Professional Readiness for Innovation, Employability, and Entrepreneurship

PROJECT REPORT

Title	IoT Based Smart Crop Protection System for Agriculture
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CONTENTS

1. INTRODUCTION

1.1 Project Overview

Food is one among the basic need for a human to live. All farmers are working hard to produce food, but every seed that are cultivated are not turning into crops. It is damaged in one or other way, which leads to loss of farmers and scarcity in food. A crop is affected by various factors like it is destroyed by insects and moths or it is damaged by animals like goats, cows, rats etc and birds. In addition to it, they are affected by low moisture level in the soil. If the moisture level in the soil is low, then the crop may not get enough water for the process of photosynthesis and leads to dryness of crops. There is a possibility of crops catching fire due to lack of water. But surveillance of the crops 24 hours a day is impossible, but we try to protect the crops from all the above-mentioned factors. Protecting the crops from insects can be done spraying pesticides. But we cannot protect them from animals and birds the whole time. A person has to be there in the field for the whole day to make the animals and birds keep away from the crops. Replacing the man with scarecrow is not that much effective. The other problem is water scarcity. Most the crops got dried due to low water level in the soil, so the water level in the soil has to monitored to keep the crops not get to be dried. So, we need a system which wants to protect the crops from animals and birds for 24 hours a day and needs to monitor the moisture level in the soil and notify the farmer if there is low moisture level in the soil. So that we can protect the crops and get higher yield.

1.2 Purpose

- The proposed system will protect the crops from the animals and birds
- It will monitor the environmental factors like temperature, soil moisture and humidity in Air for getting better growth of the crop.
- If there is low moisture level in the soil then this system will send an alert message to the farmer through SMS
- The farmer can control the motors and sprinklers remotely if he gets the alert message as low moisture level.

2. LITERATURE SURVEY

2.1 Existing problem

1. **Machine Learning Based Prediction of Reference Evapotranspiration (ET0) Using IoT.,. Zhiming Hu, Rab Nawaz Bashir, Aqeel Ur Rehman, Salman Iqbal, Malik Muhammad Ali Shahid, and Ting Xu, Sensors 2022**
    - In this paper, they proposed an approach based on Machine Learning for Evapotranspiration (ET0) rate determination on

directly sensed environmental conditions for ET0 rate determination are proposed by the architecture.
- Comparisons between various machine learning algorithm were compared in the paper.

Merits:

- The KNN model of ET0 is more efficient in reducing the Root Mean Squared Errors (RMSE) by 16%and Mean Absolute Errors (MAE) by 3%.
- The KNN model is more accurate as compared to SVM, GNB and ANN models with 92% accuracy.

2. **"IOT Based Soil Testing Instrument for Agriculture Purpose". Siddalinga Nuchhi, Vinay Kumar Bagali, Shilpa Annigeri. 2021.**
    - The major concern of the work is to develop an instrument to maximize the yield of the crop with nutritious analysis of soil.
    - In the proposed method sensor measures the soil fertility. The Arduino board is used to have a proper readout of the values and for conversions of the data.
    - With the help of the thingspeak platform the data of the measured parameters will be sent to farmers of the respective fields through a cloud platform.

    Merits:

    - The application has the capability to recommend the fertilizer required to suit the necessary requirement of the plant/crops with improvement in the standards of soil for increasing the yield.

    De-Merits:

    - Electrochemical sensor method, Spectroscopy method, and Conductivity method are the methods used here but these methods didn't give accurate results.
    - The instruments are not fabricated and commercialized.

3. **"Smart Crop Cultivation Monitoring System by Using IoT", Khampheth Bounnady, Poutthasone Sibounnavong, Khampasith Chanthavong, Savath Saypadith. 2019.**
    - In this paper, the monitoring of soil moisture, temperature, and water control has been done by using NodeMCU ESP8266, sensors, and cloud computing.
    - Implementation of three methods has been done for studying the growth rate, production rate, and water-saving rate of crops namely traditional farms, the greenhouse by using a

timer to control soil moisture, and the greenhouse by using sensors to automatically control soil moisture.

Merits:

- The growth rate of the proposed method is better than the traditional form by 41.2% and better than a timer to control soil moisture by 23.1%.
- The productivity is getting more than traditional farm by 70% and more than a timer to control soil moisture is 12.1%.
- The water saving is better than traditional farm by 20.9% and better than a timer to control soil moisture is 5.5.

De-Merits:

- It has very limited processing power so it can't be used for projects which need high processing.

4. **"IoT based System for Smart Agriculture."., Ioana M. Marcu, George Suciu. 2019.**
    - Libelium is a platform (hardware and software) used in IoT solutions systems and it is based on wireless sensor networks.
    - This integration enables the measuring of different parameters related to weather conditions, light and radiation levels, soil morphology, fertilizer presence, frost prevention, and daily monitoring to improve crop quality production and prevent harvest losses.

    Merits:

    - Libelium based on IoT technologies can lead to good and accurate.
    - Precision in monitoring, analysing, assessing and controlling agricultural fields.
    - It helps in improving maximum accuracy for crop monitoring.

    De-Merits:

    - Implementing DoS attacks to limit data transmission between Meshlium and the server.

5. **"Research on the Monitoring System of Wheat Diseases, Pests and Weeds Based on lOT"., *Shufen Zhang, Xuebin Chen, Shi Wang,* 2014.**
    - In this paper, the proposed system uses the ZigBee network to connect the terminal sensing devices, and connect the big data platform by IoT.
    - This system uses data that was collected by the IoT terminal to build a big data platform and built an intelligent warning system of wheat diseases, pests and weeds on the platform.

Merits:

- Automatic identification of the object and information sharing through the internet.
- The system not only can diagnose and forecast the occurrence of wheat diseases, pests and weeds but also can provide decision consulting.

