SMARTFARMER - IOT ENABLED SMART FARMINGAPPLICATION

NALAIYA THIRAN PROJECT BASED LEARNING

Submitted by

Team ID: PNT2022TMID040704

RAMYA T
ROHINTH M P
NAVEEN M
ROHIT KUMAR P

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1. Introduction

1.1. Overview:

In this projectI have developed a mobileapplication using which a farmercan monitor the temperature, humidity, pressure and soil moistureparameters along with weather forecasting details. Based on these details he can water the cropsby controlling the motors through the app .

1.2. Purpose:

Agriculture plays a crucial role in the life of an economy. It is the backbone of our economic system, so improving the qualityand way of production is crucial. Here comes the Smart Agriculture system. Smart agriculture helps in automated farming, collection of data from the field and then analyses it so that the farmer can make accurate decision in order to growhigh quality crop.

IoT based Smart Farming improves the entire Agriculture system by monitoring the field in real-time. With the help of sensorsand interconnectivity, the Internet of Things in Agriculture has not only saved the time of the farmersbut has also reduced the extravagant use of resources such as Water. and Electricity.

2. Literature Survey

2.1. Existing problem

Agriculture is extremely dependent on the climate. Temperature increases and carbon dioxidecan boost some crop yieldsdepending on the location; but other conditions must also exist, such as humidity, pressure, and water availability. Although slight warming and more carbon dioxide in the atmosphere could benefitsome plants to grow faster,severe warming, floods,and drought would reduce yields. Farmer need to spend a lot of time to maintain these.Heat is not

the only extremeweather. Extreme cold can benefitfarmers by freezingthe soil deepbeneath the ground.In parts of the upper Midwest, frost depths exceed40 inches. A deep frost depth can aid farmers in diverse ways. The cold helps nitrogen that is applied in the fall from vaporizing during the winter.The cycle of freezing and thawing of water helps soften the soil after the thaw. Extreme cold and frozen soils also reduce the survival rate of some insects.

Severe weather other than heat and cold can cause loss and devastation to a farm. Most farmers can't avoid the results of extreme weather.Diverse extreme weather can affect farms in different ways. Because of this, it's important thatfarmers have a proper system and need a mobile application to monitor the weather changes and to control the motor.

1. Almalki, F.A., Soufiene, B.O., Alsamhi, S.H. and Sakli, H., (2021) , has presented apaper on" A low-cost platform for environmental smart farming monitoring system based on IoT and UAVs".This paper shows a low-

costplatform for comprehensive environmentalparameter monitoring using flying IoT. The proposalis based on experimental work to fulfillthe requirements of automated and real-time monitoring of the environmental parameters using both under- and aboveground sensors.

2. Bauer,J. and Aschenbruck, N., (2018), has proposeda paper on , " Design andimplementation of an agricultural monitoring system for smart farming". In this proposed paper, a holisticIoT-based agricultural monitoring system is presented. The main componentof this system is an in-situ WSN that is tailored for the collection of sensor information thatis of special interestfor Smart Farming.The focus of the sensornetwork is on the continuousassessment of the LAI that is relevant for a precise monitoring of crop growth processes. Using an MQTT-based IoT infrastructure and PLMN connectivity, this sensor network is connected to a central server. The server is responsible for data persistence, analytics, and also for visualization that can be used as decision support for farmers.

3. Bacco, M., Berton, A., Ferro, E., Gennaro, C., Gotta, A., Matteoli, S., Paonessa, F., Ruggeri, M., Virone, G. and Zanella, A., (2018) has presented a paper titled on ,"Smart farming: Opportunities, challenges and technology enablers ". This paper presented an overview of IoT technologies in several smart farming scenarios. Different agricultural domains have been analysed in this work, highlighting the most relevant communication requirements, and providing a mapping between the presented use cases and the enabling technologies. We considered UGVs and UAVs, surveying differentuses and their requirements. We are convinced that deep learning architectures and

CNN techniques can be key enablers for their joint use, thus opening to a better understanding and management of the farmland.

4. Bacco, M., Barsocchi, P., Ferro, E., Gotta, A. and Ruggeri, M., (2019) has presented a paper on, “The digitisation of agriculture: a survey of research activities on smart farming”.A key component in this paper is the use of hardware and software technologies, like the deploying of sensor nodes, control systems, robotics, satellites for imagery and positioning,datastorage and analysis, advisory systems, and terrestrial and aerial drones.

