SMART FARMER - IOT ENABLED SMART FARMING APPLICATION

NALAIYA THIRAN PROJECT

Submitted by

Krishna prasath V
Kavimani B
Hariharan J
Keerthi Vasan M

BACHELOR OF ENGINEERING

in

ELECTRONICS AND COMMUNICATION ENGINEERING

RMK COLLEGE OF ENGINEERING AND TECHNOLOGY

TABLE OF CONTENTS

1.INTRODUCTION

Internet of Things (IoT) technology has brought revolution to each and every field of common man's Internet of Things (IoT) technology has brought revolution to each and every field of common man's life by making everything smart and intelligent. IoT refers to a network of things which make a self-configuring network. The development of Intelligent Smart Farming IoT based devices is day by day turning the face of agriculture production by not only enhancing it but also making it cost-effective and reducing wastage. The aim / objective of this report is to propose IoT based Smart Farming System assisting farmers in getting Live Data (Temperature, Soil Moisture) for efficient environment monitoring which will enable them to increase their overall yield and quality of products. The IoT based Smart Farming System being proposed via this report is integrated with Arduino Technology mixed with different Sensors and a Wifi module producing live data feed that can be obtained online from Thingsspeak.com. The product being proposed is tested on Live Agriculture Fields giving high accuracy over 98% in data feeds.

1.1 Project Overview

The objectives of this report is to proposedIoT based Smart Farming System which will enable farmers to have live data of soil moisture environment temperature at very low cost so that live monitoring can be done. The structure of the report is as follows: chapter I will cover over of overview of IoT Technology and agriculture-concepts and definition, IOT enabling technologies, IOT application in agriculture, benefits of IOT in agriculture and IOT and agriculture current scenario and future forecasts. Chapter II will cover definition of IOT based smart farming system , the components and modules used in it and working principal of it. Chapter III will cover algorithm and flowchart of the overall process carried out in the system and its final graphical output .chapter IV consist of conclusion, future scope and references

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.

2.LITERATURE SURVEY

Divya J., Divya M.,Janani V Agriculture is essential to India's economy and people's survival. The purpose of this project is to create an embedded-based soil monitoring and irrigation system that will reduce manual field monitoring and provide information via a mobile app. The method is intended to help farmers increase their agricultural output. A pH sensor, a temperature sensor, and a humidity sensor are among the tools used to examine the soil. Based on the findings, farmers may plant the best crop for the land. The sensor data is sent to the field manager through Wi-Fi, and the crop advice is created with the help of the mobile app. When the soil temperature is high, an automatic watering system is used. The crop image is gathered and forwarded to the field manager for pesticide advice.

Zuraida Muhammad, Muhammad Azri Asyraf Mohd Hafez, Nor Adni MatLeh, Zakiah Mohd Yusoff , Shabinar Abd Hamid The term "Internet of Things" refers to the connection of objects, equipment, vehicles, and other electronic devices to a network for the purpose of data exchange (IoT). The Internet of Things (IoT) is increasingly being utilised to connect objects and collect data. As a result, the Internet of Things' use in agriculture is crucial. The idea behind the project is to create a smart agriculture system that is connected to the internet of things. The technology is combined with an irrigation system to deal with Malaysia's variable weather. This system's microcontroller is a Raspberry Pi 4 Model B. The temperature and humidity in the surrounding region, as well as the moisture level of the soil, are monitored using the DHT22 and soil moisture sensor. The data will be available on both a smartphone and a computer. As a result, Internet of Things (IoT) and Raspberry Pi-based Smart Agriculture Systems have a significant impact on how farmers work. It will have a good impact on agricultural productivity as well. In Malaysia, employing IoT-based irrigation systems saves roughly 24.44 percent per year when compared to traditional irrigation systems. This would save money on labour expenditures while also preventing water waste in daily needs..

Shweta B. Saraf, Dhanashri H. Gawali The Internet of Things (IoT) is the internet-based connectivity of a huge number of devices (IoT). A unique identity links each item, allowing data to be sent without human involvement It makes it possible to develop strategies for improved natural resource management. Smart gadgets with sensors, according to the IoT concept, enable interaction with the physical and logical worlds. The proposed system in this study is built on the Internet of Things and uses real-time input data. Over a wireless sensor network, a smart farm irrigation system uses an Android phone to remotely monitor and regulate drips. Between sensor nodes and base stations, Zigbee is utilised to communicate. A web-based java graphical user interface is used to process and present the server's real-time observed data. Field irrigation system wireless monitoring eliminates human interaction and enables for remote monitoring and control using an Android phone.

Cloud computing is a potential choice due to the large volume of data created by the wireless sensor network. This research presents and examines a cloud-based wireless communication system for monitoring and controlling a collection of sensors and actuators in order to determine the water needs of plants.

Shiny Rajendrakumar, Prof. V K Parvati, Prof. Rajashekarappa Agricultural Irrigation is very important for the production of crops. Many methods have developed to save water in different ways. In traditional irrigation systems we require an operator or farmer to put water on crops but he does not come to know which crop require how much amount of water to get proper amount of yields. Irrigation means planting the crops by water. There are so many traditional irrigation methods, but all these methods consume large amount of water. Automated irrigation is the method which saves the water from up to 97% as compared to traditional methods. By using these modern methods like ICT productivity can be improved without unnecessary wastage of water. Here we are concentrating on IoT ie.

Internet of Things technique in irrigation for the purpose to save water. In this paper author states that Soil constitution is related with the availability of elements of nourishment plant requires as well as the presence in soil of elements and chemical composition that exist at different proportion that are best nourishment to plants and soil organisms and appropriate water to plant is most essential for all of the other nourishment to work at best. The Arduino will on the buzzer to give an alert to the farmer. So Serial monitor of Arduino HE gives a message as "motion detected" when the buzzer is on and as "motion ended" when the buzzer is off. This innovation is prescribed for efficient automated agricultural watering system frameworks and it might give a profitable apparatus for preserving water arranging and watering system booking which is extendable other comparable horticultural harvests. The drawback of this proposed system is the whole system works on electricity, if in the case of electricity problem the farmer cannot on the motor to irrigate his land. The solution is to have generator, if there is no electricity so that generator gets on to run this framework and irrigate his land.

2.1 Existing problem

The food shortage and the population growth are the most challenges facing sustainable development worldwide. Advanced technologies such as artificial intelligence (AI), the Internet of Things (IoT), and the mobile internet can provide realistic solutions to the challenges that are facing the world. Therefore, this work focuses on the new approaches regarding smart farming

(SF) from 2019 to 2021, where the work illustrates the data gathering, transmission, storage, analysis, and also, suitable solutions. IoT is one of the essential pillars in smart systems, as it connects sensor devices to perform various basic tasks. The smart irrigation system included those sensors for monitoring water level, irrigation efficiency, climate, etc. Smart irrigation is based on smart controllers and sensors as well as some mathematical relations. In addition, this work illustrated the application of unmanned aerial vehicles (UAV) and robots, where they can be achieved several functions such as harvesting, seedling, weed detection, irrigation, spraying of agricultural pests, livestock applications, etc. real-time using IoT, artificial intelligence (AI), deep learning (DL), machine learning (ML) and wireless communications. Moreover, this work demonstrates the importance of using a 5G mobile network in developing smart systems, as it leads to high-speed data transfer, up to 20 Gbps, and can link a large number of devices per square kilometer. Although the applications of smart farming in developing countries are facing several challenges, this work highlighted some approaches the smart farming. In addition, the implementation of Smart Decision Support Systems (SDSS) in developing countries supports the real-time analysis, mapping of soil characteristics and also helps to make proper decision management. Finally, smart agriculture in developing countries needs more support from governments at the small farms and the private sector.