De-Merits:

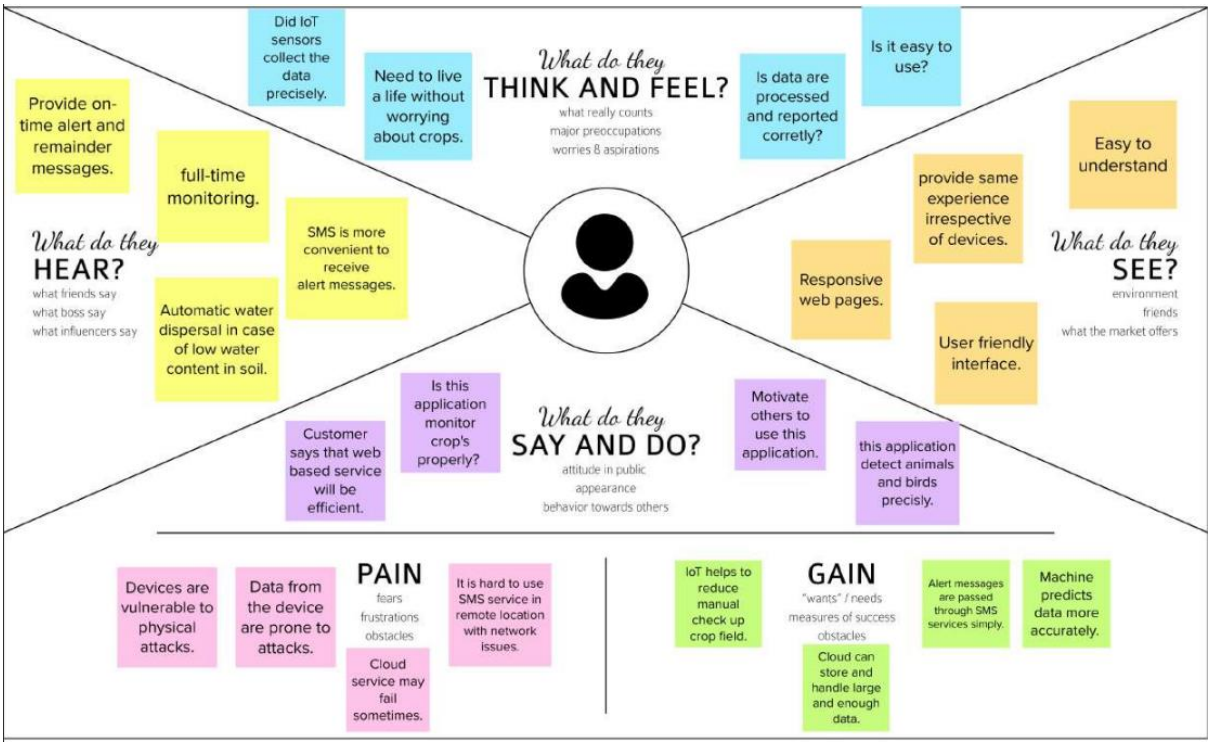
- The transmission rate of this technology is also low.
- Implementation of Zigbee technology can be expensive.

2.2 References

1. **"Machine Learning Based Prediction of Reference Evapotranspiration (ET0) Using IoT".,. Zhiming Hu, Rab Nawaz Bashir, Aqeel Ur Rehman, Salman Iqbal, Malik Muhammad Ali Shahid, and Ting Xu, Sensors 2022**
2. **“IOT Based Soil Testing Instrument for Agriculture Purpose”. Siddalinga Nuchhi, Vinay Kumar Bagali, Shilpa Annigeri. 2021.**
3. **“Smart Crop Cultivation Monitoring System by Using IoT”, Khampheth Bounnady, Poutthasone Sibounnavong, Khampasith Chanthavong, Savath Saypadith. 2019.**
4. **“IoT based System for Smart Agriculture.”., Ioana M. Marcu, George Suciu. 2019.**
5. **“Research on the Monitoring System of Wheat Diseases, Pests and Weeds Based on lOT”., Shufen Zhang, Xuebin Chen, Shi Wang, 2014.**

3. IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas



3.2 Ideation & Brainstorming

Brainstorm

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

10 minutes

Group ideas

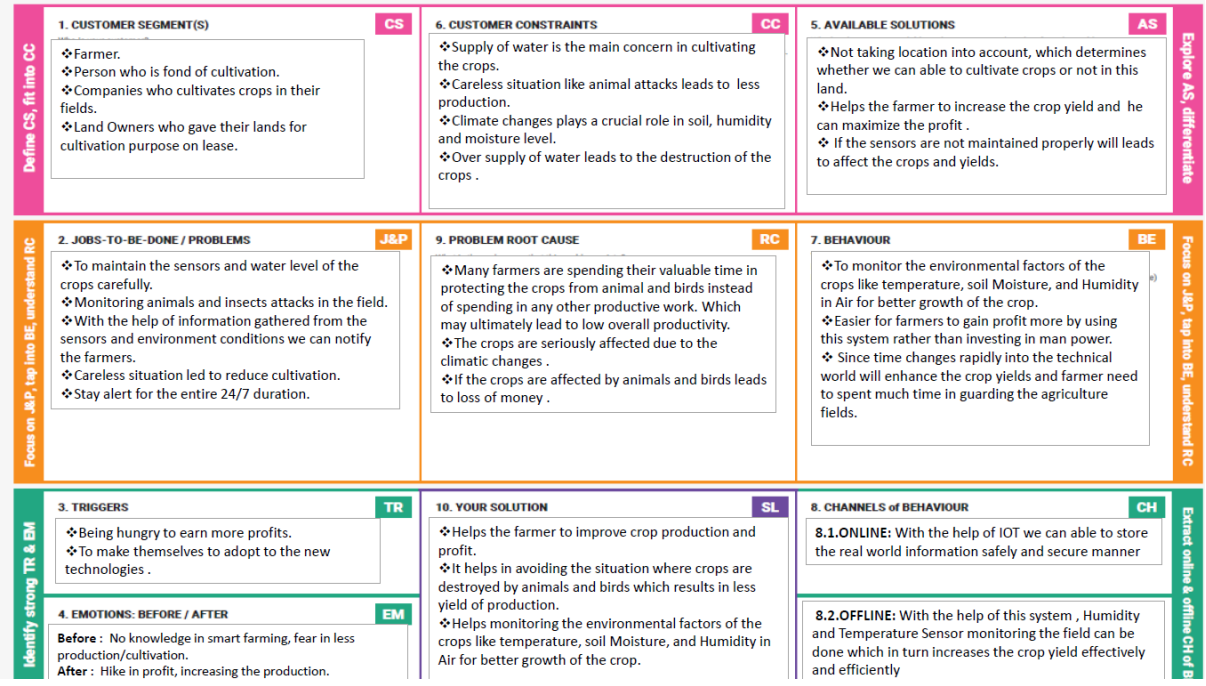
Take turns sharing your ideas while clustering similar or related notes as you go. Once all sticky notes have been grouped, give each cluster a sentence-like label. If a cluster is bigger than six sticky notes, try and see if you and break it up into smaller sub-groups.

