

SmartFarmer - IoT Enabled Smart Farming Application

The Project Report

Submitted by

Team ID : PNT2022TMID28270

Team Members : MADHUMITHA S

MARY MERLIN V

KHARTHIGA S

JAYASHREE A

MARIA JEEVITHA T

<https://github.com/IBM-EPBL/IBM-Project-30763-1660188850>

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Introduction:

overview:

In this project we have developed a mobile application using which a farmer can monitor the temperature, humidity, pressure and soil moisture parameters along with weather forecasting details. Based on these details he can water the crops by controlling the motors through the app and the app gives an alert message if temperature or humidity goes beyond a threshold value.

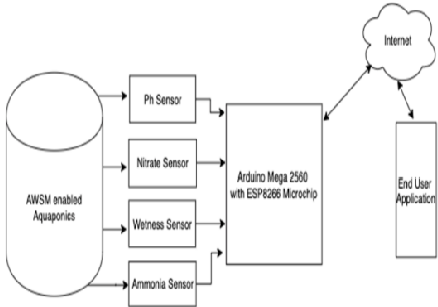
Purpose:

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

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

2 LITERATURE SURVEY

S.NO	JOURNAL PAPER	BLOCK DIAGRAM	ALGORITHM/METHODOLOGY/SOLUTION	FEATURES	DRAWBACK
1.	Smart Farm Monitoring Using LoRa Enabled IOT	<pre> graph LR subgraph TransmitterNode [Transmitter node] ESP32_T[ESP32 LoRa device] DHT11[DHT-11] Soil[Soil moisture sensor] ESP32_T --- DHT11 ESP32_T --- Soil end subgraph ReceiverNode [Receiver node] ESP32_R[ESP32 LoRa device] end ESP32_T -. LoRa .-> ESP32_R ESP32_R -- Wi-Fi --> Internet((Internet)) Internet -- MQTT --> IBMCloud[IBM Cloud] IBMCloud --> Watson[IBM Watson IoT platform & Cloud DB service] </pre>	<p>1. Agricultural practices need to be transformed in order to overcome future food scarcity due to overpopulation across the globe. By employing emerging, disruptive technologies like IoT in the agricultural sector, it is possible to monitor farm fields using low-cost and low-power consuming devices, to automate irrigationsystems for efficient usage of water resources.</p> <p>2. LPWAN technologies serve IOT applications in a better possible way so that LoRa WAN protocol or LoRa in LPWAN space gives additional advantageslike scalability, security and robustness in designing IoT applications</p>	<p>1. Scalable bandwidth</p> <p>2. High Robustness</p> <p>3. Doppler resistance</p> <p>4. Fading resistance</p> <p>5. Long range link</p> <p>6. Low power</p> <p>7. Low cost</p>	<p>1. This system has Gateway infrastructure barriers such aspublic network coverage scarce.</p> <p>2. It takes skill and commitment todeploy and maintain own gateways.</p> <p>3. It has integration complexity (Gaps in the standardization)</p>

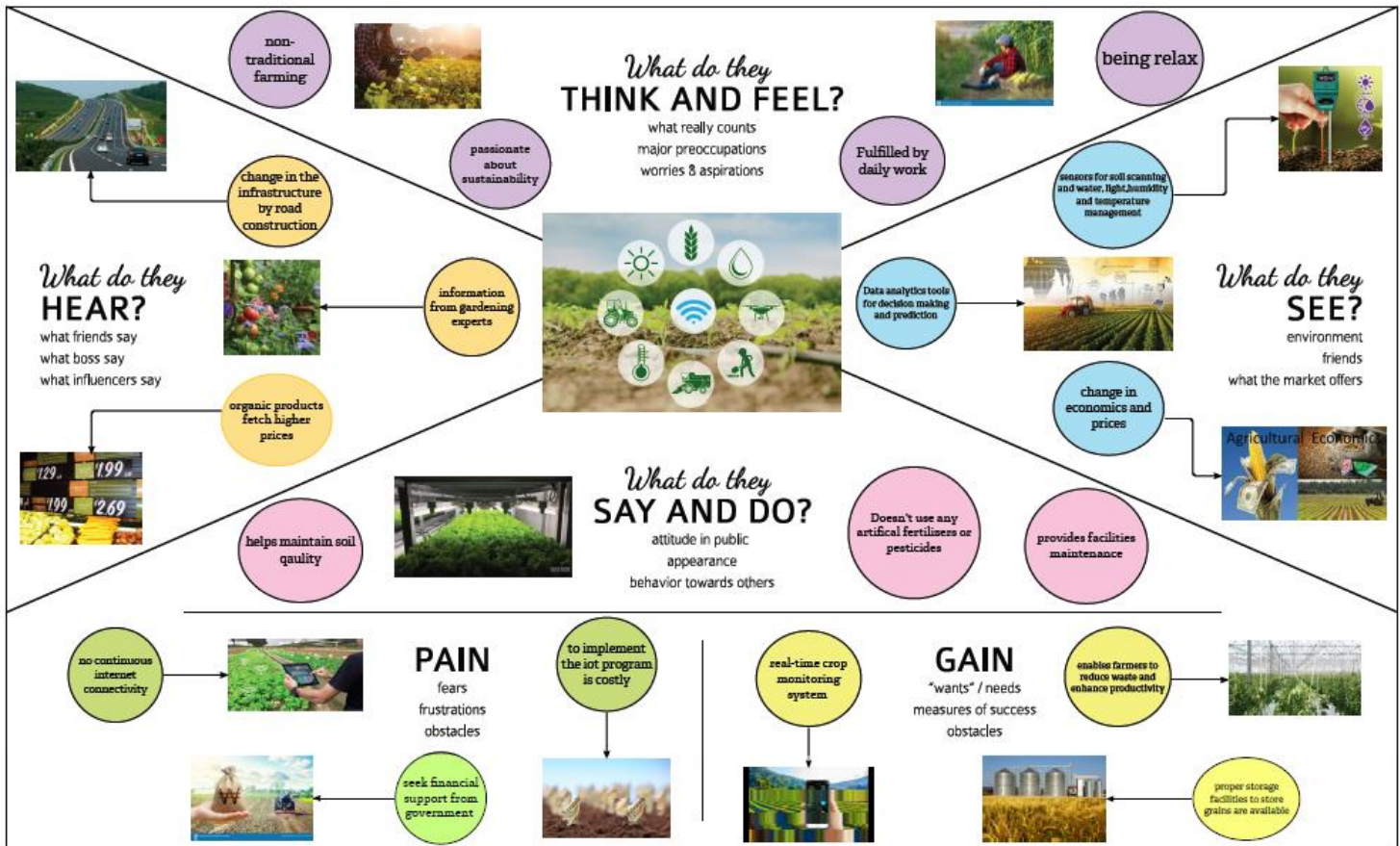
S.NO	JOURNAL PAPER	BLOCK DIAGRAM	ALGORITHM/ METHODOLOGY/ SOLUTION	FEATURES	DRAWBACKS
2.	IOT enabled aquaponics with wireless Sensor smart monitoring		<p>1. Aquaponics is an advanced and emerging farming style in which fish farming and vegetable farming turned out to be more professional and precise.</p> <p>2. AWSM enabled aquaponics system which was placed under the same Controlled environment. Sensor readings will go to the Arduino Mega 2560 for processing and the data will be processed with AWSM algorithm. The results are sent to farmers and response from the farmer is executed through Arduino Mega 2650 which will reflect in the farm.</p> <p>3. The presence of Chlorine and nitrate is detected quickly and will be intimated so that farmer can stop filling water through online instruction which will be implemented through Arduino Mega 2650 in the farm.</p>	<p>1. User friendly</p> <p>2. A mobile application is developed in the Android platform to support the farmers.</p> <p>3. It proposes an effective way to monitor and improve farming and will help farmers track the progress of the growth of the farm from anywhere in the globe.</p> <p>4. It is an efficient way of precision farming</p>	<p>1. AWSM is a notification based app and less control over the devices and pieces of equipment connected to the system.</p> <p>2. It requires an unlimited or continuous internet connection to be successful.</p>