2.2 References

[1] Nayyar, Anand & Puri, Vikram. (2016). Smart farming: IoT based smart sensors agriculture stick for

live temperature and moisture monitoring using Arduino, cloud computing & solar technology, The

international conference on communication and computing (ICCCS-2016)

[2] Gorli, Ravi & Yamini G. (2017). Future of Smart Farming with Internet of Things. Journal of

Information technology and Its Applications.

[3] S. jegadeesan, dr. g. k. d. Prasanna venkatesan Smart cow health monitoring, farm

environmental

monitoring and control system using wireless sensor networks, International journal of advanced

engineering technology.

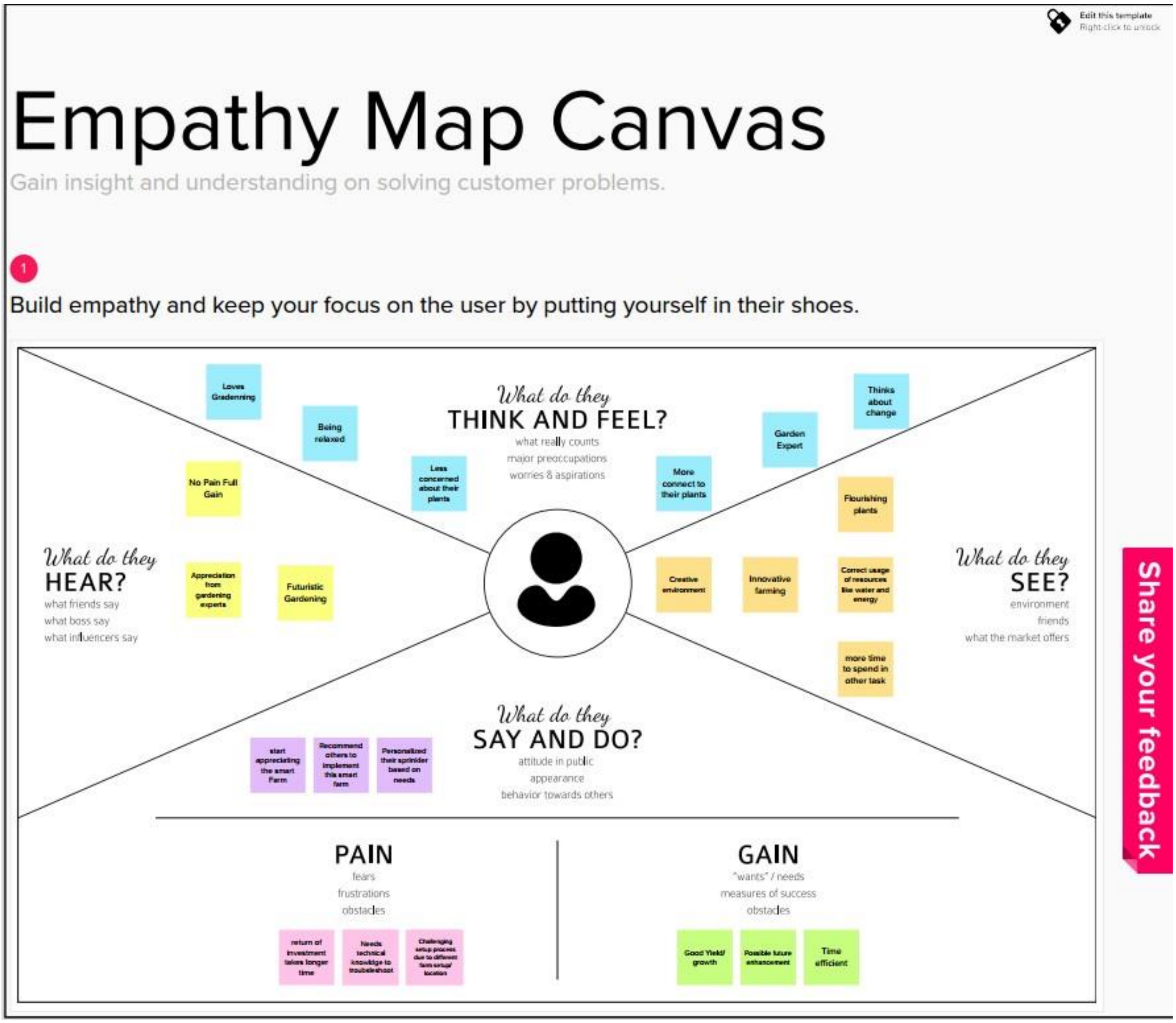
[4] IoT based agriculture monitoring and smart irrigation system using raspberry pi, International Research

Journal of Engineering and Technology (IRJET).

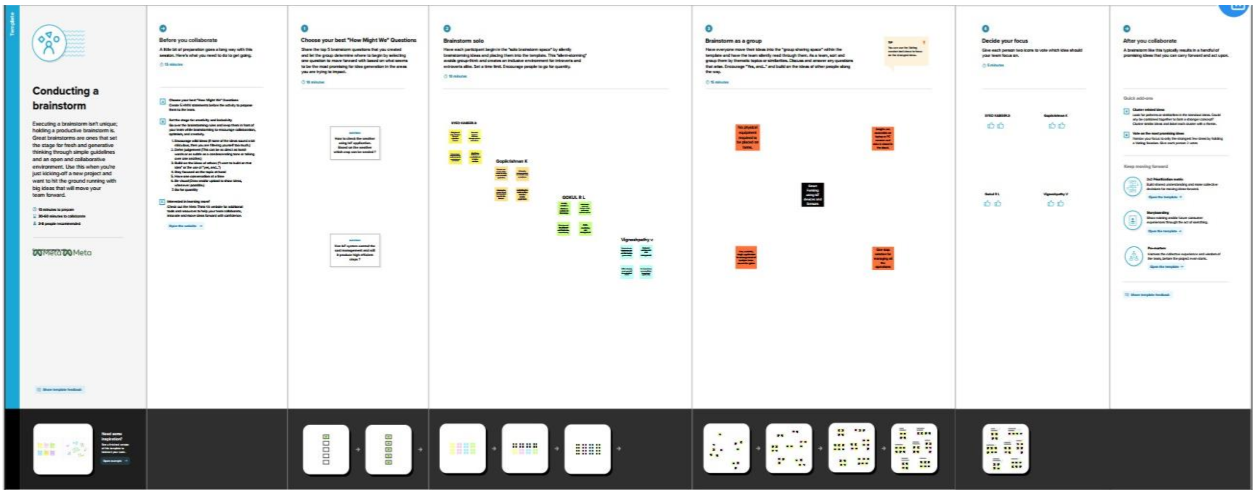
2.3 Problem Statement Definition

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.