20 minutes

3.3 Proposed Solution

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	To develop an IoT based application for protecting crops from animals and birds.
2.	Idea / Solution description	Crops were destroyed by animals and birds continuously which lead to less yield of protection. This can be avoided by using a smart crop protection system which will monitor the crops and protect them from animals and birds. The farmer can access the motor from anywhere so that the farmer won't have to visit the field periodically.
3.	Novelty / Uniqueness	By using the remote monitoring system, person has not to stay 24/7 on guard to protect crops from animals and birds and operating the motor from remote distance rather than direct visit to the field
4.	Social Impact / Customer Satisfaction	Improves the production, better yield of crops, Reduces the man work.
5.	Business Model (Revenue Model)	Community based solution by FAO's Solution through contract farming.
6.	Scalability of the Solution	By using high accurate soil moisture sensor and temperature sensor the crop yield can be increased effectively.

3.4 Problem Solution fit



4.REQUIREMENT ANALYSIS

4.1 Functional requirement

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement	Sub Requirement
FR-1	User Visibility	Sense animals nearing the crop field & sounds alarm to woo them away as well as sends SMS to farmer using Cloud service.
FR-2	User Reception	The Data like values of soil moisture , Temperature, Humidity, Sensors are Received via SMS.
FR-3	User Understanding	Based on the sensor data value to get the Information about the present of farming Land.
FR-4	User Action	The User needs take action like destruction of crop residues, deep ploughing, crop rotation, fertilizers, strip cropping, scheduled Planting operations.

4.2 Non-Functional requirements

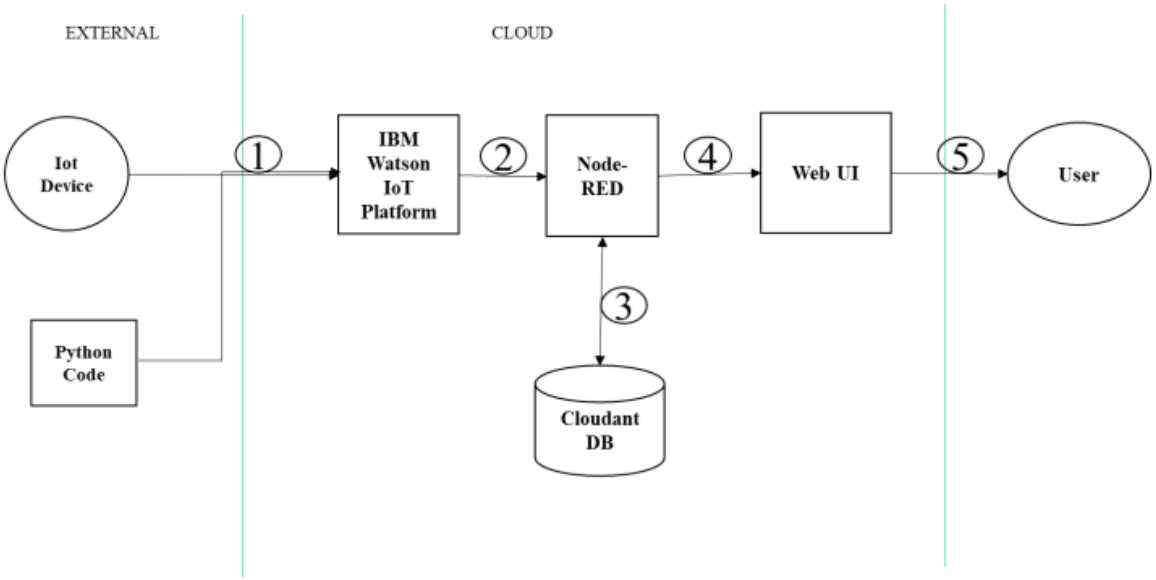
Following are the non-functional requirements of the proposed solution.

FR No.	Non-Functional Requirement	Description
NFR-1	Usability	Mobile Support Users must be able to interact in the same tasks on computers & mobile devices where practical, given mobile capabilities.
NFR-2	Security	Data requires secure access to must register and communicate securely on devices and authorized users of the system who exchange information must be able to do.
NFR-3	Reliability	It has a capacity to recognize the disturbance near the field and doesn't give a false caution signal.
NFR-4	Performance	Must provide acceptable response times to users regardless of the volume of data that is stored and the analytics that occurs in background. Bidirectional, near real-time communications must be supported. This requirement is related to the requirement to support industrial and device protocols at the edge.
NFR-5	Availability	IOT Solutions and domains demand highly available systems for 24 x 7 operations. Isn't a critical production application, which means that operations or production don't go down if the IOT solution is down.
NFR-6	Scalability	System must handle expanding load & data retention needs that are based on the up scaling of the solution scope, such as extra manufacturing facilities.