S.NO	JOURNAL PAPER	BLOCK DIAGRAM	ALGORITHM/ METHODOLOGY/ SOLUTION	FEATURES	DRAWBACKS
3.	Agri-IoT: A Semantic Framework for Internet of Things-enabled Smart Farming Applications		<p>1. Agri-IoT, focused on the feasibility of using RSP in agricultural Applications</p> <p>2. This system uses a machine running Debian GNU/Linux 6.0.10, with 8-cores of 2.13 GHz processor 64 GB RAM</p> <p>3. Two realistic scenarios were considered:</p> <p>Scenario A: Fertility management of dairyCows.</p> <p>Scenario B: Soil fertility for crop cultivation.</p>	<p>1. Agri-IoT, a semantic framework for IoT based smartfarming applications, which supports reasoning over various heterogeneous sensor data streams in real-time.</p> <p>2. It can integrate multiple cross-domain data streams, providing a complete semantic processing pipeline offering common framework for smart farming applications.</p> <p>3. Agri-IoT has the capabilities of combining and analyzing data streams</p>	<p>Some limitations of Agri-IoT include</p> <ol style="list-style-type: none"> 1. Dynamicity 2. autonomy 3. Full adaptability to heterogeneity.

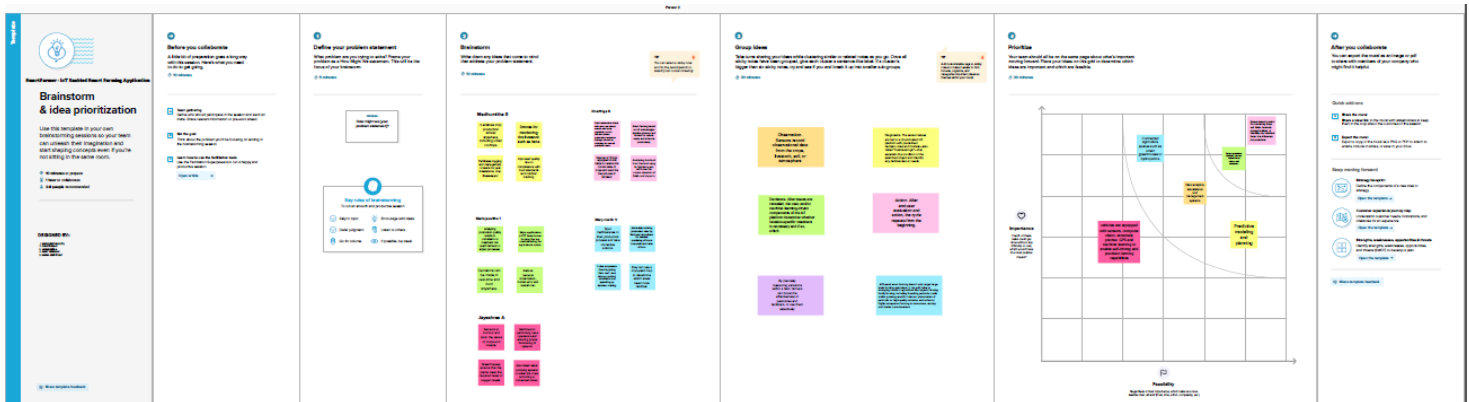
S.NO	JOURNAL PAPER	BLOCK DIAGRAM	ALGORITHM/ METHODOLOGY/ SOLUTION	FEATURES	DRAWBACKS
4.	Smart Farm Monitoring via the Blynk IoT Platform		<p>1. Blynk is an IoT platform that support both iOS and Android</p> <p>2. Blynk application, which is used to control a device and display data.</p> <p>3. Blynk server, which is a cloud service responsible for all communications between smartphones and things.</p> <p>4. This system Composed of A. Smart Farm Monitoring B. Super Chart Widget C. Database D. Smart Capsule System Status E. Blynk Notification</p> <p>5. This indicated that the developed system was suitable for monitoring the humidity of paddy in order to prevent excessive humidity, is the main cause of paddy rotting.</p>	<p>1. This smart system can be used to improve the productivity and quality of modern farming.</p> <p>2. The prototype of smart capsule developed to measure the humidity.</p> <p>3. The Blynk Mobile application was used to monitor and display real-time humidity data through the digital dashboard.</p>	<p>1. Leakage monitoring technologies are expensive, limited in their application</p> <p>2. Space for paddy storage is less.</p> <p>3. Difficult to Installation and Removal.</p>

3 IDEATION & PROPOSED SOLUTION

EMPATHY MAP



4.IDEATION AND BRAINSTORMING



PROPOSED SOLUTION

As the climates are changing rapidly and weather is unpredictable, so farmers are facing difficulties so they need a system to tackle this, here we use “open weather API” to get weather information such as temperature, pressure, humidity and weather description at their current location.

Based on which they can decide whether to turn on the motors or turn off the motor if needed temperature and moisture sensors from IBM simulator is displayed on UI for monitoring the weather. An algorithm developed with threshold values of temperature, pressure, humidity is programmed to intimate the farmer if weather conditions go bad. He can control motors remotely from any place through IoT. Internet interface that allow data inspection and irrigation scheduling to be programmed through mobile application or Node-RED UI. The technological development in software and hardware make it easy to develop this which can make better monitoring and wireless network made it possible to use in monitoring and control of greenhouse parameter in precision agriculture.