5. Idoje, G., Dagiuklas, T. and Iqbal, M., (2021) , has proposed a paper on , “Survey forsmart farming technologies: Challenges and issues” . The application of smart farming to crop and animal production and post-harvesting is discussed. The impact of climate changeon agriculture is also considered. This paper contributes to knowledge by iterating the challenges of smart technology to agriculture while highlighting the issues identified from existingframework of smartagriculture. The authorsidentify many gaps in existingresearchaffecting the application of IoT in smart farming, and suggest further research to improve the current food production globally, to provide better food management and sustainability measures across the globe.

6. Maduranga, M.W.P. and Abeysekera, R., (2020) ,has presented a paper entitled on “ Machine learning applications in IoT based agriculture and smart farming: A review. This paper proposed that , High-performance computingcapability in ML opens up new opportunities for data-intensive

science as the amount of data collected increases; MLalgorithms could be applied to further enhanceapplication intelligence and functionality. Inthis article we review existing approaches have been made to the smart agriculture and farming based on IoT and ML separately.

7. Mahajan, H.B., Badarla, A. and Junnarkar, A.A., (2021), has proposed a paper on, "CL-IoT: cross-layer Internetof Things protocolfor intelligent manufacturing of smart farming".This paper proposed that , The existing protocols use energy and distance in general for clustering and data transmissions which did not solve the problems of long-distance communications in farming applications. So a cross-layer-based clustering and routing algorithms have designed to reduce network communication delay, latency, and energy consumption.

8. Ramli, M.R., Daely, P.T., Kim, D.S. and Lee, J.M., (2020), has presented a paper on,"IoT-based adaptive networkmechanism for reliablesmart farm system".This paper presentsan adaptive network mechanism for a smart farm system by using LoRaWAN and IEEE 802.11ac protocols. The system has the ability to adjust a protocol based on the network condition.

2.2. Problem Statement Definition

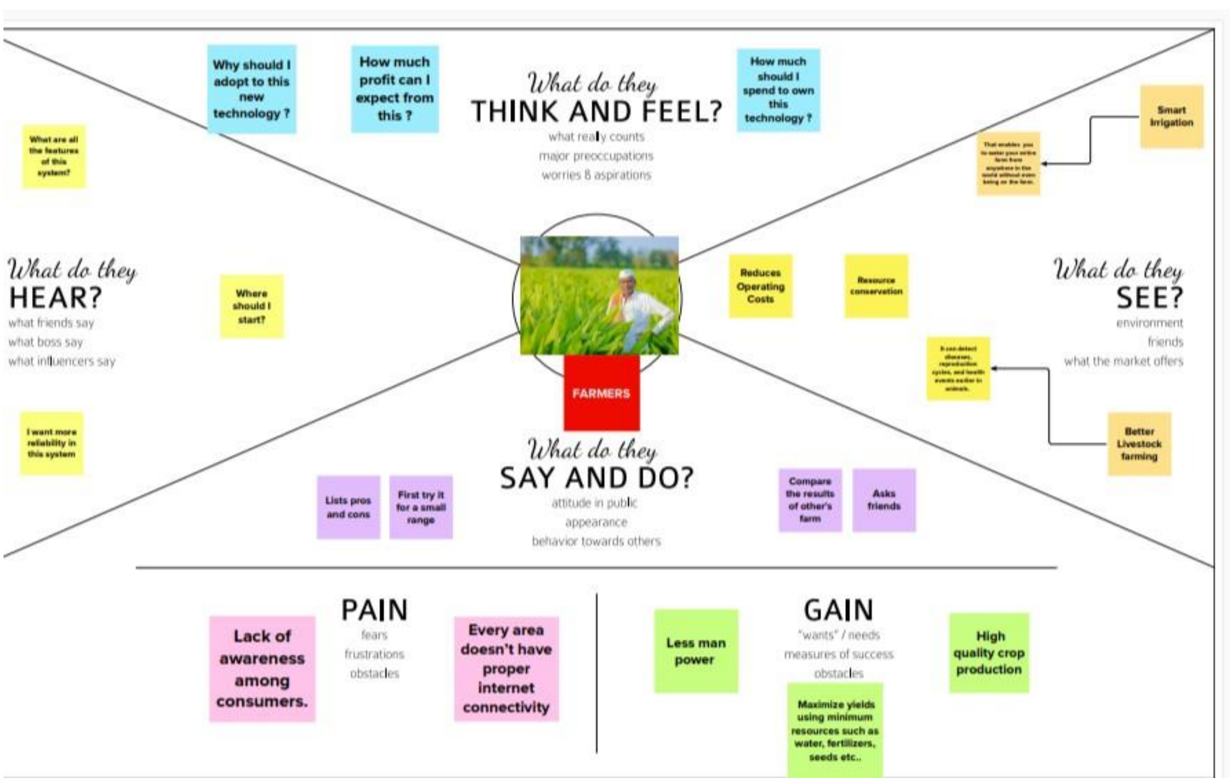
Incorporation of technology into farming to reduce work and labour, increase productivity and to improve the soil and plant the next crop. Many experienced and young farmers face issues in incorporating the technologies in agriculture. The major issues faced are labour cost, coping with climate change, soil erosion and biodiversity losses. This may lead to loss of agricultural land and the decrease in the varieties of crops and livestock produced. These issues mainly occur due to increasing pressure from climatic changes, soil erosion which mostly starts from the first day of farming. It is important to fix these issues as it is required for the growth of better-quality food products. It is important to maximise the crop yield and to maintain soil richness.

