Get Sensor Data from DHT11 temp=random.randint(0,100) pulse=random.randint(0,100) moisture= random.randint(0,100) humidity=random.randint(0,100); lat = 17 lon = 18 data = { 'temperature' : temp, 'humidity' : humidity, 'Moisture' :

```
moisture}  #print
data


def myOnPublishCallback():
    print ("Published Temperature = %s C" % temp, "Humidity = %s
    %%" % humidity, "Soil Moisture = %s %%" % moisture,"to IBM
    Watson")  success = deviceCli.publishEvent("IoTSensor",
"json", data, qos=0,   on_publish=myOnPublishCallback)  if not
success:
    print("Not connected to IoTF")       time.sleep(1)
        deviceCli.commandCallback     =
myCommandCallback # Disconnect the device and
application from the cloud deviceCli.disconnect()
```

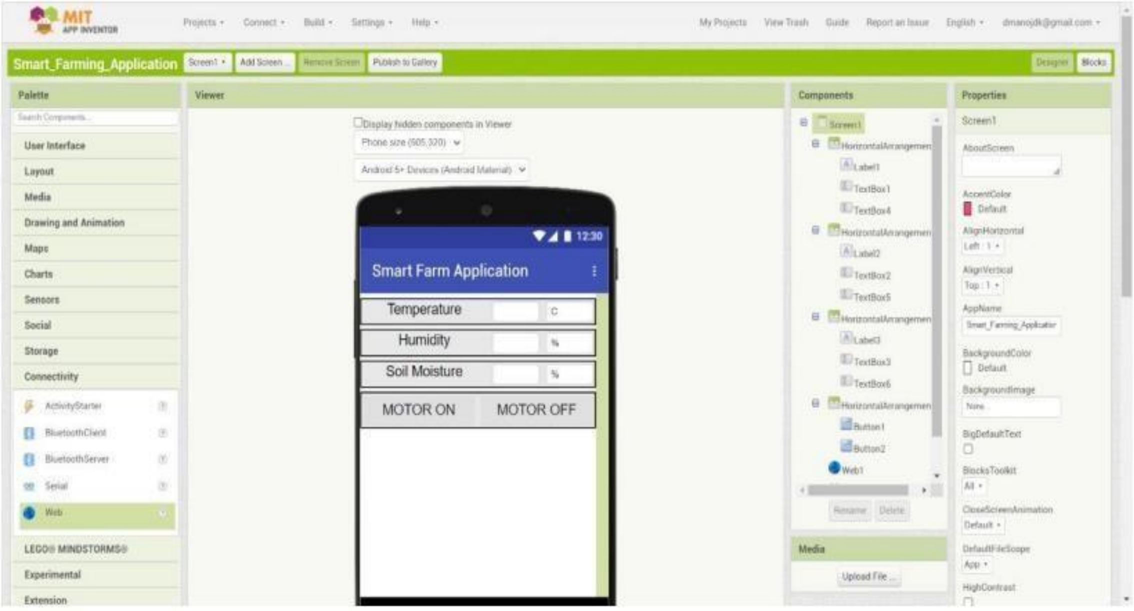
Output:



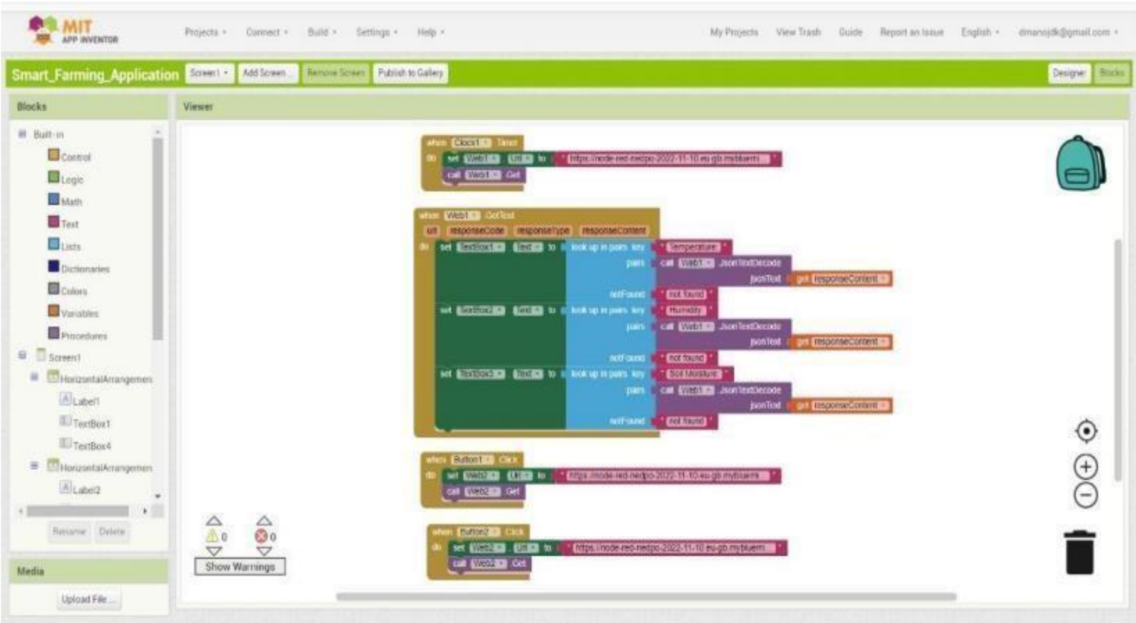
```
*Python 3.7.0 Shell*
File Edit Shell Debug Options Window Help
Published Temperature = 88 C Humidity = 66 % Soil Moisture = 3 % to IBM Watson
Published Temperature = 50 C Humidity = 97 % Soil Moisture = 63 % to IBM Watson
Published Temperature = 24 C Humidity = 33 % Soil Moisture = 50 % to IBM Watson
Published Temperature = 73 C Humidity = 29 % Soil Moisture = 56 % to IBM Watson
Published Temperature = 23 C Humidity = 1 % Soil Moisture = 90 % to IBM Watson
Published Temperature = 31 C Humidity = 12 % Soil Moisture = 38 % to IBM Watson
Published Temperature = 91 C Humidity = 62 % Soil Moisture = 58 % to IBM Watson
Published Temperature = 15 C Humidity = 49 % Soil Moisture = 70 % to IBM Watson
Published Temperature = 51 C Humidity = 81 % Soil Moisture = 84 % to IBM Watson
Published Temperature = 61 C Humidity = 17 % Soil Moisture = 37 % to IBM Watson
Published Temperature = 91 C Humidity = 87 % Soil Moisture = 70 % to IBM Watson
Published Temperature = 35 C Humidity = 6 % Soil Moisture = 95 % to IBM Watson
Published Temperature = 52 C Humidity = 41 % Soil Moisture = 63 % to IBM Watson
Published Temperature = 40 C Humidity = 51 % Soil Moisture = 86 % to IBM Watson
Published Temperature = 33 C Humidity = 21 % Soil Moisture = 38 % to IBM Watson
Published Temperature = 29 C Humidity = 48 % Soil Moisture = 22 % to IBM Watson
Published Temperature = 45 C Humidity = 32 % Soil Moisture = 23 % to IBM Watson
Published Temperature = 98 C Humidity = 38 % Soil Moisture = 8 % to IBM Watson
Published Temperature = 44 C Humidity = 71 % Soil Moisture = 16 % to IBM Watson
Command received: motoron
Motor is ON
Published Temperature = 62 C Humidity = 2 % Soil Moisture = 34 % to IBM Watson
Published Temperature = 21 C Humidity = 14 % Soil Moisture = 82 % to IBM Watson
Published Temperature = 35 C Humidity = 2 % Soil Moisture = 5 % to IBM Watson
Published Temperature = 34 C Humidity = 78 % Soil Moisture = 44 % to IBM Watson
Command received: motoroff
Motor is OFF

Published Temperature = 93 C Humidity = 81 % Soil Moisture = 87 % to IBM Watson
Command received: motoron
Motor is ON
Command received: motoroff
Motor is OFF
Published Temperature = 54 C Humidity = 36 % Soil Moisture = 81 % to IBM Watson
Published Temperature = 56 C Humidity = 76 % Soil Moisture = 56 % to IBM Watson
Published Temperature = 70 C Humidity = 53 % Soil Moisture = 74 % to IBM Watson
Published Temperature = 58 C Humidity = 22 % Soil Moisture = 68 % to IBM Watson
Command received: motoron
Motor is ON
Published Temperature = 93 C Humidity = 34 % Soil Moisture = 11 % to IBM Watson
Command received: motoroff
Motor is OFF
Published Temperature = 86 C Humidity = 67 % Soil Moisture = 38 % to IBM Watson
Published Temperature = 49 C Humidity = 70 % Soil Moisture = 61 % to IBM Watson
Published Temperature = 94 C Humidity = 48 % Soil Moisture = 77 % to IBM Watson
Published Temperature = 59 C Humidity = 6 % Soil Moisture = 11 % to IBM Watson
Published Temperature = 16 C Humidity = 6 % Soil Moisture = 41 % to IBM Watson
```