5.PROJECT DESIGN

5.1 Data Flow Diagrams

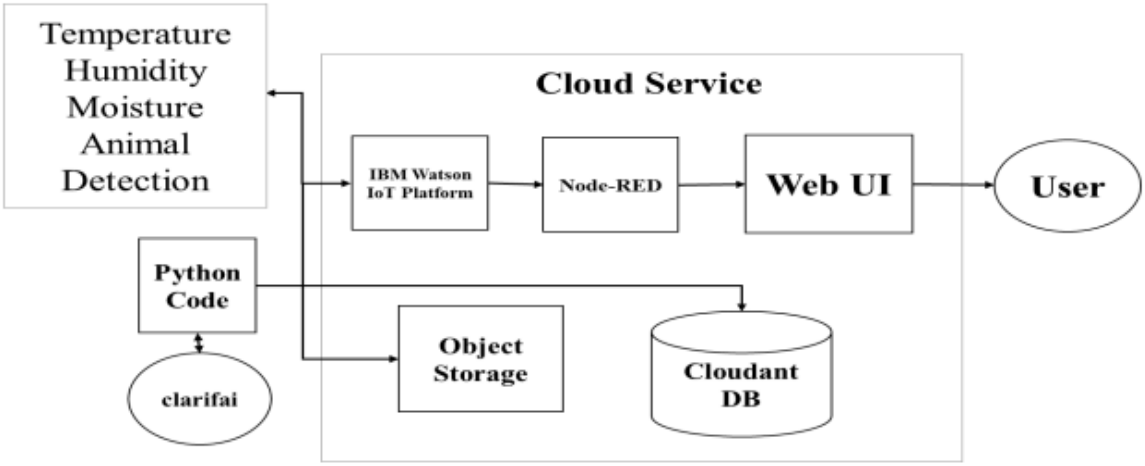
A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.



1. Data collected from IoT sensor and from Python code and passed to IBM Watson IoT Platform, which act like a intermediatory between Devices and Node-red application.
2. Data from device passed to IoT platform and then to Node-red for processing and displaying.
3. Image of detected animal stored in Cloud object storage sense and image URL stored in Cloudant DB.
4. Node-red pass data for visualization.
5. User can access the web UI for visualization and get clear understanding about crops.

5.2 Solution & Technical Architecture

Solution Architecture:



Technical Architecture:

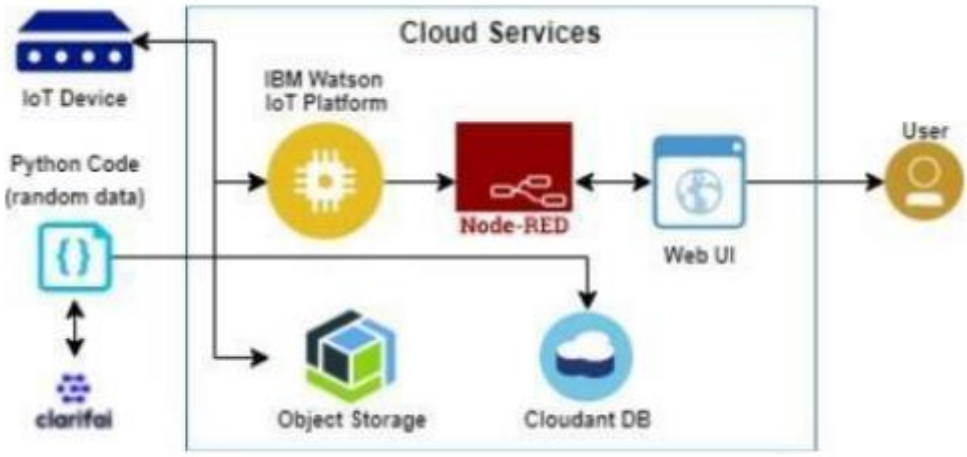


Table-1 : Components & Technologies:

S.No	Component	Description	Technology
1.	User Interface	Web UI, Mobile App.	Node-red, Kubernetes, MIT mobile app inventor.
2.	Application Logic-1	Generating random sensor data	Python, IBM Watson IoT platform
3.	Cloud Database	Database Service on Cloud	IBM DB2, IBM Cloudant.
4.	External API-1	Sending SMS to customer.	Twilli SMS API, etc
5.	Infrastructure (Server / Cloud)	Application Deployment on Cloud	Kubernetes

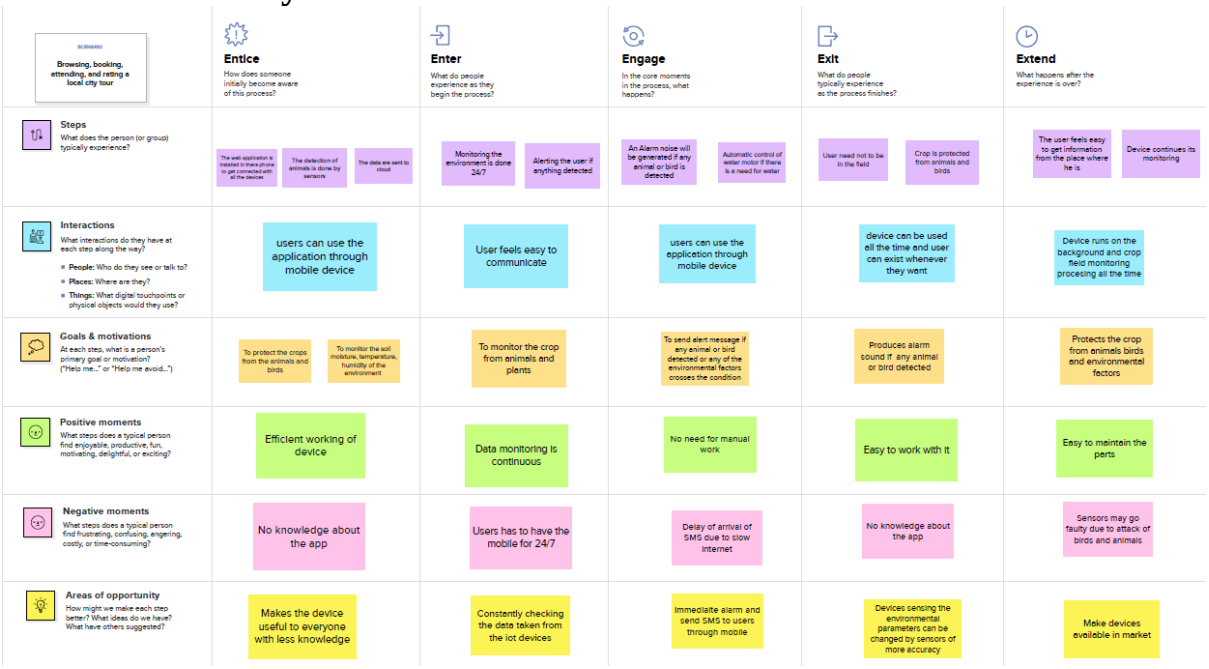
Table-2: Application Characteristics:

S.No	Characteristics	Description	Technology
1.	Open-Source Frameworks	open-source frameworks used to develop our project	Node – Red, IBM Cloudant, IBM Watson IOT Platform
2.	Security Implementations	Use of Login facility for individual user	Password protection in MIT App, User login for web application.
3.	Scalable Architecture	Web Ui designed for easy access and usage.	Node – Red (Web UI)
4.	Availability	Web application can be accessed from anywhere	Node–Red(Web UI)
5.	Performance	All Farmers can access the application at same time	Cloudant DB, IBM Watson IoT Platform

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	User can enter into the web application.	I can access my account / dashboard	High	Sprint-1
		USN-2	User can register their credential.	I can receive confirmation email & click confirm	High	Sprint-1
	Login	USN-3	User can login into the application.	I can login into my account.	High	Sprint-1
	Dashboard	USN-4	User can view temperature, humidity, moisture, animal detection.	I can view all the needed data from the web application	High	Sprint-2
Customer (Web user)	Usage	USN-1	User can view the web page and get the information.	I can view the data given by the device	High	Sprint-3
	Working	USN-2	User act according to the alert given by the device	I can get the data work according to it	High	Sprint-3
		USN-3	User turns ON the water motors / Buzzer / Sound Alarm when occur the disturbance on field	I can get the data work according to it		Sprint-4
Customer care Executive	Action	USN-1	User solve the problem when some faces any usage issues	I can solve the issues when someone fails to understanding the procedure	High	Sprint-4
Administrator	Administration	USN-1	User stores the information for further use.	I can store the gained information	High	Sprint-4

5.4 Customer Journey



6.PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning & Estimation

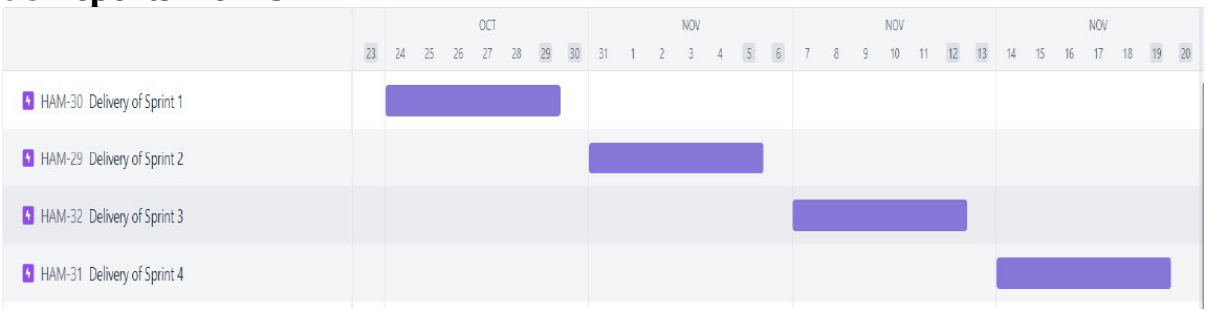
Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	IBM Cloud Services	USN-1	Create a Cloud Account in IBM	10	High	Whole Team
	Python IDE	USN-2	Install the Python IDE	5	Medium	Gopi Krishnan V
	Clarifai	USN-3	Create an Account in Clarifai	5	High	Kani Raj S Raja Kumaran G
Sprint-2	IBM Watson Platform	USN-4	Create IBM Watson IoT Platform and Device	5	High	Mariappan K
	Node Red Services	USN-5	Create Node Red Services (To Create a Web Application)	4	High	Saravanan B
	Cloudant DB	USN-6	Create a Database in Cloudant DB (To Store the Image URL, Launch the Cloudant DB)	4	High	Saravanan B
	Cloud Object Storage	USN-7	Create a Cloud Object Storage Service	4	High	Saravanan B
Sprint-3	Python Code	USN-8	Develop a Python Script	15	High	Mariappan K Saravanan B
Sprint-4	Web UI(User Interface)	USN-9	Develop a Web Application using Node-RED Service. (Display the image in the Node-RED web UI and also display the temperature, humidity, and soil moisture levels.)	15	High	Saravanan B

6.2 Sprint Delivery Schedule

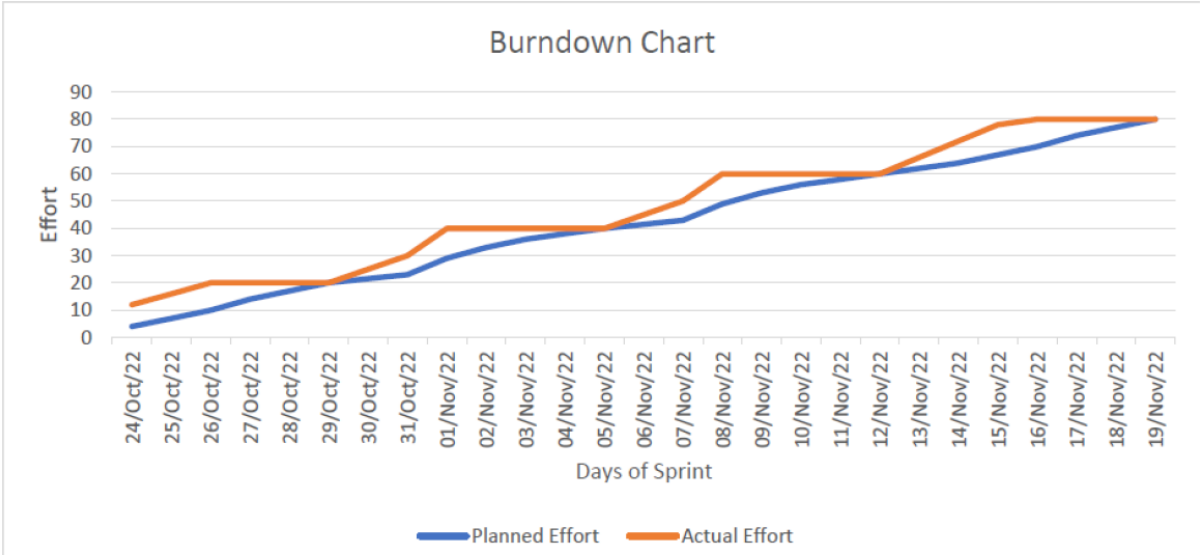
PROJECT TRACKER, VELOCITY & BURNDOWN CHART