The soil moisture sensor measures wetness content in the soil. The Arduino UNO microcontroller used to receive input from various sensors and it can be controlled automatically. When the soil moisture sensor goes low the water pump will be on and it exceeds defined levels of the water motor will turn off automatically. We can constantly monitor the growth of a crop using ultrasonic sensors. PIR sensor detects the motion or unusual movement in the agricultural land. This device is very helpful to the former to monitor and control environmental parameters in their field. The farmers did not go to their field, they can remotely monitor and control using the cloud.

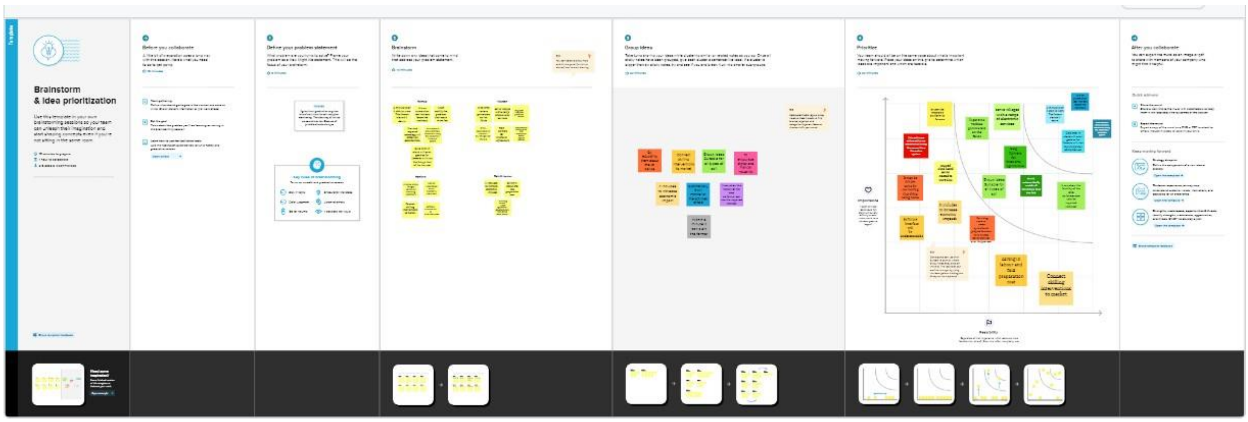
3.IDEATION & PROPOSED SOLUTION

3.1.EMPATHY MAP CANVAS

An empathy map is a simple, easy-to-digest visual that captures knowledge about a user's behaviours and attitudes. It is a useful tool to help teams better understand their users. Creating an effective solution requires understanding the true problem and the person who is experiencing it. The exercise of creating the map helps participants consider things from the user's perspective along with his or her goals and challenges.



3.2 Ideation and Brainstorming



Brainstorming provides a free and open environment that encourages everyone within a team to participate in the creative thinking process that leads to problem solving. Prioritizing volume over value, out-of-the-box ideas are welcome and built upon, and all participants are encouraged to collaborate, helping each other develop a rich amount of creative solutions. Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room.

Introduction on Internet of Things (IoT), application of IoT in agricultural field to improve the yield and quality by reducing the cost is provided. The sensors which are used in the architecture are discussed briefly and the process of transmission of data from the agriculture field to the central system is explained. The proposed system advantages are included. In addition, open research issues, challenges, and the future of IoT in the agricultural field are highlighted. The concept is basically developed on an idea, where there are numerous things or objects - such as Arduino, sensors, GSM models, LCD display, etc., that are connected with the Internet. Each of the objects has a different address and is able to interact with other items. The things or objects cooperate with each other to reach a common goal.