- **Development of Mobile application using MIT App Inventor:** In the MIT App Inventor platform, an application is created which monitors the farmland parameters such as temperature, humidity, soil moisture and controls the actuators such as motors.

MIT App Front End:



Backend:



App working:

The app works based on HTTP protocol. The app uses HTTP GET method to parse the JSON data from the Node red website and displays the value in the UI. Using the HTTP POST method, the app sends command when a specific button is pressed. From where, the python code subscribes the command data from the cloud thereby notifying the command is received.

Python code: import time

import sys import

ibmiotf.application

import ibmiotf.device

import random

#Provide your IBM Watson Device Credentials organization = "nckdv7" deviceType = "NodeMCU" deviceId = "12345" authMethod = "token" authToken = "12345678" # Initialize GPIO def myCommandCallback(cmd): print("Command received: %s" % cmd.data['command']) status=cmd.data['command'] if status=="motoron":

print("Motor is ON") else:

print("Motor is OFF")

#print(cmd)

try: deviceOptions = {"org": organization, "type": deviceType, "id": deviceId, "auth-method": authMethod, "auth-token": authToken}

deviceCli = ibmiotf.device.Client(deviceOptions)

#.. except

Exception as e: print("Caught exception connecting device: %s" % str(e))

sys.exit()

Connect and send a datapoint "hello" with value "world" into the cloud as # an event of type "greeting" 10 times deviceCli.connect() while True: #Get Sensor Data from DHT11 temp=random.randint(0,100) pulse=random.randint(0,100) moisture= random.randint(0,100) humidity=random.randint(0,100); lat = 17 lon = 18 data = { 'temperature' : temp, 'humidity' : humidity, 'Moisture' :

moisture}

#print data def

myOnPublishCallback():

print ("Published Temperature = %s C" % temp, "Humidity = %s %%" % humidity, "Soil Moisture = %s %%" % moisture,"to IBM Watson") success = deviceCli.publishEvent("IoTSensor", "json", data, qos=0, on_publish=myOnPublishCallback) if not success:

print("Not connected to IoTF") time.sleep(1)

deviceCli.commandCallback = myCommandCallback #

Disconnect the device and application from the cloud

deviceCli.disconnect()

Output:

Python 3.7.0 Shell

File Edit Shell Debug Options Window Help

```
Published Temperature = 88 C Humidity = 66 % Soil Moisture = 3 % to IBM Watson
Published Temperature = 50 C Humidity = 97 % Soil Moisture = 63 % to IBM Watson
Published Temperature = 24 C Humidity = 33 % Soil Moisture = 50 % to IBM Watson
Published Temperature = 73 C Humidity = 29 % Soil Moisture = 56 % to IBM Watson
Published Temperature = 23 C Humidity = 1 % Soil Moisture = 90 % to IBM Watson
Published Temperature = 31 C Humidity = 12 % Soil Moisture = 38 % to IBM Watson
Published Temperature = 91 C Humidity = 62 % Soil Moisture = 58 % to IBM Watson
Published Temperature = 15 C Humidity = 49 % Soil Moisture = 70 % to IBM Watson
Published Temperature = 51 C Humidity = 81 % Soil Moisture = 84 % to IBM Watson
Published Temperature = 61 C Humidity = 17 % Soil Moisture = 37 % to IBM Watson
Published Temperature = 91 C Humidity = 87 % Soil Moisture = 70 % to IBM Watson
Published Temperature = 35 C Humidity = 6 % Soil Moisture = 95 % to IBM Watson
Published Temperature = 52 C Humidity = 41 % Soil Moisture = 63 % to IBM Watson
Published Temperature = 40 C Humidity = 51 % Soil Moisture = 86 % to IBM Watson
Published Temperature = 33 C Humidity = 21 % Soil Moisture = 38 % to IBM Watson
Published Temperature = 29 C Humidity = 48 % Soil Moisture = 22 % to IBM Watson
Published Temperature = 45 C Humidity = 32 % Soil Moisture = 23 % to IBM Watson
Published Temperature = 98 C Humidity = 38 % Soil Moisture = 8 % to IBM Watson
Published Temperature = 44 C Humidity = 71 % Soil Moisture = 16 % to IBM Watson
Command received: motoron
Motor is ON
Published Temperature = 62 C Humidity = 2 % Soil Moisture = 34 % to IBM Watson
Published Temperature = 21 C Humidity = 14 % Soil Moisture = 82 % to IBM Watson
Published Temperature = 35 C Humidity = 2 % Soil Moisture = 5 % to IBM Watson
Published Temperature = 34 C Humidity = 78 % Soil Moisture = 44 % to IBM Watson
Command received: motoroff
Motor is OFF
Published Temperature = 93 C Humidity = 81 % Soil Moisture = 87 % to IBM Watson
Command received: motoron
Motor is ON
Command received: motoroff
Motor is OFF
Published Temperature = 54 C Humidity = 36 % Soil Moisture = 81 % to IBM Watson
Published Temperature = 56 C Humidity = 76 % Soil Moisture = 56 % to IBM Watson
Published Temperature = 70 C Humidity = 53 % Soil Moisture = 74 % to IBM Watson
Published Temperature = 58 C Humidity = 22 % Soil Moisture = 68 % to IBM Watson
Command received: motoron
Motor is ON
Published Temperature = 93 C Humidity = 34 % Soil Moisture = 11 % to IBM Watson
Command received: motoroff
Motor is OFF
Published Temperature = 86 C Humidity = 67 % Soil Moisture = 38 % to IBM Watson
Published Temperature = 49 C Humidity = 70 % Soil Moisture = 61 % to IBM Watson
Published Temperature = 94 C Humidity = 48 % Soil Moisture = 77 % to IBM Watson
Published Temperature = 59 C Humidity = 6 % Soil Moisture = 11 % to IBM Watson
Published Temperature = 16 C Humidity = 6 % Soil Moisture = 41 % to IBM Watson
```

CHAPTER 8 - PERFORMANCE METRICS

S. No.	Name of the Phase	Tasks Performed	Performance Metrics
1.	Development of Problem Statement	The underlying problem analyzed and a rough idea of the solution was planned	The Problem statement was developed
2.	Ideation Phase	Extracting use and test cases	Empathy map, Ideation and Literature survey were formulated.
3.	Project Design Phase 1	Solution for the problem is formulated and architecture is designed	Problem solution fit was designed and the Proposed solution is finalized with the help of Solution architecture.
4.	Project Design Phase 2	In depth analysis of the solution is performed including requirements, tech stack, etc.	Solution Requirements, Overall Technology stack, Data flow diagrams, User stories were formulated.
5.	Project Planning Phase	Various sprints were designed as individual progressive steps.	Project Milestone and Sprint Plans were developed.