3.1 Empathy Map Canvas



3.2 IDEATION & BRAINSTROMING



3.3 Proposed Solution Template:

Project team shall fill the following information in proposed solution template.

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	**Smart Farming helps farmers to better understand the important factors such as water, topography, aspect, vegetation and soil types. This allows farmers to determine the best uses of scarce resources within their production environment.**
2.	Idea / Solution description	**The solution creates a digital map of a farm using a drone or satellite imaginary, which is overlapped with a grid of sensors spread across the farm that monitors multiple soli parameters ranging from temperature and moisture to carbon and nitrogen levels.**

3.	Novelty / Uniqueness	**The IoT system immediately alerts the farmer when the crops needs attention such as to water the crops, To check the temperature and to save other resources.**
4.	Social Impact / Customer Satisfaction	**It monitors the climate and weather conditions. When the weather conditions goes bad IoT Devices immediately alerts the farmer about the weather conditions to prevent the crops.**
5.	Business Model (Revenue Model)	**Now-a-days crops need more attention because sometimes farmer may forgot to water the crops or farmer might feed more water than usual water limit. To save resources and maintain balance IoT system are used. These system models should be affordable for every farmer to buy and install it.**
6.	Scalability of the Solution	**When any problem arises then system can allow the famer to do things such as monitoring crops, surveying, and mapping the fields.** **The system provides data to farmers for rational farm management plans to save both time and money.**

3.4 PROBLEM SOLUTION FIT

Problem solution fit

1.Customer segments: Types of Customers who are going to this project are • Large Scale Farmers • Remote Farmer	**4.Emotions:** Farmers feel very relaxed and feel stress less while working in field.	**7.Behavior:** The customer needs to make a revolutionary change in farming by means of modern technologies.
2.Jobs to be done : The Customers want to automate the irrigation process, reduce cost of manual workers and minimize the power consumption.	**5.Available solutions :** We can give solutions to this problem by using the Smart Farming Application which collects the Moisture level data from the field and operate in the basis of that moisture level.	**8.Problem route cause:** The route cause for Smart farming Application is farmer's need to be felt comfortable.
3.Triggers: Farmers are facing many problems while farming in traditional manner. This triggers the Smart Farming Applications	**6.Customer constrains:** The customer needs a solution which will solve the problems in farming when he is in a remote location and that solution should fulfill the following needs. • Cost efficient • Low power consumption • Time efficient	**9.Solution:** Our solution for this project is to give environment sustainable Product for the farming in modern era with reduced cost and with best efficiency

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	**Reliability**	In the context of sustainable agriculture, this negates the purpose of precision smart farming, which relies on the most up-to-date data and real-time environmental

		monitoring
FR-2	**Seamless data storage and access**	The cloud allows farmers to sensor-monitor hundreds of different points and create an aggregated view of the data, which can then be analyzed by AI for insights. Without the cloud, data would be fragmented and stuck in silos. This will be particularly important for farmers who want to monitor hundreds of crops or cattle assets close together or run several autonomous machines at the same time
FR-3	**Low latency**	Lower latency and edge cloud, and where computation happens closer to the IoT device—can give farmers more authority over their systems, facilitating absolute control and monitoring of autonomous devices and near instantaneous field intelligence.
FR-4	**Security**	Farmers can opt for private networking, a wireless access point (WAP) solution that segregates traffic when connecting with mobile devices for a secure, scalable foundation for adopting new wireless platforms and technologies.

4.2 Non-functional Requirements:

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

FR No.	Non-Functional Requirement	Description
NFR-1	**Observation**	Sensors record observational data from the crops, livestock, soil, or atmosphere.
NFR-2	**Diagnostics**	The sensor values are fed to a cloud-hosted IoT platform with predefined decision rules and models—also called "business logic"—that ascertain the condition of the examined object and identify any deficiencies or needs.
NFR-3	**Decisions**	After issues are revealed, the user, and/or machine learning-driven components of the IoT platform determine whether location-specific treatment is necessary and if so, which.

NFR-4	**Action**	After end-user evaluation and action, the cycle repeats from the beginning

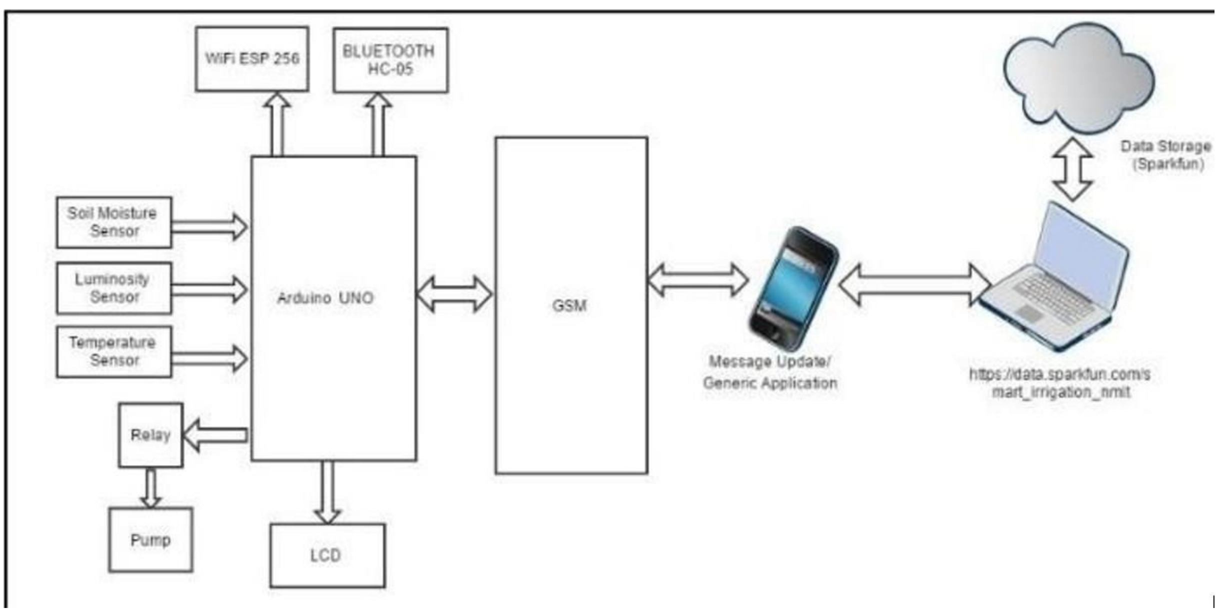
PROJECT DESIGN

5.1 Data Flow Diagrams

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 requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.

b



User Stories

Use the below template to list all the user stories for the product.