PROBLEM SOLUTION FIT

<p>Define CS, fit into CC</p> <p>1. CUSTOMER SEGMENT(S) Who is your customer? I.e. working parents of 0-5 y.o. kids</p> <p>CS</p> <p>A farmer who raises crops is the target market for this product. Our intention is to assist them by remotely monitoring field conditions. This product prevents the demise of agriculture.</p>	<p>6. CUSTOMER CONSTRAINTS</p> <p>CC</p> <p>What constraints prevent your customers from taking action or limit their choices of solutions? I.e. spending power, budget, no cash, network connection, available devices.</p> <p>Using numerous sensors is challenging. A number continued Internet connection is essential for success.</p>	<p>5. AVAILABLE SOLUTIONS</p> <p>AS</p> <p>Which solutions are available to the customers when they face the problem or need to get the job done? What have they tried in the past? What pros & cons do these solutions have? I.e. pen and paper</p> <p>Weather data and fields collect parameters, processed to automate irrigation process. Efficiency is a disadvantage only at close range Difficult data storage.</p> <p>Explore AS, differentiate</p>
<p>Focus on J&P, tap into BE, understand RC</p> <p>2. JOBS-TO-BE-DONE / PROBLEMS Which jobs-to-be-done (or problems) do you address for your customers? There could be more than one; explore different sides</p> <p>J&P</p> <p>The purpose of this product is to employ sensors allowing acquisition of different fields settings and treat them with one centralized processing system. On cloud-based usage</p>	<p>9. PROBLEM ROOT CAUSE</p> <p>RC</p> <p>What is the real reason that this problem exists? What is the back story behind the need to do this job?</p> <p>Frequent changes and unpredictability made the task difficult due to weather and climate get farmers in business .These factors play an important role when deciding whether water your plant.difficult to monitor field when farmer is not in the field. .</p>	<p>7. BEHAVIOUR</p> <p>BE</p> <p>What does your customer do to address the problem and get the job done? I.e. directly related: find the right solar panel installer, calculate usage and benefits; indirectly associated: customers spend free time on volunteering work (I.e. Greenpeace)</p> <p>To do this, use a suitable drainage system Overcome the Effects of Abundance water from heavy rain. Using hybrid A pest-resistant plant.</p> <p>Focus on J&P, tap into BE, understand RC</p>

4 REQUIREMENT ANALYSIS

FUNCTIONAL REQUIREMENT

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
Online		
FR-1	User Registration	Registration through Form Registration through Gmail Registration through LinkedIn
FR-2	User Confirmation	Confirmation via Email Confirmation via OTP
FR-3	Cloud Account	Creating an IBM cloud account Sign in and confirmation via OTP/Mail
FR-4	MIT App Account	Download MIT App Sign up/Sign in MIT App Confirmation via OTP/Mail
Offline		
FR-1	Sensor Setup	Setting up of required sensors in required places Connecting the main controller to the IBM cloud platform

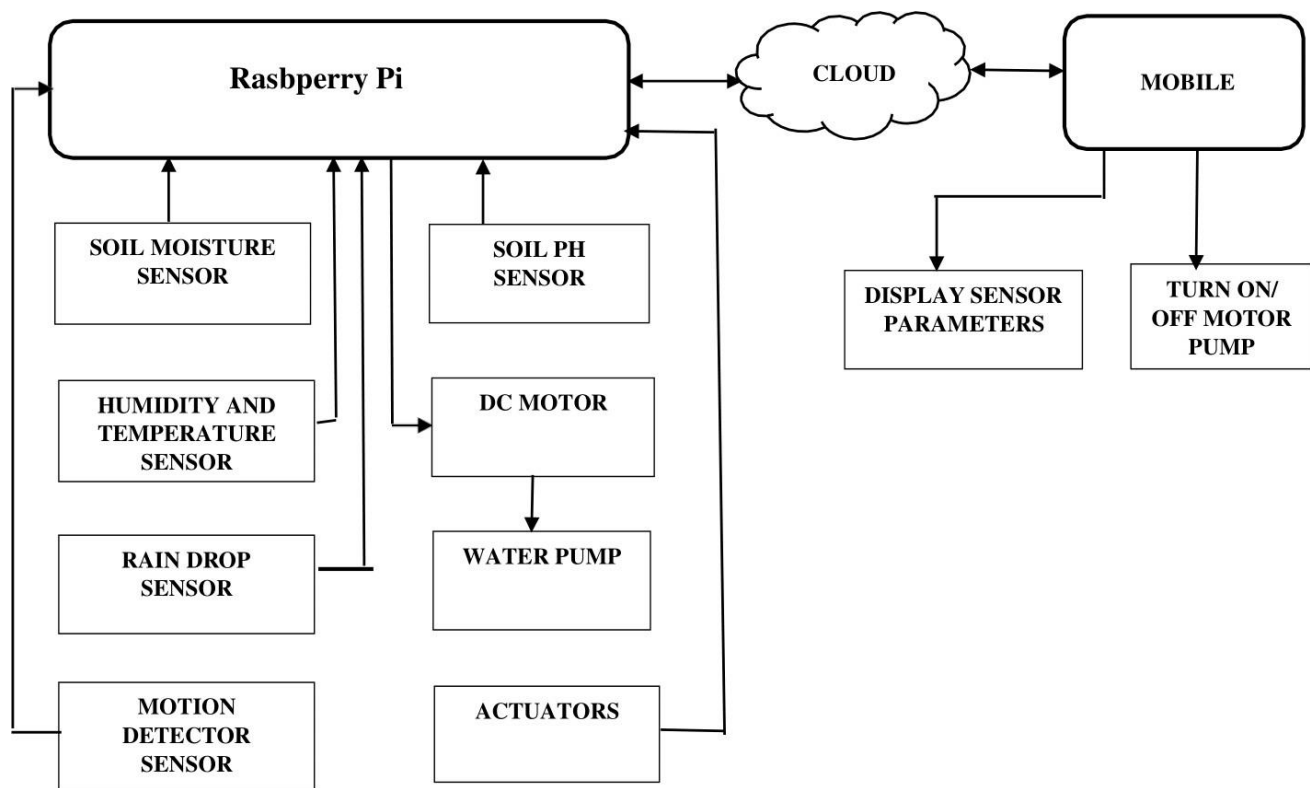
NON FUNCTIONAL REQURIMENT

FR No.	Non-Functional Requirement	Description
NFR-1	Usability	Usability includes easy learnability, efficiency in use, remembering, and subjective pleasure.
NFR-2	Security	Data will be protected from their production until the decision-making and storage stages.
NFR-3	Reliability	By using a share protection scheme we can provide better security at optimal cost
NFR-4	Performance	The idea of implementing integrated sensors in the field will be more efficient for overall monitoring.
NFR-5	Availability	Data will store in the cloud and so will be available globally.
NFR-6	Scalability	Since cloud technology has a variety of scalability options we can scale based on the needs in real-time