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	31 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	6 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	07 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	21 Nov 2022

6.3 Reports from JIRA



6.4 Burndown chart



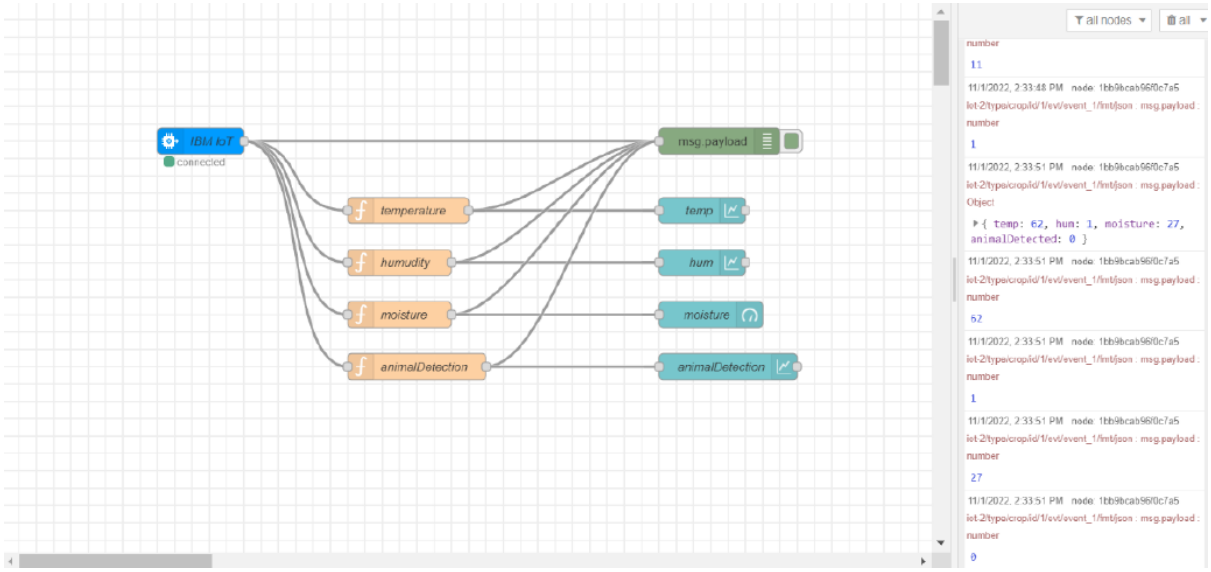
7.CODING & SOLUTIONING

7.1 Python Script

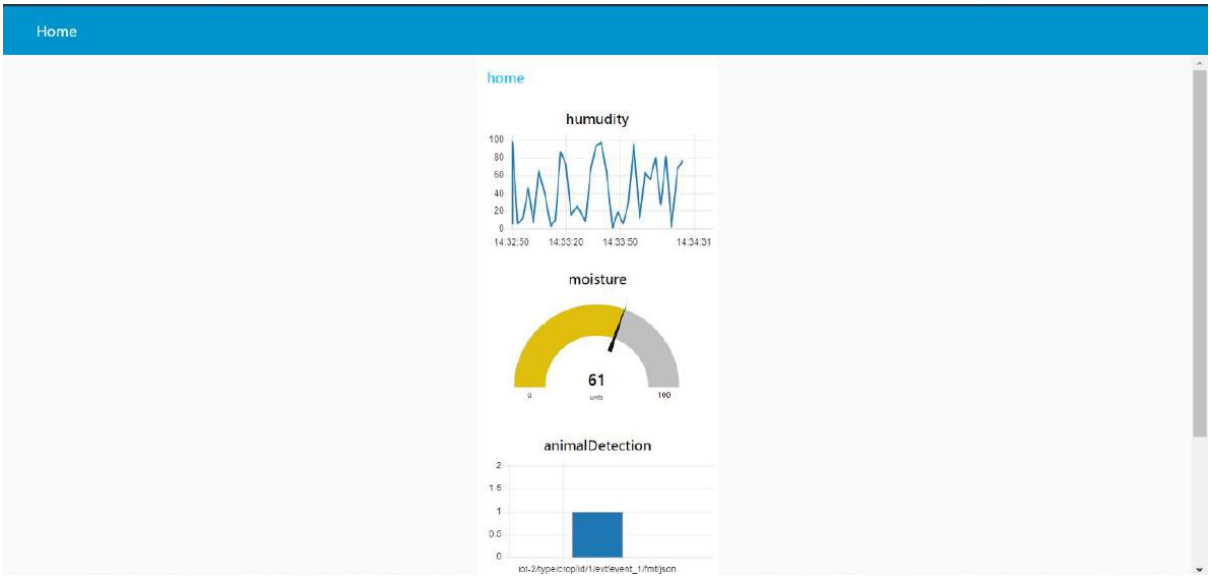
```
import time
import sys
import ibmiotf.application
import ibmiotf.device
import random
#Provide your IBM Watson Device Credentials
organization = "wu5b55"
deviceType = "crop1"
deviceId = "1234"
authMethod = "token"
authToken = "1234567890"
# Initialize GPIO
try:
    deviceOptions = {"org": organization, "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()
deviceCli.connect()
while True:
    temp=random.randint(0,100)
    Hum=random.randint(0,100)
    moisture=random.randint(0,100)
    data = { 'temperature' : temp, 'Humidity': Hum, 'Moisture':moisture }
    def myOnPublishCallback():
    print ("Temperature = " + str(temp)+" C Humidity = " + str(hum)+ "
        moisture = " + str(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(10)
deviceCli.commandCallback = myCommandCallback
  deviceCli.disconnect()
```