We are going to construct a smart agricultural monitoring system which can collect crucial agricultural data and send it to an IoT platform called Thingspeak in real time where the data can be logged and analysed. The logged data on Thingspeak is in graphical format, a botanist or a reasonably knowledgeable farmer can analyse the data (from anywhere in the world) to make sensible changes in the supplied resources (to crops) to obtain high quality yield.

3.3 Proposed Solution

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	It is hard for the farmers to check the environmental condition of their crops every time?
2.	Idea / Solution description	Using modern IoT techniques get the data like temperature and humidity of the soil whenever we want with the help sensors.
3.	Novelty / Uniqueness	Use of mobile application for displaying data gives good user experience and also the app provides smart suggestions.
4.	Social Impact / Customer Satisfaction	User friendly app and easy to install the embedded setup up. It makes the decision making easy for the farmers.
5.	Business Model (Revenue Model)	Apart from the data we can give smart suggestion when they subscribe.
6.	Scalability of the Solution	As industries develop. It is very important for Agricultural industry to compete equally so this product will be successful in the future

3.4 Problem solution fit

1.Customer segments:- Types of Customers who are going to this project are • Large Scale Farmers • Remote Farmers	**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 fulfil the following needs. • Cost efficient • Low power consumption • Time efficient	**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.
2. Jobs to be done :- The Customers want to automate the irrigation process, reduce cost of manual workers and minimize the power consumption	**9. Problem route cause:-** The route cause for Smart farming Applica	**7. Behavior:-** The customer needs to make a revolutionary change in farming by means of modern technologies.
3. Triggers:- Farmers are facing many problems while farming in traditional manner. This triggers the Smart Farming Applications. **4. Emotions:-** Farmers feel very relaxed and feel stressless while working in field.	**10. 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	**8.Channels of behaviour:-** The channels of behavior recombines the ration of the following • Online • Offline

4. Requirement Analysis

4.1 Functional Requirements

FR No.	Functional Requirement (Epic)	SubRequirement (Story / Sub-Task)
FR-1	**Arduino Board**	To interface temperature, humidity, soil moisturesensors.
FR-2	**ESP 8266** Following arethe functional requirements of the proposed solution.	It facilitates any microcontroller to access Wi-Fi network.
FR-3	**IBM cloud**	To store thesensors information
FR-4	**MIT App inventor**	To develop an app to display thetemperature,humidity andsoil moisture level.
FR-5	**Open weather API**	Used to get the information and access the resources.

Non-functional Requirements:

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

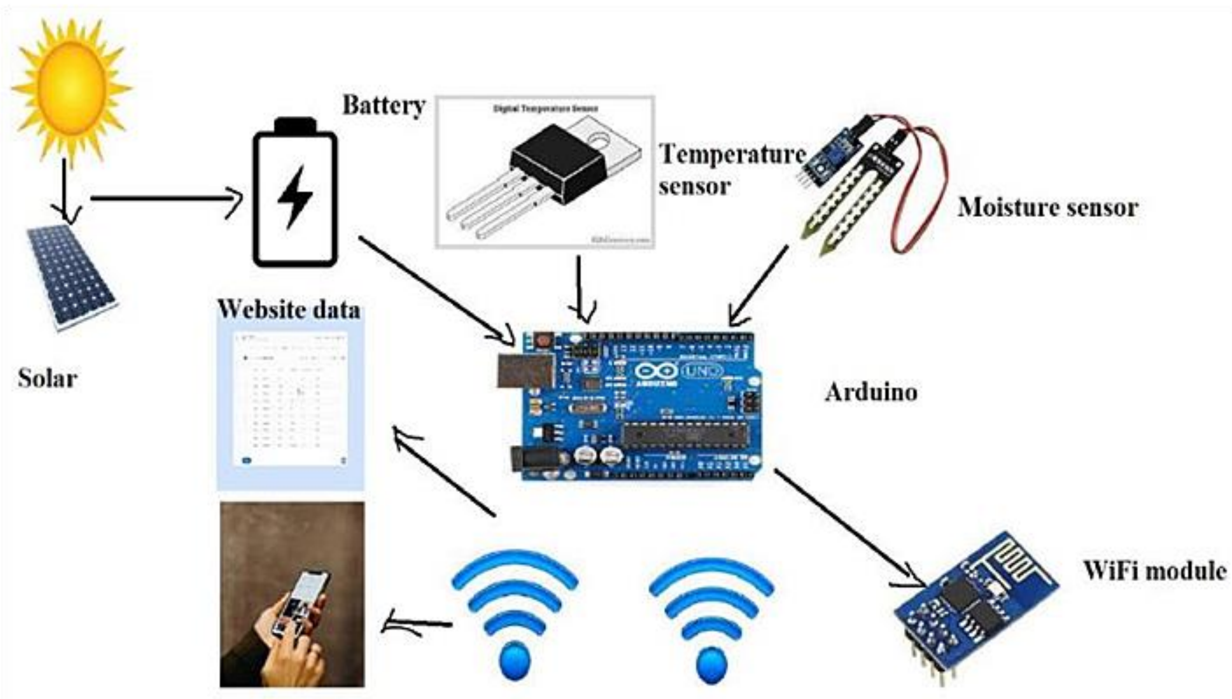
FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	The temperature, humidity and soil moisture sensors are connected to arduino and by usingthe IBM cloud to store the information of the sensors. With the help of mobile application, farmer will easily know the results about theirfield. The mobileapplication will send the notification message to his mobile phone.