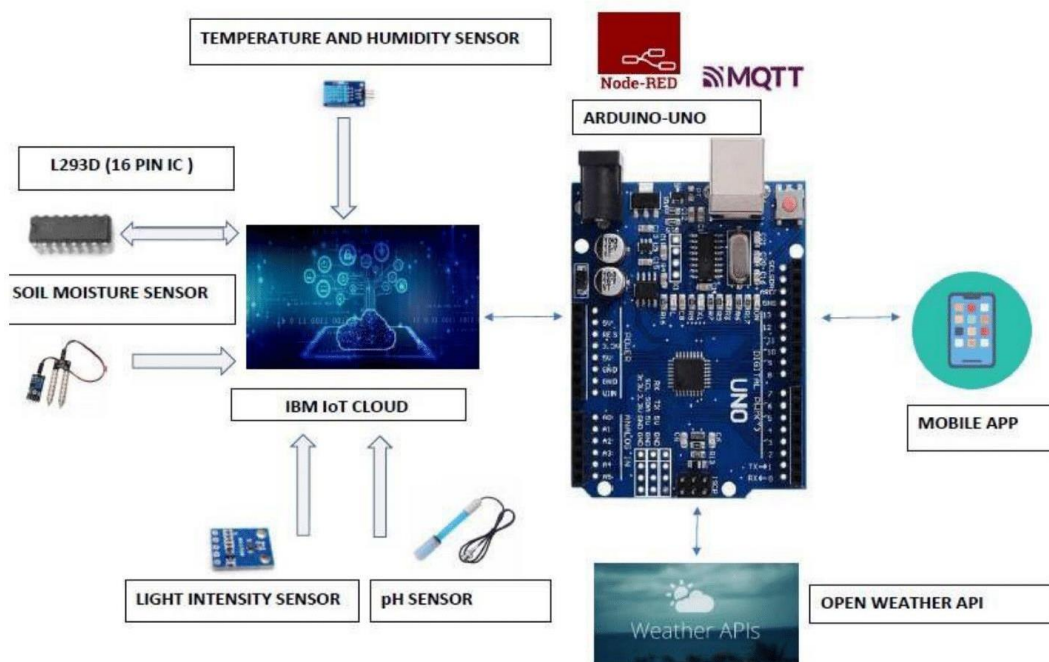
5.PROJECT DESIGN

DATA FLOW DIAGRAM

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



SOLUTION AND TECHNICAL ARCHITECTURE



- The different soil parameters (temperature, humidity, light intensity, pH level) are sensed using different sensors and the obtained value is stored in IBM cloud.
- The L293D is a 16-pin Motor Driver IC which can control a set of two DC motors simultaneously in any direction. The L293D is designed to provide bidirectional drive currents of up to 600 mA (per channel) at voltages from 4.5 V to 36 V (at pin 8!).
- Arduino UNO is used as a processing unit which processes the data obtained from sensors and weather data from weather API.
- Node-RED is a programming tool for wiring together hardware devices, APIs and online services in new and interesting ways. It provides a browser-based editor.
- The MQTT protocol is followed for communication.
- All the collected data is provided to the user through a mobile application which was developed using MIT app inventor.
- Open Weather provides hyperlocal minute forecast, historical data, current state and from short-term to annual and forecasted weather data. All data is available via industry standard APIs.
- The user could make decision through an app, whether to water the crop or not, depending upon the sensor values.

USER STORIES

User Type	Functional Requirement (Epic)	User Story Number	User Story/ Task	Acceptance Criteria	Priority	Release
Farmer (Mobile App)	Display the sensor parameters fixed in the field	USN- 1	The farmer can view the parameters values like soil moisture, humidity, motion detection, soil alkalinity	Display the parameters	High	Sprint- 1
Farmer (Mobile App)	Turn on/ off the motor	USN- 2	Can turn on/ off the Dc motor if the moisture level and rain the reaches a threshold	Turn on/ off the dc motor for water pump	High	Sprint- 1
Raspberry Pi	Microcontroller setup in the fields	USN- 3	The soil moisture sensor, humidity and temperature sensor, rain drop sensor, motion detection sensor, soil Ph sensor and DC motor connected with the water pump are interfaced with the micro- controller	Measures the parameters by the sensors interfaced with the micro-controller in the fields	High	Sprint- 1
IBM Cloud	Data transfer	USN- 4	The micro-controller in the field is connected to the IBM cloud and transfers data from and to the remote user	Transfers data between the fields and the user through internet	Medium	Sprint- 2

6 PROJECT PLANNING & SCHEDULING SPRINT DELIVERY AND SCHEDULE

SPRINT PLANNING AND ESTIMATION

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Mobile/web user Registration	USN-1	As a user I can register the application by entering my email and password so that feels good	10	High	Narasimhan.D
Sprint-1		USN-2	As a user I want confirmation mail for registration	10	Medium	Senthilkumar.V
Sprint-2	Mobile/web user Login	USN-3	As a user I can login to the application by entering my email and password so that I can enter the application	10	High	Ezhilarasan.K
Sprint-2		USN-4	As a user I can login to the application by enter my phone number so can easily enter the dashboard	10	Low	Karthik.P
Sprint-3	Monitoring and controlling	USN-5	As a user I want smart application so that monitor the fields	2	High	Narasimhan.D
Sprint-3		USN-6	As a user I want to know the temperature level so that easily know irrigation timing	5	High	Karthik.P
Sprint-3		USN-7	As a user I want to check the humidity sothat it is helpful to put water	5	Low	Ezhliarasan.K
Sprint-3		USN-8	As a user I want a smart application so that I can monitor anywhere at anytime	3	Low	Senthilkumar.v
Sprint-3		USN-9	As a user I want motor control so that water wastage stops.	5	High	Narasimhan.D
Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-4	Software connection	USN-10	As an admin I want to satisfy their users sothat connect & store in lbnm iot	5	Medium	Ezhilarasan.K
Sprint-4		USN-11	As an admin I want to make software (node red,IBM Watson) connection so that simulate the values	5	Medium	Karthik.P
Sprint-4		USN-12	As an admin I want to test the application sothat I know if it's working or not	10	High	Narasimhan.D

SPRINT DELIVERY SCHEDULE

Project Tracker, Velocity & Burndown Chart:(4Marks)

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	20	6 Days	24 Oct 2022	29 Oct 2022	20	29 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	05 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	12 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

Velocity:

Imagine we have a 06-day sprint duration, and the velocity of the team is 20 (points per sprint). Let's calculate the team's average velocity (AV) per iteration unit (story points per day)

$$\text{Average Velocity} = \text{Sprint Duration} / \text{Velocity} = 20/6=3.33$$