7.2 Web Development

I. Node-Red data flow



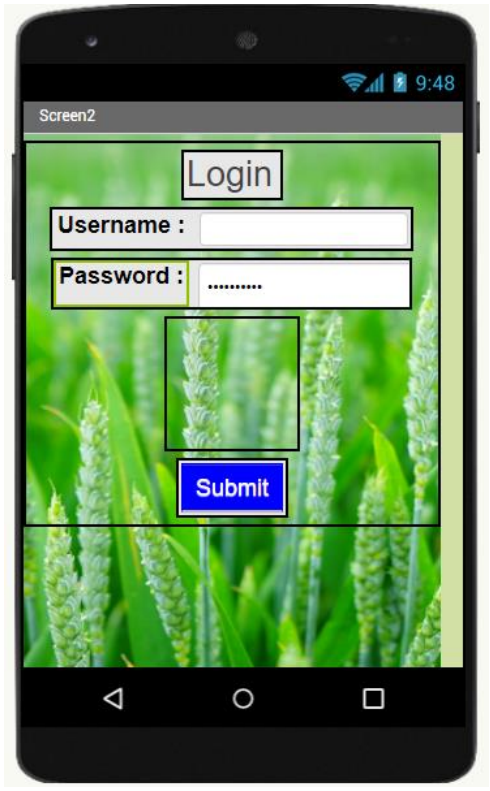
II. Web Application Data Visualization



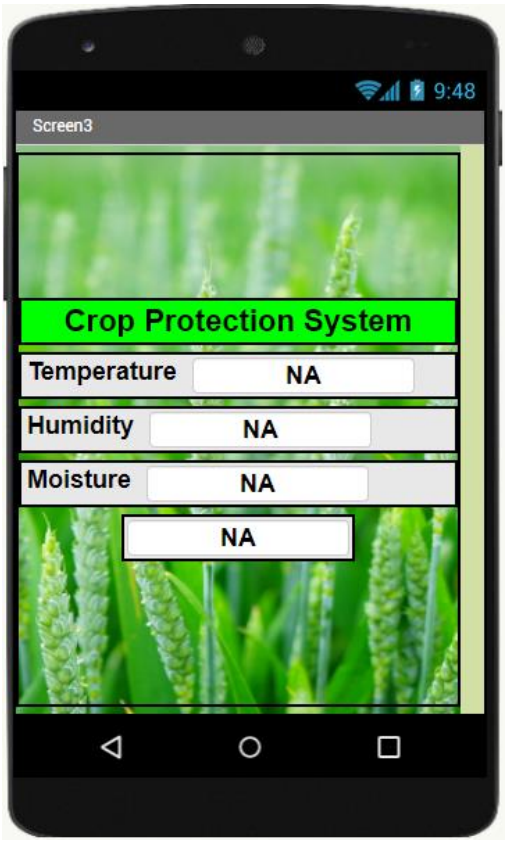
7.3 Mobile Application

I. Screen 1

II. Screen 2



III. Screen 3



8.TESTING

8.1 Test Cases

Section	TotalCases	Not Tested	Fail	Pass
PrintEngine	3	0	0	3
ClientApplication	43	0	0	43
Security	2	0	0	2
OutsourceShipping	3	0	0	3
ExceptionReporting	8	0	0	8
FinalReportOutput	4	0	0	4
VersionControl	2	0	0	2

8.2 User Acceptance Testing

Test case ID	Feature Type	Component	Test Scenario	Pre-Requisite	Steps To Execute	Test Data	Expected Result	Actual Result	Status	Commnets	BUG ID
LoginPage_TC_001	Functional	Home Page	Verify whether the user is able to see the login page after opening the mobile app	Download the mobile app for viewing the data	Click the app that was previously installed. Wait for the log to be displayed and wait for 2 more seconds for the login screen to load		Login page should display	Working as expected	Pass		
LoginPage_TC_002	UI	Home Page	Verify if all the UI elements in the application is in its place even if used on a mobile of different dimensions		Download the app on 2 different mobile devices. Open the application on both these devices. Observe the layout of the components in both these devices.		Both devices must contain the following components: Logo of the company, Name of the company, and the Username and password fields along with te submit button	Working as expected	Fail	Layout changes with mobile dimensions	bug_001
LoginPage_TC_003	Functional	Home page	Verify user is able to log into application with Valid credentials		Open the application and wait for the app to load the login page. Enter the correct credentials	Username: kaushik password: kaushik	User should navigate to user account homepage	Working as expected	Pass		
LoginPage_TC_004	Functional	Login page	Verify user is able to log into application with InValid credentials		Open the application and wait for the app to load the login page. Enter the correct credentials	Username: kaushik password: 1234	Application should show 'Incorrect email or password ' popup message.	Working as expected	Pass		
LoginPage_TC_004	Functional	Login page	Verify user is able to log into application without credentials		Open the application and wait for the app to load the login page. Enter the correct credentials	Username: password:	Application should show 'Enter username and password ' popup message.	Working as expected	Pass		
LoginPage_TC_005	Functional	Home Page	Verify user is able to view the data obtained from the sensord	Log into the user's vaid account	Log into the user's account and wait for a few seconds to establish connectiion.		The Temperature field must display new data for every 2 seconds and the user must get "High Temperature alert .." popup message during anamoly	Working as expected	Pass		

Resolution	Severity_1	Severity_2	Severity_3	Severity_4	Subtotal
By Design	11	4	2	3	21
Duplicate	1	0	2	0	3
External	2	3	0	0	5
Fixed	9	4	5	23	41
Not Reproduced	0	0	1	0	1
Skipped	0	0	1	1	2
Won't Fix	0	5	2	1	8
Totals	23	16	14	28	81

9.RESULTS

9.1 Performance Metrics

The conclusion from this project's performance that the project system's detection of unfavorable condition is remarkable. Useful for both domestic and professional needs. We can use this technology to save large field of crops in sudden situations. The crop protection system indicates an alert when the area's temperature and soil moisture reach bottom limit. Power usage and transmission range estimates are made. The sensor was constructed using straightforward techniques and an Arduino UNO Micro controller.