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
Customer (higher authority)	confirmation	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
Customer (fire service 101)	Safety measure register	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
Customer (mobile user)	Mobile application	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
Customer (credential)	Login	USN-5	As a user, I can log into the application by entering email & password	I can access my account / dashboard	High	Sprint-1
	Dashboard	USN-6	Uploading data	I can be able to upload my dataset	High	Sprint 2
Customer (Web user)	Notification	USN-7	when there is a emergency the alert notification will be received through GSM module	The alert message is sent to the owner's mobile as an SMS.	High	Sprint 2
Customer Care Executive	Network Connectivity	USN-8	When the maximum moisture level is detected in the field	The sensor detects the moisture and notifies the owner via message	High	Sprint 3
Administrator	Accessing	USN-9	When there is an issue in accessing the device	Admin/Device operator's advice should be undertaken	High	Sprint 3
		USN-10	Asking Help / feedback	I can be able to ask help if I can face any issues or problems while using the webpage	Medium	Sprint 4
		USN-11	Managing the database	I can assure that my data is in secure state	High	Sprint 4
		USN-12	Managing the overall process	I can assure that my data and process is going better	High	Sprint 4

6.1 SPRINT PLANNING AND ESTIMITION

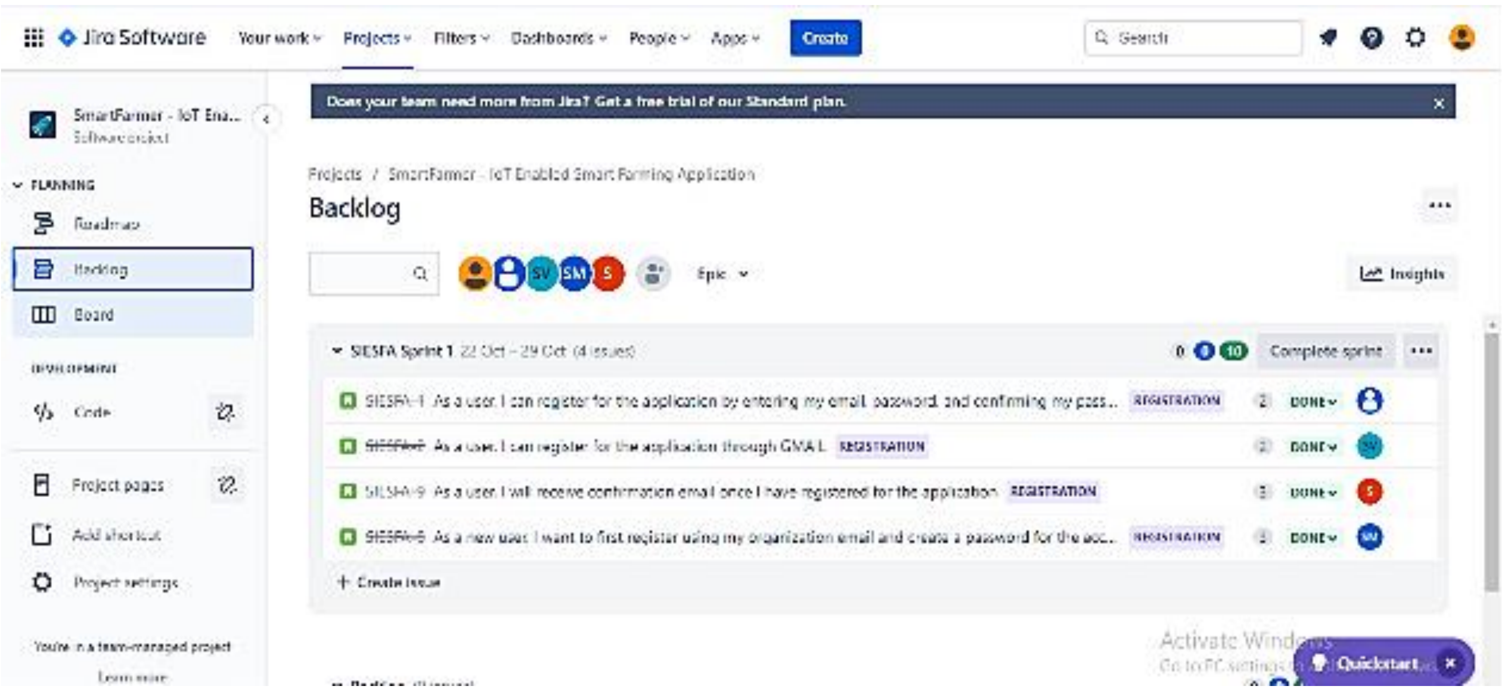
Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	2	High	Nameera
Sprint-1		USN-2	As a user, I will receive confirmation email once I have registered for the application	1	High	Devi Priya
Sprint-2		USN-3	As a user, I can register for the application through Facebook	2	Low	Siva Haritha
Sprint-1		USN-4	As a user, I can register for the application through Gmail	2	Medium	Bhuvana
Sprint-1	Login	USN-5	As a user, I can log into the application by entering email & password	1	High	Nameera
	Dashboard					

Project Tracker:

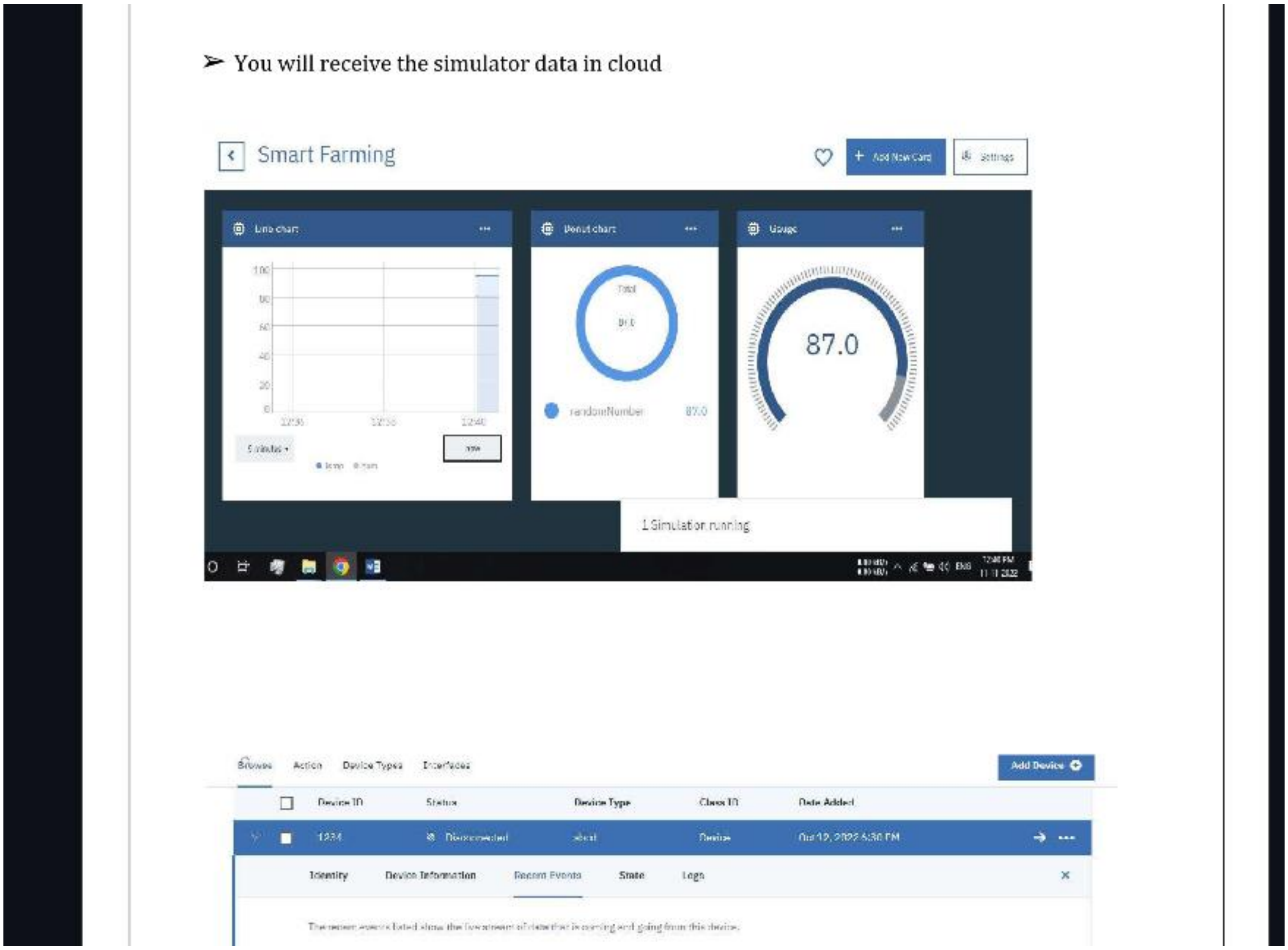
Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	20	6 Days	24 Oct 2022	Oct 2022	20	October 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022		November 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022		November 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022		November 2022