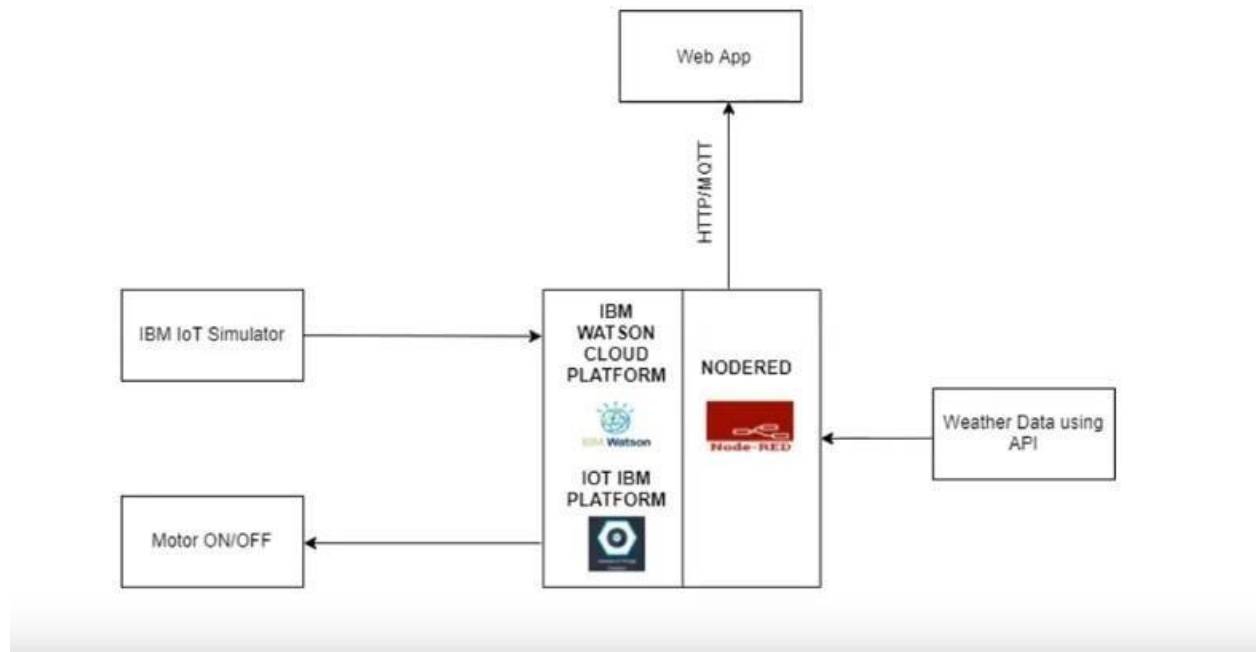
REPORTS FROM JIRA

	T	NOV	DEC	JAN '23	FEB '23	MAR '23
Sprints		SMA... SMA... SMA... SMAR...				
⚡ SMAR-1 Mobile/web user Registration	■					
⚡ SMAR-2 Mobile/web user Login		■				
⚡ SMAR-3 Monitoring and controlling			■			
⚡ SMAR-4 Software connection			■			