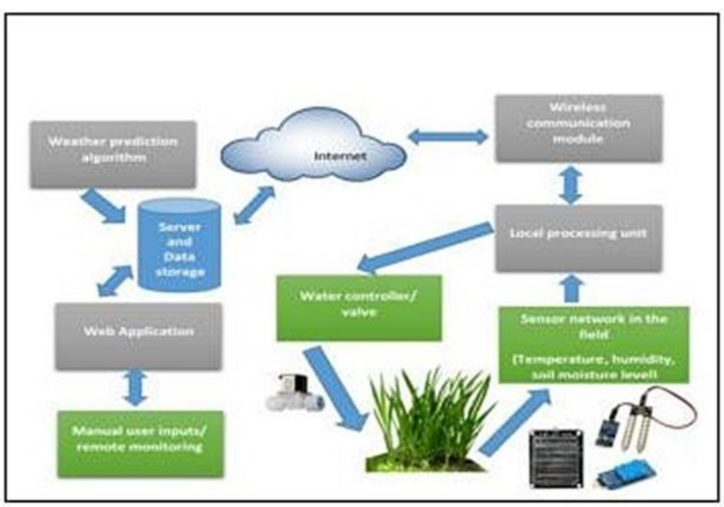
NFR-2	**Security**	To preventfrom the intruder, password isspecified.
NFR-3	**Reliability**	The mobileapplication is morereliable to thefarmer because it isdeveloped with API.
NFR-4	**Performance**	
		Because of using the sensors, it provides an accurate results.
NFR-5	**Availability**	Automatic adjustment of farming equipmentmade possible by linking information like crops/weather and equipment to auto-adjusttemperature, humidity, etc.
NFR-6	**Scalability**	Without getting any inputs fromthe farmer,theresults will be updated.

5.PRODUCT 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 requirement graphically. It shows how data enters and leaves the system, whatchangesthe information, and where data is stored.





5.2. USER STORIES

Use the below templateto list all the user stories for the product.

User Type	Functional Requirement (Epic)	User Story Number	User Story/ Task	Acceptance criteria	Priority	Release
Customer	Registration (Farmer)	USN-1	As a user,I can register for theapplication byentering my email, password, and confirming my password	I can accessmy database	High	Sprint-1
Customer	I/O interface for Sensors.	USN-2	I can connect the various sensors like temperature, moisture sensorwith Arduinoboard	I can monitor temperature,moisture etc..	High	Sprint-2
Customer	IoT Device setup	USN-3	Integrating all the devices and sensors		High	Sprint-3
Customer	Customized UI in mobile app	USN-4	To make the user to interact with the software	User can access the appforthe services.	High	Sprint-4

5.3. Solution & Technical Architecture:

- The different soil parameters temperature, soil moistures and then humidity are sensed using different sensorsand obtained value is storedin the IBM cloud.
- Arduino UNO is used as a processing Unit that process the data obtained from the sensors and whether data from the weather API.
- 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 ornot depending upon the sensor values. By using the app, they can remotely operate the motor switch.

6.PROJECT PLANNING & SCHEDULING

6.1. Sprint Planning, Estimation & Schedule

Sprint	Functional Requirement(Epic)	User Story Number	User Story/Task	Story Points	Priority	Team Member
Sprint-1	Registration(Farmer)	USN-1	As a user, I canregisterfor the application by entering my username, password.	4	High	Ramya T
Sprint-1	IBM IoT cloud Service	USN-2	Publish and subscribeto IBM IoT cloud	4	High	Rohinth M.P