10. ADVANTAGES & DISADVANTAGES

Advantage:

- Fast-pace communication

  In this automated system, it detects temperature and soil moisture changes in the environment and detect very accurately. We get the required data from sensor and pass to web application for

processing. With a good internet connection this system shows better result than average.

- Round-the-clock support

  Because the data gathering is done by sensors, a little power supply is enough to keep the device running and provide protection to the area round the clock.

- Convenient mode of communication

  This system mainly uses in mobile application for displaying constant changes in the crop field. Since mobile phone have a advantage of easy access, it gives a easier way to monitor field all time. Alert messages are passed through SMS.

Disadvantage:

- Lack of decision-making skills

  Decision-making situation like turn on motor pump or turn off, are leave to customer end. This system poses no intelligent for decision-making. For that system need to consider so many facts that are not covered in this system.

- Unsuitable for some customers

  This system is not suitable for customer who thinks human are more trustable than machine. Although its true since machine poses no intelligent unlike human. Decision-making skills are much developed in human than machine.

11. CONCLUSION

By using the proposed system, the farmer can reduce their hard work by knowing the condition of crops from the home itself. The farmer can operate the motor and sprinklers for irrigation from the remote application and the alarm system installed in the field will keep all the animals and birds away from the crops if detected by the system. So that we get good yield in production.

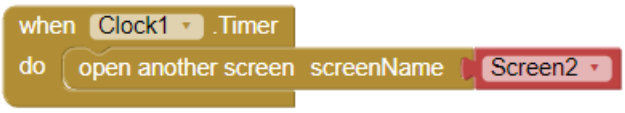
12. FUTURE SCOPE

This proposed system detects temperature and soil moisture, and alert customer based on some limit. In future we plan to add some more parameter such as weather to automate the entire thing like motor on based on soil moisture and weather condition. By this system can decision on their own for crop best needs.

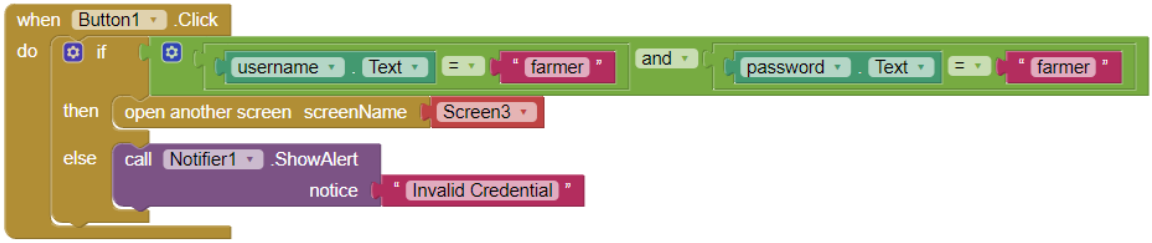
13. APPENDIX

Source Code

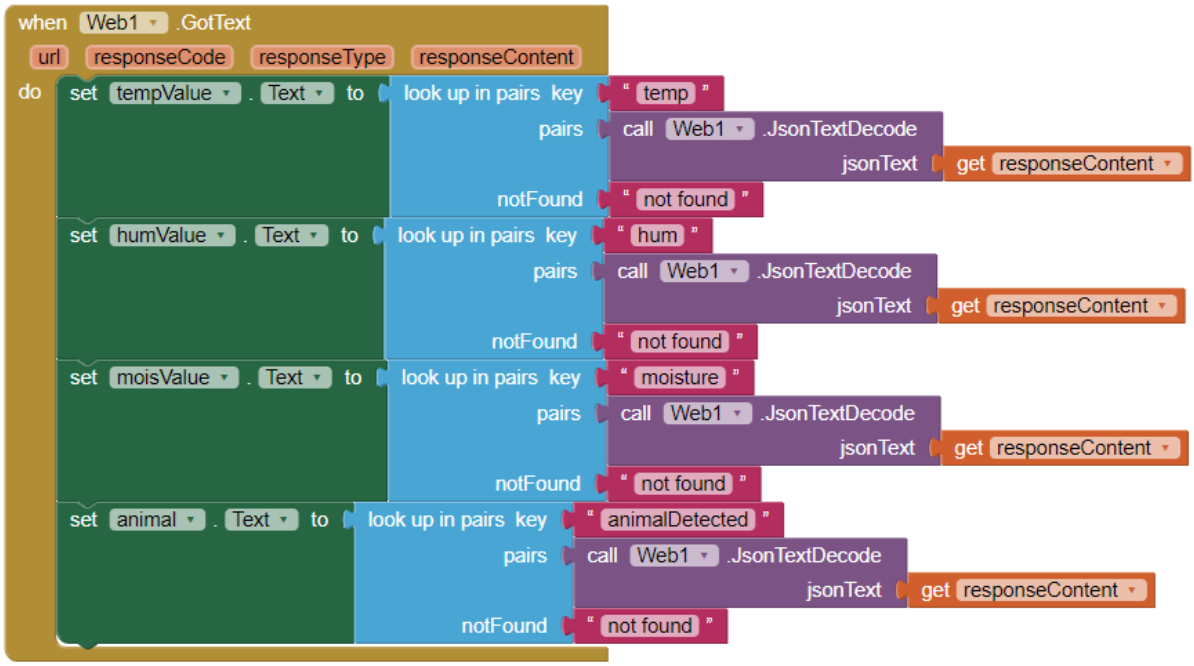
Mit application screen 1 block:



Mit application screen 2 block:



Mit application screen 3 block :



Code for event generation in IBM Watson IoT platform

```
{
        "temperature": random(0, 100),
        "humidity": random(0, 100),
        "moisture": random(0, 100),
        “animalDetected”:random(0,2)
}
```

Node-red function:

Temperature function:

```
        msg.payload = msg.payload.temperature;
        return msg;
```

Humidity function:

```
        msg.payload = msg.payload.humidity;
        return msg;
```

Moisture function:

```
        msg.payload = msg.payload.moisture;
        return msg;
```

Node-red value function:

```
        msg.payload = {"temp":global.get("t"),
                        "hum":global.get("h"),
                        "moisture":global.get("m"),
                        “animalDetected”:global.get(“a”)};
        return msg;
```