6.3 REPORTS FROM JIRA

SPRINT 1:



SPRINT 2:


➢ You will receive the simulator data in cloud
Smart Farming
Add New Card
Settings
Line chart
Donut chart
Gauge
Total
87.0
randomNumber
87.0
1 Simulation running
Add Device
Device ID
Status
Device Type
Class ID
Date Added
1234
Disconnected
Device
Identity
Device Information
Recent Events
State
Logs

SPRINT 3:

Then we use another function node to parse the data and get the command and represent it visually with text node.

The Java script code for that function node is:

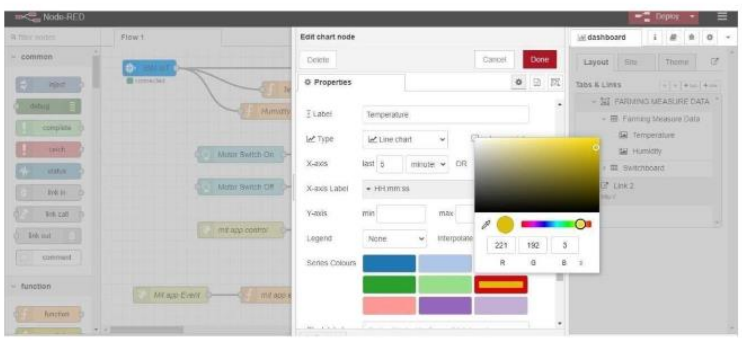
- var state=msg.payload;
  msg.payload = state.command;
- return msg;

The above images show the java script codes of analyser and state function nodes.

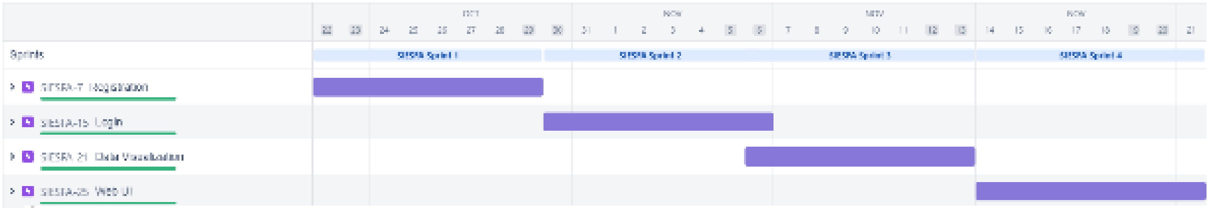
Then we add edit Json node to the conversion between JSON string & object and finally connect it to IBM IoT Out.

Edit JSON node needs to be configured like this

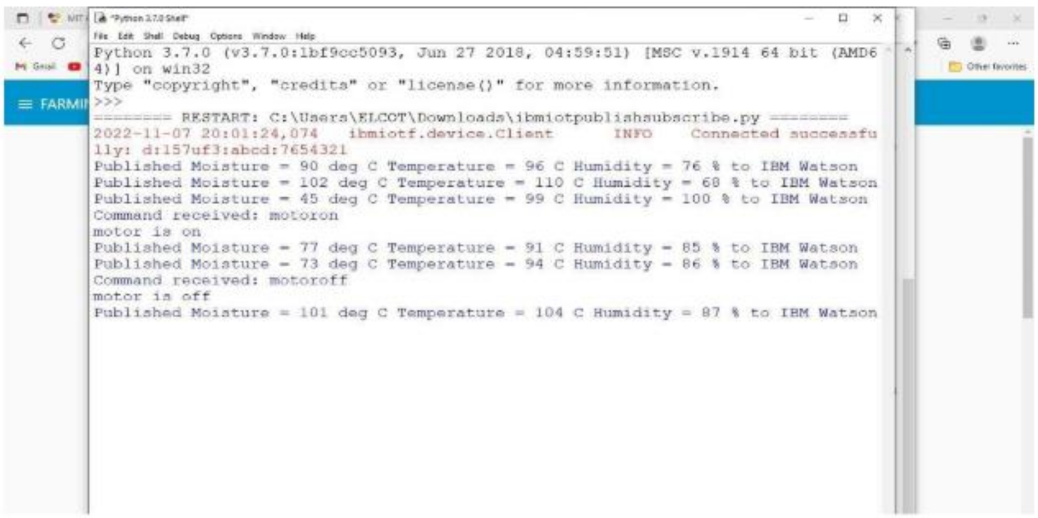
Complete Program Flow



SPRINT 4:



Sprints
Login



Python 3.7.0 Shell
File Edit Shell Debug Options Window Help
Python 3.7.0 (v3.7.0:1bf9cc5093, Jun 27 2018, 04:59:51) [MSC v.1914 64 bit (AMD6
4)] on win32
Type "copyright", "credits" or "license()" for more information.
>>>
======== RESTART: C:\Users\ELCOT\Downloads\ibmiotpublishsubscribe.py ========
2022-11-07 20:01:24,074 ibmiotf.device.Client INFO Connected successfu
lly: d:157uf3:abcd:7654321
Published Moisture = 90 deg C Temperature = 96 C Humidity = 76 % to IBM Watson
Published Moisture = 102 deg C Temperature = 110 C Humidity = 68 % to IBM Watson
Published Moisture = 45 deg C Temperature = 99 C Humidity = 100 % to IBM Watson
Command received: motoron
motor is on
Published Moisture = 77 deg C Temperature = 91 C Humidity = 85 % to IBM Watson
Published Moisture = 73 deg C Temperature = 94 C Humidity = 86 % to IBM Watson
Command received: motoroff
motor is off
Published Moisture = 101 deg C Temperature = 104 C Humidity = 87 % to IBM Watson