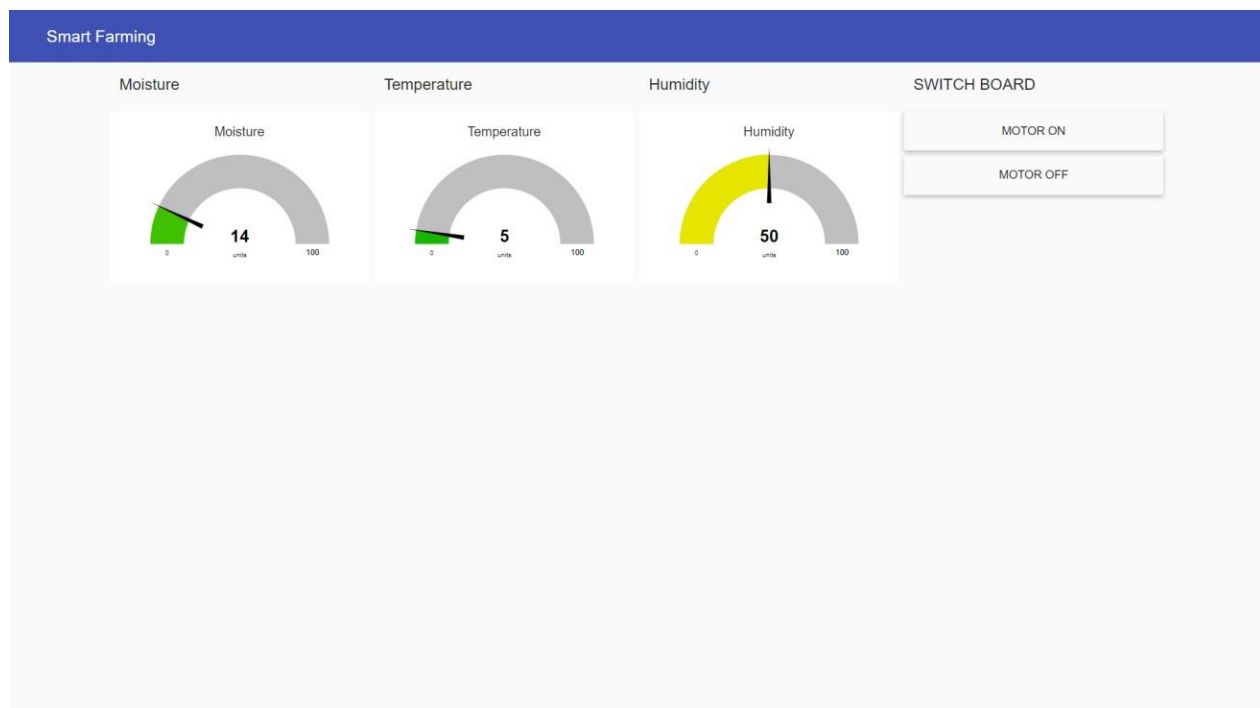
7 CODING AND SOLUTION

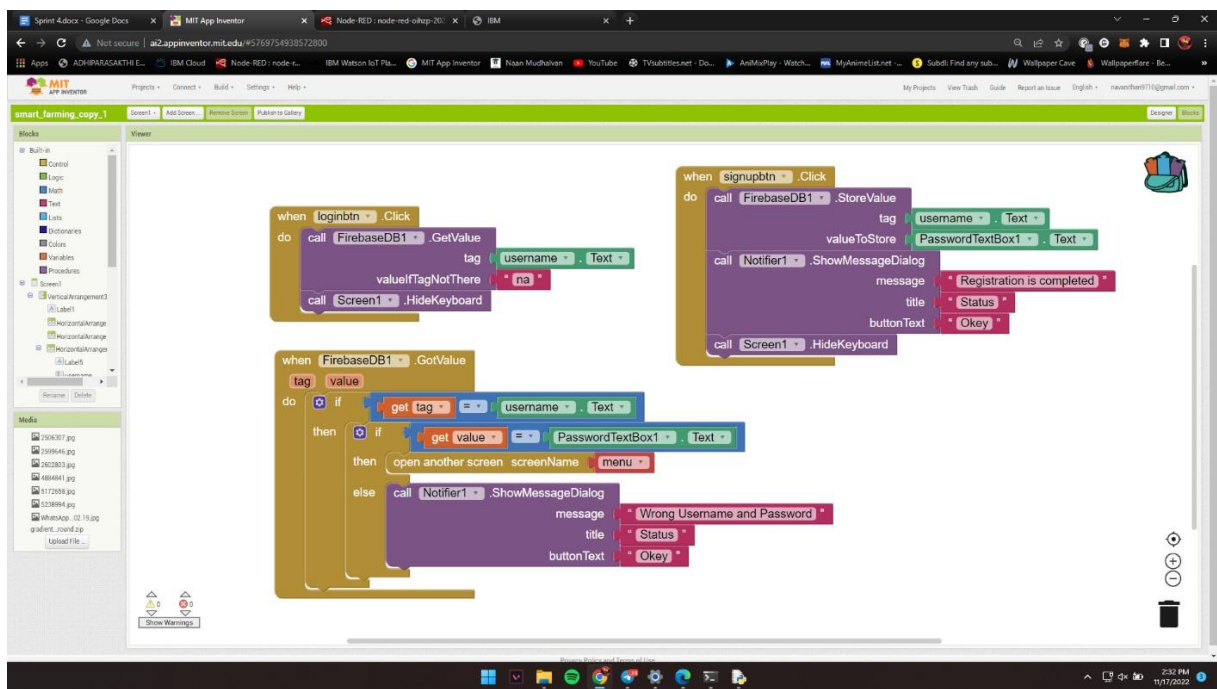
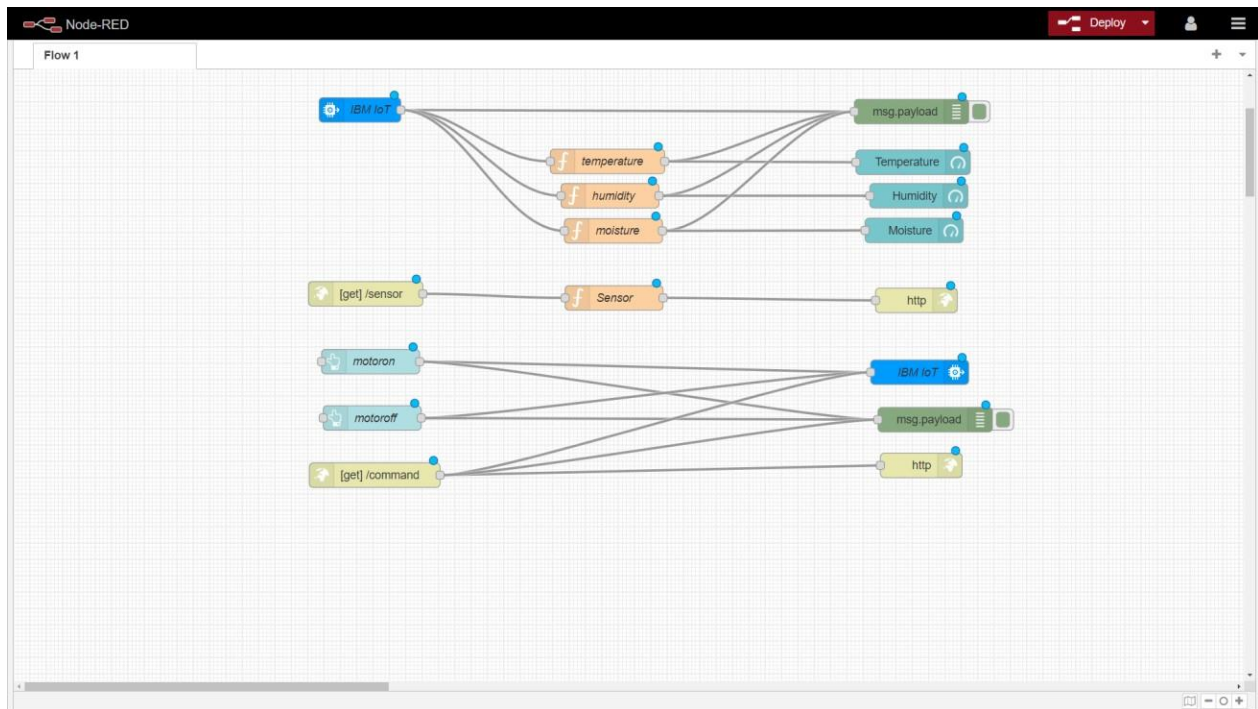
Theoritical Analysis:

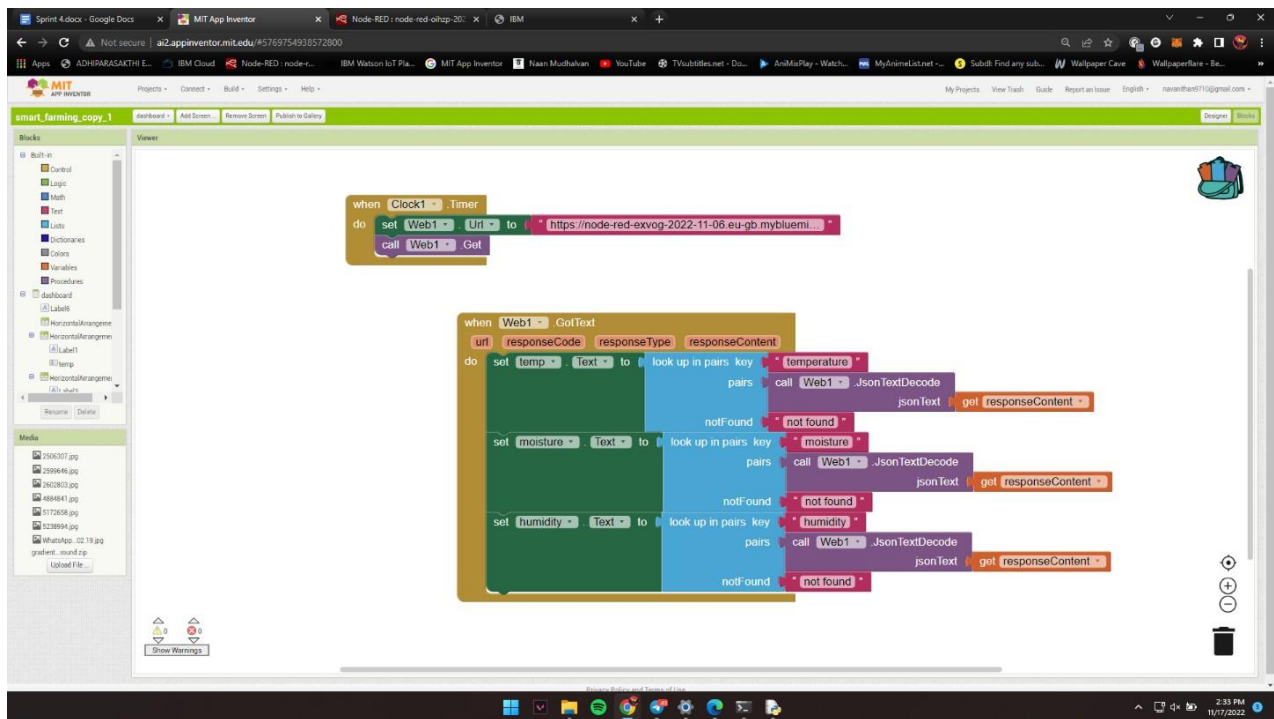
3.1 Block diagram



3.2 Software designing

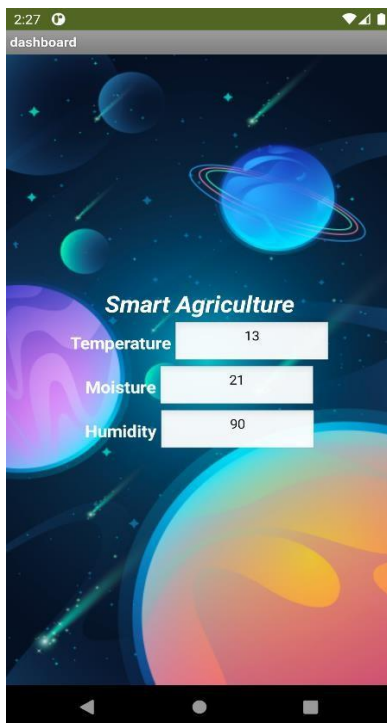






Final UI's:

APP:

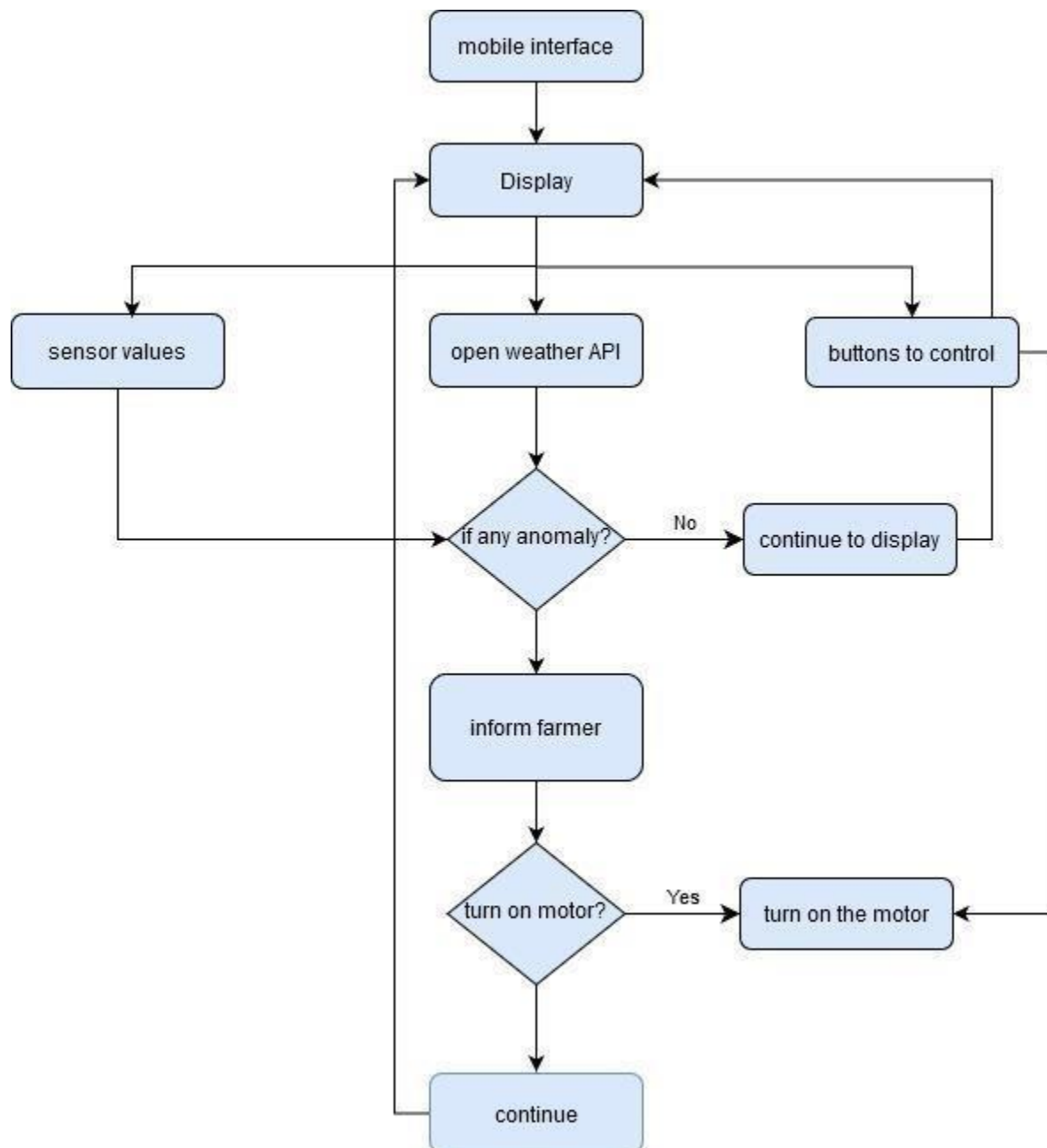


Node-Red UI:

Experimental Investigations:

The weather forecast is obtained from the Open weather API and is displayed in the node-red UI to the farmer and a threshold is set, if temperature, pressure, humidity and soil moisture goes beyond certain value the farmer get intimated and he can turn on/off the motor accordingly.