CHAPTER 9 - ADVANTAGES AND DISADVANTAGES

9.1 Advantages:

- By monitoring the soil parameters of the farm, the user can have a complete analysis of the field, in terms of numbers.
- Using the website and the application, an interactive experience can be achieved.
- As the data gets pushed to the cloud, one can access the data anywhere from this world. ○ Without human intervention, water pump can be controlled through the mobile application and it's flow can be customized using servo motors.
- By using Raspberry Pi MCU, scalability can be increased due to its high processing power and enough availability of GPIO pins

9.2 Disadvantages:

- Data transfer is through the internet. So data fetch and push might delay due to slow internet connection, depending on the location and other physical parameters.
- System can only monitor a certain area of the field. In order to sense and monitor an entire field, sensors should be placed in many places, which may increase the cost.
- Data accuracy may vary according to various physical parameters such as temperature, pressure, rain.
- Cost of the system is high due to usage of Raspberry Pi. ○ Rodent and insects may cause damage to the system.

CHAPTER 10 – CONCLUSION

The project thus monitors important parameters present in the field such as temperature, humidity, soil moisture etc., and controls important actuators such as motors etc. It is helpful for farmers to remotely monitor their fields even during adverse weather conditions and help them control farming equipments remotely using cloud.

CHAPTER 11 - FUTURE SCOPE

The project can be further extended by monitoring other parameters such as nutrient contents in the soil, soil texture etc. AI techniques integrated with cloud can be integrated to monitor any pest attacks present in the plant. The application can be made interactive which provides suggestions to farmers to improve their farmlands.

CHAPTER 12 – APPENDIX

12.1 Source Code:

```
import time import
sys import
ibmiotf.application import
ibmiotf.device import
random

#Provide your IBM Watson Device
Credentials organization = "nckdv7"
deviceType = "NodeMCU" deviceId =
"12345" authMethod = "token" authToken =
"12345678"

# Initialize GPIO def myCommandCallback(cmd):
print("Command received: %s" % cmd.data['command'])
status=cmd.data['command'] if status=="motoron":
print("Motor is ON") else: print("Motor is OFF")
#print(cmd) try: deviceOptions = {"org": organization, "type":
deviceType, "id":
deviceId, "auth-method": authMethod, "auth-token":
authToken} deviceCli =
ibmiotf.device.Client(deviceOptions)
#..............................................

except Exception as e:
```

print("Caught exception connecting device: %s" % str(e)) sys.exit()

Connect and send a datapoint "hello" with value "world" into the cloud as an event of type "greeting" 10 times deviceCli.connect()

while True:

#Get Sensor Data from DHT11

temp=random.randint(0,100)

pulse=random.randint(0,100)

moisture= random.randint(0,100)

humidity=random.randint(0,100);

lat = 17 lon = 18

data = { 'temp' : temp, 'humidity' : humidity, 'Soil Moisture' : moisture}

#print data def myOnPublishCallback():

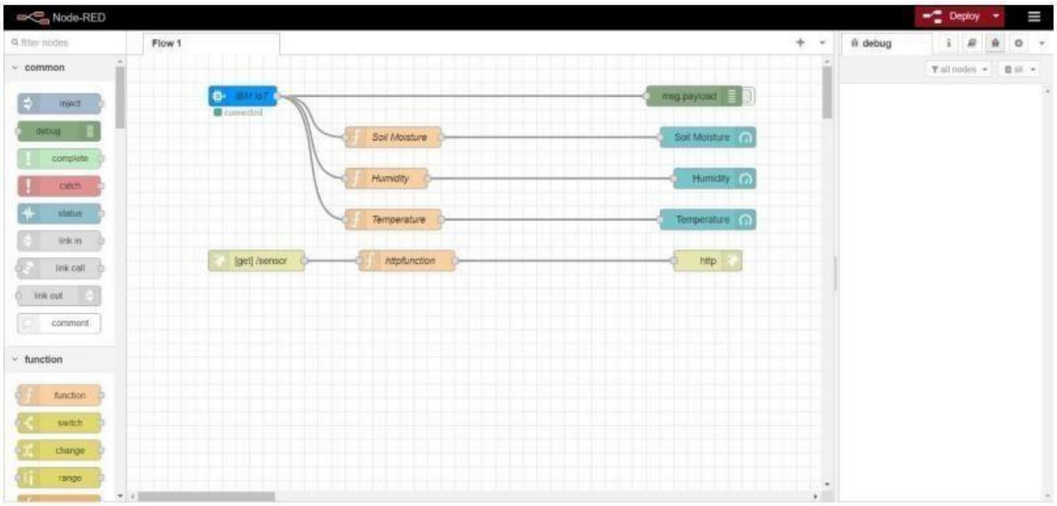
print ("Published Temperature = %s C" % temp, "Humidity = %s %%" % humidity, "Soil Moisture = %s %%" % moisture,"to IBM Watson")