7 : coding and solution

new_code.py - C:\Users\vaio\Documents\new_code.py (3.7.0)

File Edit Format Run Options Window Help

```python
#IBM Watson IOT Platform
#pip install wiotp-sdk
import wiotp.sdk.device
import time
import random
myConfig = {
    "identity": {
        "orgId": "4lmir6",
        "typeId": "TestDeviceType",
        "deviceId":"12345"
    },
    "auth": {
        "token": "dxV@N9UtEhSp4lc6*u"
    }
}

def myCommandCallback(cmd):
    print("Message received from IBM IoT Platform: %s" % cmd.data['command'])
    m=cmd.data['command']
    if(m=="motoron"):
        print("Motor is switched on")
    elif(m=="motoroff"):
        print("Motor is switched OFF")
    print(" ")

client = wiotp.sdk.device.DeviceClient(config=myConfig, logHandlers=None)
client.connect()

while True:
    soil=random.randint(0,100)
    temp=random.randint(-20,125)
    hum=random.randint(0,100)
    myData={'soil_moisture':soil,'temperature':temp, 'humidity':hum}
    client.publishEvent(eventId="status", msgFormat="json", data=myData, qos=0, onPublish=None)
    print("Published data Successfully: %s", myData)
    client.commandCallback = myCommandCallback
    time.sleep(2)
client.disconnect()
```

Python 3.7.0 Shell

File Edit Shell Debug Options Window Help

```
Published data Successfully: %s {'soil_moisture': 58, 'temperature': 52, 'humidity': 17}
Published data Successfully: %s {'soil_moisture': 6, 'temperature': 101, 'humidity': 54}
Published data Successfully: %s {'soil_moisture': 73, 'temperature': 24, 'humidity': 7}
Published data Successfully: %s {'soil_moisture': 93, 'temperature': 65, 'humidity': 16}
Published data Successfully: %s {'soil_moisture': 37, 'temperature': 1, 'humidity': 52}
Published data Successfully: %s {'soil_moisture': 44, 'temperature': -14, 'humidity': 72}
Published data Successfully: %s {'soil_moisture': 90, 'temperature': 109, 'humidity': 55}
Published data Successfully: %s {'soil_moisture': 54, 'temperature': 19, 'humidity': 27}
Published data Successfully: %s {'soil_moisture': 14, 'temperature': 17, 'humidity': 57}
Published data Successfully: %s {'soil_moisture': 79, 'temperature': 42, 'humidity': 90}
Published data Successfully: %s {'soil_moisture': 29, 'temperature': 70, 'humidity': 21}
Published data Successfully: %s {'soil_moisture': 21, 'temperature': 27, 'humidity': 88}
Published data Successfully: %s {'soil_moisture': 80, 'temperature': 73, 'humidity': 35}
Published data Successfully: %s {'soil_moisture': 4, 'temperature': 72, 'humidity': 51}
Published data Successfully: %s {'soil_moisture': 80, 'temperature': 15, 'humidity': 50}
Published data Successfully: %s {'soil_moisture': 69, 'temperature': -2, 'humidity': 42}
Published data Successfully: %s {'soil_moisture': 89, 'temperature': 77, 'humidity': 65}
Published data Successfully: %s {'soil_moisture': 34, 'temperature': 21, 'humidity': 53}
Published data Successfully: %s {'soil_moisture': 45, 'temperature': 33, 'humidity': 63}
Published data Successfully: %s {'soil_moisture': 97, 'temperature': 1, 'humidity': 33}
Published data Successfully: %s {'soil_moisture': 73, 'temperature': 90, 'humidity': 18}
Published data Successfully: %s {'soil_moisture': 0, 'temperature': 31, 'humidity': 98}
Published data Successfully: %s {'soil_moisture': 28, 'temperature': 95, 'humidity': 57}
Published data Successfully: %s {'soil_moisture': 70, 'temperature': 30, 'humidity': 77}
Published data Successfully: %s {'soil_moisture': 34, 'temperature': 2, 'humidity': 35}
Published data Successfully: %s {'soil_moisture': 61, 'temperature': 11, 'humidity': 4}
Published data Successfully: %s {'soil_moisture': 71, 'temperature': 93, 'humidity': 95}
Published data Successfully: %s {'soil_moisture': 32, 'temperature': 114, 'humidity': 19}
Published data Successfully: %s {'soil_moisture': 27, 'temperature': 78, 'humidity': 55}
Published data Successfully: %s {'soil_moisture': 87, 'temperature': 89, 'humidity': 91}
Published data Successfully: %s {'soil_moisture': 87, 'temperature': 118, 'humidity': 76}
Published data Successfully: %s {'soil_moisture': 7, 'temperature': -13, 'humidity': 59}
Published data Successfully: %s {'soil_moisture': 53, 'temperature': 3, 'humidity': 85}
Published data Successfully: %s {'soil_moisture': 40, 'temperature': 124, 'humidity': 31}
Published data Successfully: %s {'soil_moisture': 29, 'temperature': 56, 'humidity': 91}
Published data Successfully: %s {'soil_moisture': 28, 'temperature': 6, 'humidity': 86}
Published data Successfully: %s {'soil_moisture': 78, 'temperature': 21, 'humidity': 30}
Published data Successfully: %s {'soil_moisture': 25, 'temperature': 90, 'humidity': 99}
Published data Successfully: %s {'soil_moisture': 6, 'temperature': 18, 'humidity': 59}
Published data Successfully: %s {'soil_moisture': 66, 'temperature': -2, 'humidity': 96}
Published data Successfully: %s {'soil_moisture': 78, 'temperature': 63, 'humidity': 0}
Published data Successfully: %s {'soil_moisture': 45, 'temperature': 30, 'humidity': 11}
Published data Successfully: %s {'soil_moisture': 30, 'temperature': 31, 'humidity': 65}
Published data Successfully: %s {'soil_moisture': 71, 'temperature': 30, 'humidity': 93}
Published data Successfully: %s {'soil_moisture': 14, 'temperature': 20, 'humidity': 0}
```

8.TESTING:

TEST CASES:

Although smart agriculture IoT, as well as industrial IoT in general, aren’t as popular as consumer connected devices; yet the market is still very dynamic. The adoption of IoT solutions for agriculture is constantly growing. Namely, COVID-19 has had a positive impact on IoT in the agriculture market share. There are many types of IoT sensors for agriculture as well as IoT applications in agriculture in general:

1. Monitoring of climate conditions

Probably the most popular smart agriculture gadgets are weather stations, combining various smart farming sensors.Located across the field, they collect variousdata from the environment and send it to the cloud. The provided measurements can be used to map the climate conditions, choose the appropriate crops, and take the required measures to improve their capacity (i.e. precision farming).

2. End-to-end farm management systems

This offers remote farm monitoring capabilities and allows you to streamline most of the business operations. Similar solutions are represented by FarmLogs and Cropio. In addition to the listed IoT agriculture use cases, some prominent opportunities include vehicle tracking (or even automation), storage management, logistics, etc.