Sprint-2	I/O interfacefor Sensors.	USN-3	As a user, I can connect the various sensors like temperature, moisture sensor withArduino board.	8	High	Naveen M
Sprint-3	Interface for connecting to IBM IoT cloud.	USN-4	Temperature and soil moisture sensor sends thedata to the cloud via IBM Watson service.	3	High	Rohith Kumar P
Sprint-3	Create Node Red Simulator	USN - 5	Create Node-Red Service and create a web application	3	Medium	Ramya T
Sprint - 4	App Development	USN - 6	Add a user interface ina mobile app to monitor temperature, humidity and control the motor.	6	High	Rohinth M P

Project Tracker,Velocity & BurndownChart:

Sprint	Total Story Poin ts	Duration	Sprint StartDate	Sprint EndDate (Planne d)	Story Points Completed (as on Planned End Date)	Sprint Release Date(Actua l)
Sprint-1	8	6 Days	24 Oct 2022	29 Oct 2022	8	29 Oct 2022
Sprint-2	8	6 Days	31 Oct 2022	05 Nov 2022	8	05 NOV 2022
Sprint-3	6	6 Days	07 Nov 2022	12 Nov 2022	6	12 NOV 2022
Sprint-4	6	6 Days	14 Nov 2022	19 Nov 2022	6	19 NOV 2022

VELOCITY:

Average Velocity for sprint 1= Sprint Duration /velocity =6/8 = 0.75

Average Velocity for sprint 2= Sprint Duration /velocity =6/8 = 0.75

Average Velocity for sprint 3= Sprint Duration /velocity =6/6 = 1

AverageVelocity for sprint4= Sprint Duration/velocity =6/6 = 1

6.2. Milestone and Activity List:

Title	Description	Date
Literature Survey & Information Gathering	Conducting a literature review on the chosen project and acquiring data by consulting technical papers, research publications, etc.	09 SEPTEMBER 2022
Prepare Empathy Map	Get an Empathy Map Canvas readyto record the user's gains and pains.Make a listof the problems.	09 SEPTEMBER 2022
Brainstorming ideas	By planning the brainstorming session, makea list of the ideas and rank the top threeaccording to importance andviability.	19 SEPTEMBER 2022
Proposed Solution	Create a proposal for a solution thatdetails its innovation, viability as a business idea, social impact, scalability, andother factors.	19 SEPTEMBER 2022
Problem Solution Fit	Prepare problem - solution Fitdocument.	19 SEPTEMBER 2022
Solution Architecture	Prepare solution Architecture document.	19 SEPTEMBER 2022

Customer Journey	Prepare the customer journey maps to understand the user interactions & experiences with the application	03 OCTOBER 2022
Data Flow Diagrams	Draw the data flow Diagrams andsubmit for review.	03 OCTOBER 2022
Technology Architecture	Architecture diagram.	03 OCTOBER 2022

Sprint Delivery	Prepare the Sprint delivery on Numberof Sprint planning meetings organized, Minutes of meetingrecorded.	03 NOVEMBER 2022
Milestone & Activity List	Prepare the milestones & Activitylistof the project.	03 NOVEMBER 2022
Project Development Delivery of Sprint-1,2,3&4	Develop &submit the developedcode by testing it.	IN PROGRESS...