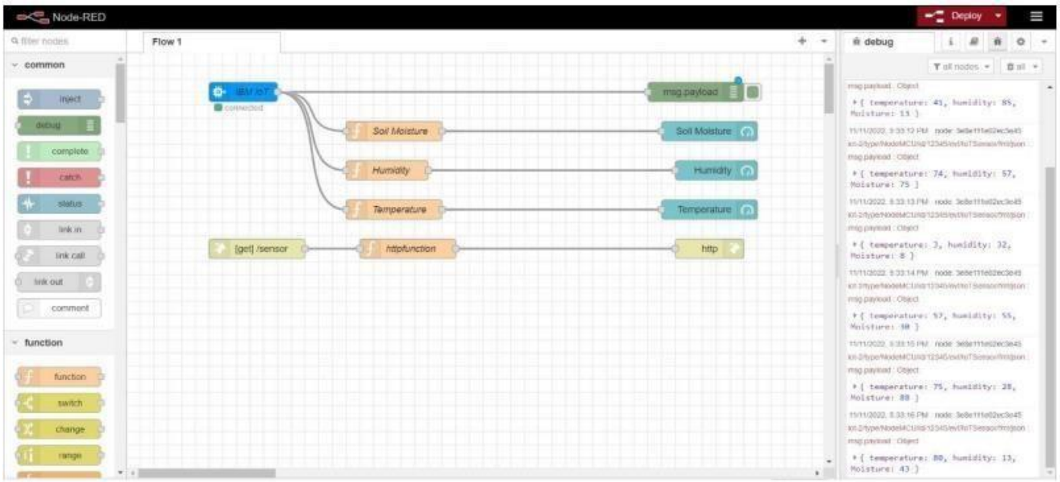
success = deviceCli.publishEvent("IoTSensor", "json", data, qos=0, on_publish=myOnPublishCallback) if not success: print("Not connected to IoTF") time.sleep(1)

deviceCli.commandCallback = myCommandCallback

Disconnect the device and application from the cloud deviceCli.disconnect()

Node Red Service Creation:





Code block for the function palette:

1) <u>Soil moisture</u>:

Soil = msg.payload.Moisture

msg.payload = "Soil Moisture : "

global.set('m',Soil) msg.payload =

Math.round(Soil) return msg; **2) <u>Humidity:</u>**

Humidity = msg.payload.humidity msg.payload = "Humidity : " global.set('h',Humidity) msg.payload = Math.round(Humidity) return msg; **3)**

Temperature:

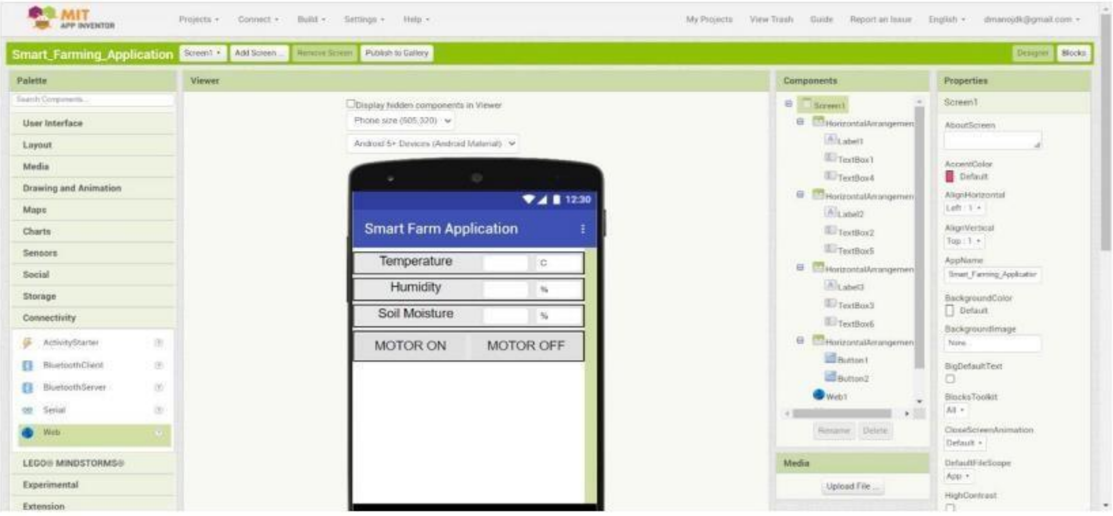
Temperature = msg.payload.temperature msg.payload = "Temperature : " global.set('t',Temperature) msg.payload =Math.round(Temperature) return msg; **4)**

HTTP Function:

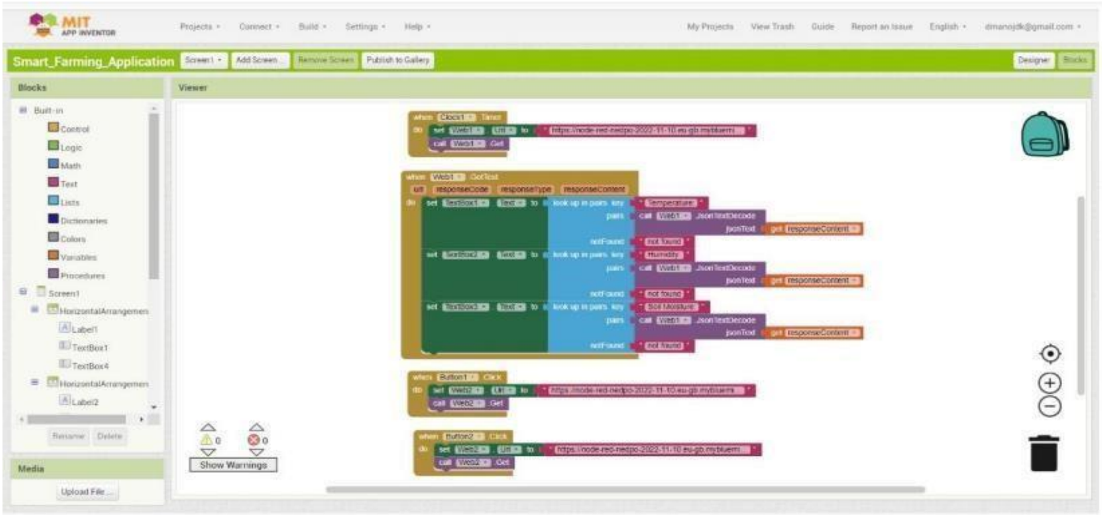
msg.payload = {"Temperature:": global.get('t'),"Humidity:": global.get('h'),"Soil Moisture:": global.get('m')}

return msg;

MIT App Front End:



Backend:



12.2 GitHub and Project Demo Link:

GitHub source code link:

[IBM-Project-8667-1658926777/PNT2022TMID05165-Source Code.py at main · IBM-EPBL/IBM-Project-8667-1658926777 (github.com)]

Project demo Link:

[IBM-Project-8667-1658926777/Final Deliverables at main · IBM-EPBL/IBM-Project-8667-1658926777 (github.com)]