3. Predictive analytics for smart farming

Precision agriculture and predictive data analytics go hand in hand. While IoT and smart sensor technology are a goldmine for highly relevant real-time data, the use of data analytics helps farmers make sense of it and come up with important predictions: crop harvesting time, the risks of diseases and infestations, yield volume, etc. Data analytics tools help make farming, which is inherently highly dependent on weather conditions,more manageable, and predictable. For example, the Crop Performance platform helps farmers access the volumeand quality of yields in advance, as well as their vulnerability to unfavorable weather conditions, such as floods and drought.

4. Greenhouse automation

Typically, farmers use manual intervention to control the greenhouse environment. The use of IoT sensors enables them to get accurate real-time information on greenhouse conditions such as lighting, temperature, soil condition, and humidity.For instance, Farmapp and Growlinkare also IoT agriculture productsoffering such capabilities among others.

5. Crop management

Onemore type of IoT productin agriculture and another elementof precision farmingare crop management devices. Just like weather stations, they should be placed in the field to collect data specific to crop farming; from temperature and precipitation to leaf water potential and overall crop health.Thus, you can monitor your crop growth and any anomalies to effectively prevent any diseases or infestations that can harm your yield. Arable and Semios can serve as good representations of how this use case can be applied in real life.

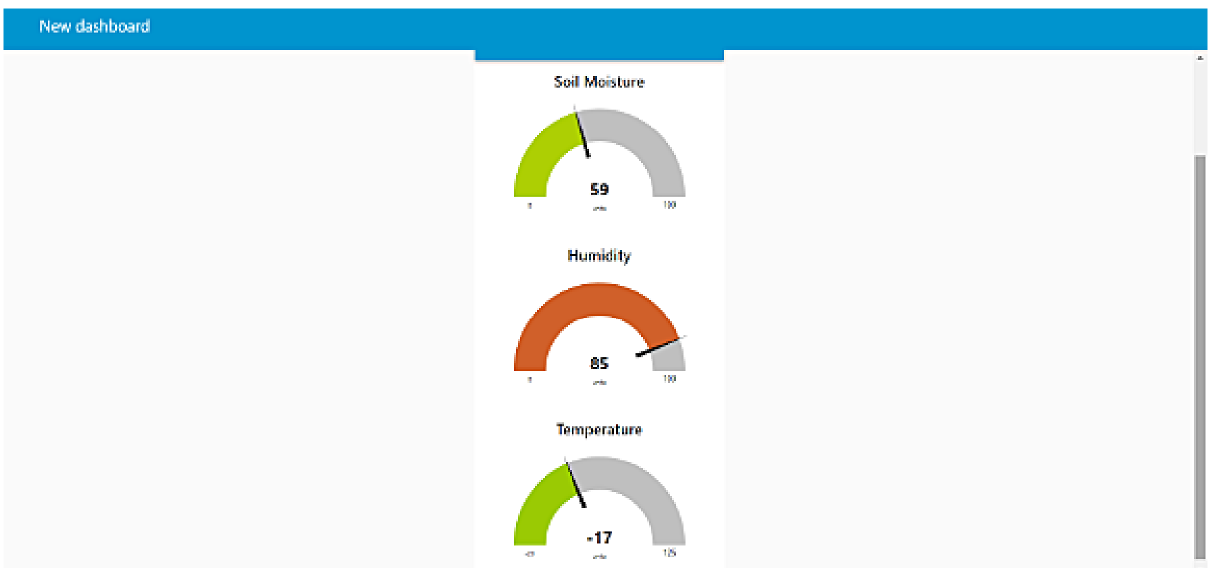
6. Cattle monitoring and management

Just like crop monitoring, there are IoT agriculture sensors that can be attached to the animals on a farm to monitortheir health and log performance. Livestock tracking and monitoring help collect data on stock health, well-being, and physical location.

For example, such sensors can identify sick animals so that farmers can separate them from the herd and avoid contamination. Using drones for real-time cattle tracking also helps farmers reduce staffing expenses.This works similarlyto IoT devices for petcare.

7. Precision farming

Precision farming is all about efficiency and making accurate data-driven decisions. It's also one of the most widespread and effective applications of IoT in agriculture. By using IoT sensors, farmers can collect a vast array of metrics on every facet of the field microclimate and ecosystem: lighting, temperature, soil condition, humidity, CO2 levels, and pest infections. This data enables farmers to estimate optimal amounts of water, fertilizers, and pesticides.



8.1 USER ACCEPTANCE TESTING

RESOLUTION	SEVERITY 1 TOTAL	SEVERITY 2	SEVERITY 3	SEVERITY 4	SUB
BY DESIGNING	5	1	0	0	6
DUPLICATE	0	0	0	0	0
EXTERNAL	8	0	4	1	12
FIXED	13	2	4	1	18
NOT REPRODUCED	7	2	0	0	9
SKIPPED	1	0	0	0	1
WON'T FIX	0	0	0	0	0

Section	Total	Not	Fai	Pas
Temperature	3	0	0	3
Ultrasonic	4	0	0	4
Soil	2	0	0	2
Wi-Fi	2	0	0	2
Transmission of data to IBM Cloud	3	0	1	2
Data Transmission	5	0	2	3

User login in Mobile Application	1	0	0	1
Accessing the Parameters in Mobile App	1	0	2	1
Controlling the Motor from the Mobile App	5	0	0	5
Viewing the parameters in the Node RED	5	0	0	5
	3	0	0	3

CHAPTER 9 RESULTS

9.1 PERFORMANCE METRICS

			NFT - Risk Assessment						
S.No	Project Name	Scope/feature	Functional Changes	Hardware Changes	Software Changes	Impact of Downtime	Load/Volume Changes	Risk Score	Justification
1.	Smart Farmer	Existing- Simulating the project through the Tinkercad with Temperature and humidity sensors, soil moisture, ultrasonic distance sensors, and DC and servo motors.	Moderate	High	High	No data transmission to Cloud	>80 to 90%	ORANGE	There is no Wi-Fi module in the Tinkercad simulator so data can't be sent to IBM Cloud.
2.	Smart Farmer	New- Simulating the project through the Wokwi simulator with Temperature and humidity sensor, ultrasonic distance sensors, servo motor, and LCD.	High	High	Moderate	The non-availability of certain sensors in Wokwi.	>30 to 40%	YELLOW	The random function is used for the Soil Moisture sensor to generate some random value.
3.	Smart Farmer	Existing - Visualizing the weather parameters in the Watson IoT platform.	Moderate	No Changes	Low	Delayed Visualization of Data.	>50 to 60%	GREEN	The stable internet connection is enough for a constant data transmission.
4.	Smart Farmer	Existing- Visualizing the weather parameters in the Watson IoT platform.	No Changes	No Changes	Moderate	Delayed Visualization of Data.	>40 to 50%	GREEN	The data can be easily transferred to other applications and also can be visualized in the dashboard.
5.	Smart Farmer	New- Login to the Smart Farmer mobile application and viewing the parameters.	Moderate	No Changes	High	Latency of data will be high.	>20 to 10%	GREEN	The parameter send by the module will be stored in the cloud and then sent to the mobile app, so there will be less latency.
6.	Smart Farmer	New – Controlling the motor from the mobile application and its indication in the simulator.	Low	Low	Low	Motor control will be delayed.	>30 to 20%	YELLOW	The motor control can be controlled by sending a response from the mobile app to the module.