7.CODING & SOLUTIONING

7.1 FEATURE

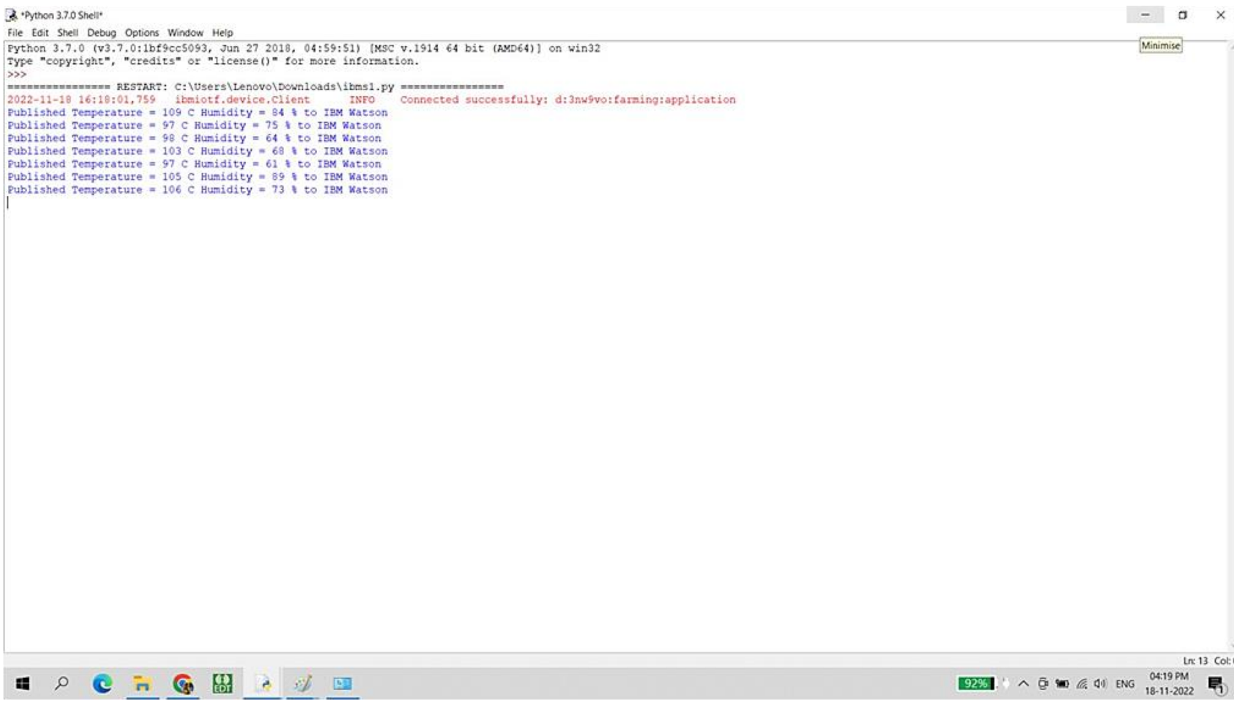
```
import time
import sys
import ibmiotf.application
import ibmiotf.device
import random

#Provide your IBM WatsonDevice
Credentialsorganization = "3nw9vo"
deviceType =
"farming"
deviceId =
"application"
authMethod =
"token"
authToken =
"87654321"

# Initialize GPIO
def myCommandCallback(cmd):
    print("Command received: %s" %
    cmd.data['command'])
    status=cmd.data['command']
    if
        status=="mo
        toron": print
        ("Motor is
        on")
    elif status ==
        "motoroff":
        print ("Motor
        is off")
    else :
```

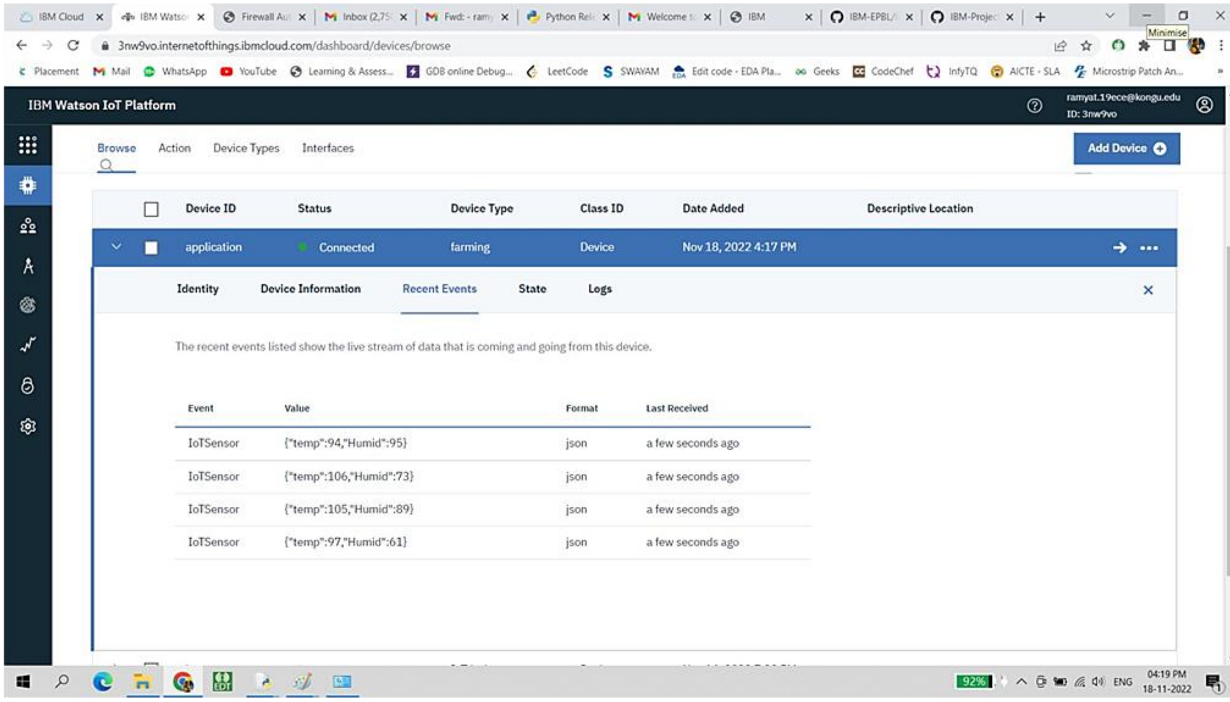
```
    print ("please send propercommand")


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 cloudas an event
of type"greeting" 10 times
deviceCli.connect()


while True:
    #Get Sensor Data from DHT11


    temp=random.randint(9
    0,110)
    Humid=random.randint
    (60,100)

    data = { 'temp' : temp, 'Humid':
    Humid }#print data
    def myOnPublishCallback():
      print ("Published Temperature = %s C"% temp, "Humidity = %s %%"% Humid,
"toIBMWatson")


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

to IoTF")time.sleep(10)

deviceCli.commandCallback = myCommandCallback

Disconnect the device and application from the clouddeviceCli.disconnect()

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ID: 3nw9vo
Browse
Action
Device Types
Interfaces
Add Device
Device ID
Status
Device Type
Class ID
Date Added
Descriptive Location
application
Connected
farming
Device
Nov 18, 2022 4:17 PM
Identity
Device Information
Recent Events
State
Logs
The recent events listed show the live stream of data that is coming and going from this device.
Event
Value
Format
Last Received
IoTSensor
{"temp":94,"Humid":95}
json
a few seconds ago
IoTSensor
{"temp":106,"Humid":73}
json
a few seconds ago
IoTSensor
{"temp":105,"Humid":89}
json
a few seconds ago
IoTSensor
{"temp":97,"Humid":61}
json
a few seconds ago
04:19 PM
18-11-2022

8. RESULT

8.1. PERFORMANCE METRICS

Hence a helpful and useful system is built for farmers to assist them in farming and also prevent them from natural calamities. It also saves farmers time to maintain all these things as this is working on cloud he can turn on/off motor from anywhere so basically it helps farmers and make them relived thus helping our economy to grow.

9.ADVANTAGES & DISADVANTAGES

Advantage:

- monitoring weather parameters such as temperature, pressure, humidity, soilmoisture remotely controlling motorseasily through buttons
- alert farmers in caseof any calamities
- threshold values are set any anomalies will be reportedto the farmer
- user friendly and efficient
- low cost

Disadvantage:

- sensors may sometimemalfunction
- maybe inaccurate sometimes
- farmer needs internetconnectivity
- farmer must have a phone and have basic knowledgeto operate it

Applications:

- Monitoring of ClimateConditions -Probably the most popularsmart agriculture gadgets are weather stations, combining various smart farming sensors. Located across the field, they collectvarious data 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 measuresto improve their capacity (i.e. precision farming).

- Greenhouse Automation-In additionto sourcing environmental data, weather stationscan automatically adjustthe conditions to match the given parameters. Specifically, greenhouse automation systems use a similar principle.

- Crop Management - One more type of IoT product in agriculture and another elementof precision farmingis crop management devices. Just likeweather 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, these can all be used to readily collect data and information for improved farming practices.
- Cattle Monitoring and Management-Just like crop monitoring, there are IoT agriculture sensorsthat can be attached to the animalson a farm to monitortheir health and log performance. This works similarly to IoT devices for pet care.
- End-to-End Farm Management Systems-A more complex approach to IoT products in agriculture can be represented by the so-calledfarm productivity management systems. They usuallyinclude a number of agriculture IoT devices and sensors, installed on the premises as well as a powerful dashboardwith analytical capabilities and in-built accounting/reporting features.

10.CONCLUSION

Smart Farming and IoT-driven agriculture are paving the way for what can be called a Third Green Revolution.The Third Green Revolution is taking over agriculture. That revolution draws upon the combined application of data-driven analytics technologies, such as precision farming equipment, IoT, “big data” analytics, Unmanned Aerial Vehicles (UAVs or drones), robotics, etc.

In the future this smart farming revolution depicts, pesticide and fertilizer use will drop while overall efficiency will rise. IoT technologies will enable better food traceability, which in turn will lead to increased food safety. It will also be beneficial for the environment, for example, more efficient use of water, or optimization of treatments and inputs.Therefore, smart farming has a real potential to deliver a more productive and sustainable form of agricultural production,based on a more precise and resource-efficient approach. New farms will finally realize the eternal dream of mankind.

GitHub Link

https://github.com/IBM-EPBL/IBM-Project-21962-1659799125

Video Link

https://vimeo.com/772825065