Figure 9.1:Performance Metrics

NFT - Detailed Test Plan				
S.No	Project Overview	NFT Test approach	Assumptions/Dependencies/Risks	Approvals/Sign Off
1.	Smart Farmer	Spike Testing – For the sensors in the module.	1. For the temperature and humidity sensor, the values should be tested at extreme high, moderate, and extreme low levels to know that the indication is going on correctly. 2. For the Ultrasonic distance sensor, the distance will be increased and decreased to simulate the water level in the field. 3. For soil moisture, the random function should generate the values within the limit. 4. The ESP32 module should process and transmit data to IBM cloud.	Approved
2.	Smart Farmer	Endurance Testing – For Watson IoT visualization boards.	1. The parameter data should be accessed through the IBM Watson IoT Platform. 2. The visualization data should be continuously stored for a specified long duration.	Approved
3.	Smart Farmer	Resilience Testing – For Node-Red Dashboard Visualization.	1. The Node-Red should be able to perform well with different datasets or payloads coming from the module. 2. The Node-Red should display the correct parameter data and both the IBM and Node-Red data should match.	Approved
4.	Smart Farmer	Load Testing – For accessing the parameter data and controlling the motor from the mobile application.	1. The parameter data can be viewed and the motor should be controlled from the mobile application itself. 2. The data should be precise even if multiple user data for visualization.	Approved

Figure 9.2 :NFT - DETAILED TEST PLAN

End Of Test Report							
S. No	Project Overview	NFT Test approach	NFR - Met	Test Outcome	GO/NO-GO decision	Identified Defects (Detected/Closed/Open)	Approvals /Sign Off
1	Smart Farmer	Performance Testing	No delay in logging in to the application.Controlling motor like ON or OFF should not take more than 5 seconds. Live update of parameters through IBM Watson IoT platform to mobile application should not take more than 10 to 15 seconds.	POSITIVE	GO	Closed	Approved
2	Smart Farmer	Stress Testing	Unexpected load given to the application does not cause any error to the system.	POSITIVE	GO	Closed	Approved
3	Smart Farmer	Load Testing	Expected load given to the system to make sure that system works fine. Like large number of user installing application to view the parameters.	POSITIVE	GO	Closed	Approved
4	Smart Farmer	Compatibility Testing	Application developed can be installed in all versions of android smart phone.	POSITIVE	GO	Closed	Approved
5	Smart Farmer	Recovery Testing	If the application crashes, it can be uninstalled and can reinstall. Data that are passed to the mobile application are stored in IBM Watson IoT platform for future use.	POSITIVE	GO	Closed	Approved

10:ADVANTAGES AND DISADVANTAGES:

ADVANTAGES:

- Smart farming is a term that describes an innovative approach to agriculture that uses information and communication technologies to improve agriculture production , profitability , sustainability and food quality.
- Smart farming is a new energy –efficient agriculture technology that is being developed to help farmers , who often struggle with a lack of water and other resources ,to produce more food with fewer resources .
- It users sensors , analytics and other technologies to improve the efficiency of the agriculture process .This enables producers to increase production,reduce costs and protect the environment.
- IoT-enabled agriculture allows farmers to monitor their product and conditions in real-time. They get insights fast, can predict issues before they happen and make informed decisions on how to avoid them. Additionally, IoT solutions in agriculture introduce automation, for example, demand-based irrigation, fertilizing and robot harvesting.
- One of the benefits of using IoT in agriculture is the increased agility of the processes. Thanks to real-time monitoring and prediction systems, farmers can quickly respond to any significant change in weather, humidity, air quality as well as the health of each crop or soil

in the field. In the conditions of extreme weather changes, new capabilities help agriculture professionals save the crops.

DISADVANTAGES:

- Smart agriculture needs the availability of the internet continuously. Rural parts of most of the developing countries do not fulfill this requirement. Moreover, internet connection is slower.
- The smart farming based equipment requires farmers to understand and learn the use of technology. This is a major challenge in adopting smart agriculture farming at large scale across the countries.
- Smart farming has its disadvantages in the following areas : increased use of chemicals ,uneven water distribution ,reliance on organic fertilizers, and increased food miles.
- Smart farming can also have negative impacts and it is not smart when it comes to environmental impact.

11:CONCLUSION:

- The development of the agriculture sector will always be a priority especially given the dynamics of the world today. Therefore, using IoT in agriculture has a big promising future as a driving force of efficiency, sustainability, and scalability in this industry.
- Smart farming **reduces the ecological footprint of farming**. Minimized or site- specific application of inputs, such as fertilizers and pesticides, in precision agriculture systems will mitigate leaching problems as well as the emission of greenhouse gases

12: FUTURE SCOPE:

Future work would be focused more on increasing sensor on this system to fetch more data especially with regard to Pest Control and by also integrating GPS modules in this system to enhance this Agriculture IoT Technology to full-fledged Agriculture

Precision ready product

- IoT helps us meet our food needs by reducing environmental hazards, such as extreme weather and climatic transitions.
- The harvesters and tractors were both mechanical inventions that work in

  agriculture since the 20th century. The agriculture industry is heavily dependent on innovative ideas because of the increasing demand for food.
- The Industrial IoT has aided increased agricultural productivity with a lower cost,

  so, over the next few years, smart systems based on IoT will be more common in agricultural operations.
- A recent estimate shows that the agricultural industry will experience a compound

  annual growth rate (CAGR) of 20% due to IoT system installations.
- In addition, the number of linked agricultural devices will increase from 13 million in 2014 to 225 million by 2024

13: APPENDIX

SOURCE CODE:

```
import wiotp.sdk.device
import time
import random
myConfig = {
```

```
    "identity":  {
        "orgId": "4lmir6",
        "typeId": "TestDeviceType",
        "deviceId":"12345"
    },
    "auth": {
        "token": "dxV@N9UtEhSp4lc6*u"
    }
}

def myCommandCallback(cmd):
    print("Message received from IBM IoT Platform: %s" % cmd.data['command'])
    m=cmd.data['command']
    if(m=="motoron"):
        print("Motor is switched on")
    elif(m=="motoroff"):
        print("Motor is switched OFF")
    print(" ")

client = wiotp.sdk.device.DeviceClient(config=myConfig, logHandlers=None)
client.connect()

while True:
    soil=random.randint(0,100)
    temp=random.randint(-20,125)
    hum=random.randint(0,100)
    myData={'soil_moisture':soil,'temperature':temp, 'humidity':hum}
```

```
    client.publishEvent(eventId="status", msgFormat="json", data=myData, qos=0,
  onPublish=None)
    print("Published data Successfully: %s", myData)
    client.commandCallback = myCommandCallback
    time.sleep(2)
client.disconnect()
```

Github Link : https://github.com/IBM-EPBL/IBM-Project-1241-1658380644