Flowchart:



8 TESTING

TESTCASES

A	B	C	D	E	F	G	H	I	J
1	DATE: 23 NOVEMBER 2022				TEAM ID : PNT2022TMD38592				
2									
3	SNO	Project Name	Scope/Feature	Functional Changes	Hardware Changes	Software Changes	Impact of downtime	Load/Volume Changes	Risk Score
4	5	1 smart farming - IoT Enabled Smart Farming application	New	Low	Moderate	Moderate	Low	>15 to 30%	RED
6	7								No changes seen
8	9								
10	11								
12	13								
14	15								
16	17								
18	19								
20	21								
22	S.no	Project overview	NFT Test Approach	NFR MET	Test outcome	GO/NO-GO Decision	Recommendations	Identified Defects (Detected/Closed/Opened)	Approval/SignOff
24	1 Smart farming	Stress	Performance	CPU-01	GO	High Performance		closed	Approved
25	2 Smart farming	Load	Stability	Dtabase Storage-01	NO-GO	One MongoDB instance for free		closed	Approved
26									

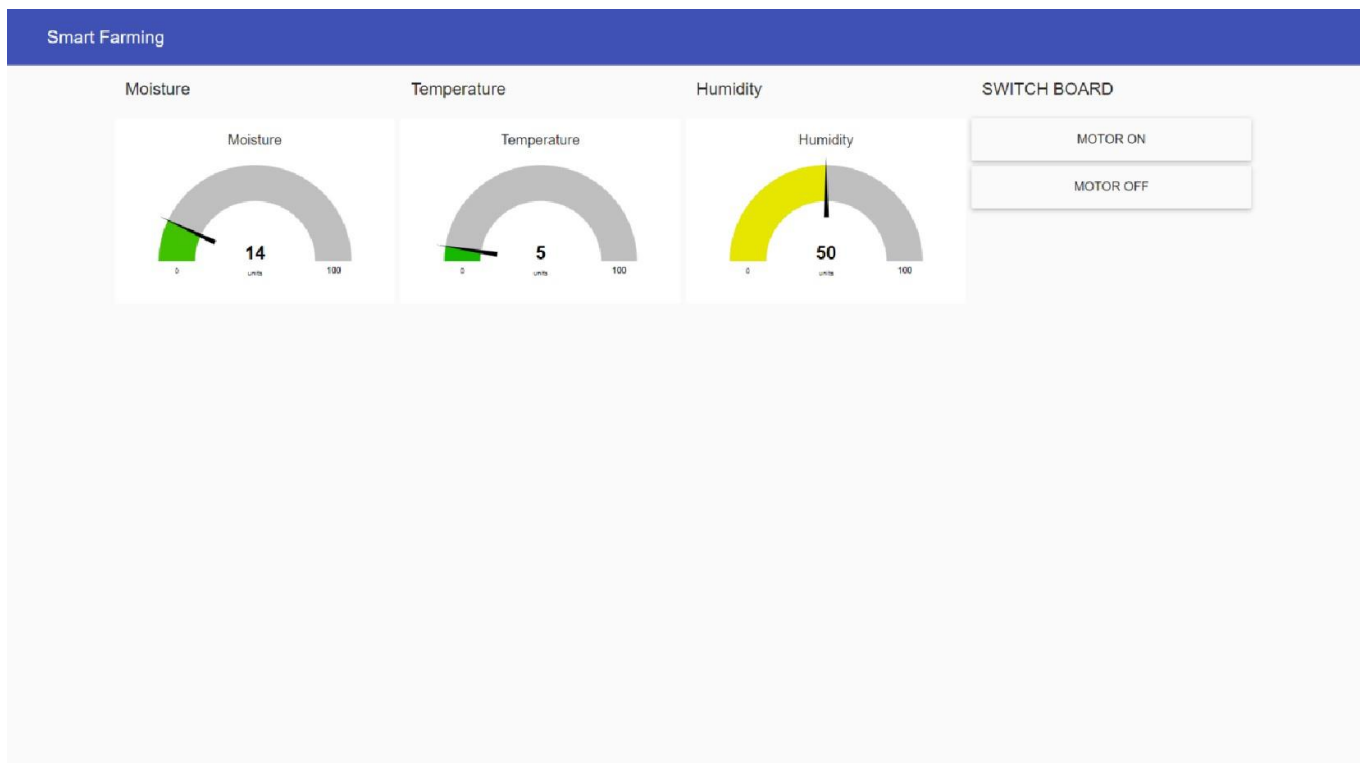
8.2 USER ACCEPTANCE TESTING

				Date	24-Nov-22								
				Team ID	PNT2022TMD38592								
				Project Name	Smart Farmer-IoT enabled smart farming application								
				Maximum Marks	4 marks								
Test case ID	Feature Type	Component	Test Scenario	Pre-Requsite	Steps To Execute	Test Data	Expected Result	Actual Result	Status	Comments	TC for Automation(Y/N)	BUG ID	Executed By
Home page	Dashboard UI	Info Page	It should get the date from the field and cloudant db	MIT App Inventor	1.Enter Username and Password in the respected boxes. 2.Click on sign up to store the values. 3.Now click login to view the parameters. 4.If invalid password entered in password text box 5.Click on login button	http://mlitapp3000/	User should able to view the parameters	working as expected	Pass	got the exact results	yes	Nil	Senthikumar.V
Backend	App configuration	Node.JS	It should gives the data to the info page and database	wokwi	1.Navigate to the Soil Moisture UI 2.User should see the measurement Fields for Temperature, Pressure, Humidity and SoilMoisture 3. All those fields should initially	3. Arduino board, ESP8266, Soil Moisture Sensor	users should navigate the motor ON or OFF manually to click the button	working as expected	pass	Got the exact results	yes	nil	Narasimhan.D

9 Result:

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.

9.1 PERFORMANCE METRICS



10 Advantages & Disadvantages:

Advantage:

- monitoring weather parameters such as temperature, pressure, humidity, soil moisture remotely
- controlling motors easily through buttons
- alert farmers in case of any calamities
- threshold values are set any anomalies will be reported to the farmer
- user friendly and efficient
- low cost

Disadvantage:

- sensors may sometime malfunction
- maybe inaccurate sometimes
- farmer needs internet connectivity
- farmer must have a phone and have basic knowledge to operate it

11 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.

Future Scope:

With the exponential growth of world population, according to the UN Food and Agriculture Organization, the world will need to produce 70% more food in 2050, shrinking agricultural lands, and depletion of finite natural resources, the need to enhance farm yield has become critical. Limited availability of natural resources such as fresh water and arable land along with slowing yield trends in several staple crops, have further aggravated the problem. Another impeding concern over the farming industry is the shifting structure of agricultural workforce. Moreover, agricultural labor in most of the countries has declined. As a result of the declining agricultural workforce, adoption of internet connectivity solutions in farming practices has been triggered, to reduce the need for manual labor.

IoT solutions are focused on helping farmers close the supply demand gap, by ensuring high yields, profitability, and protection of the environment. The approach of using IoT technology to ensure optimum application of resources to achieve high crop yields and reduce operational costs is called precision agriculture. IoT in agriculture technologies comprise specialized equipment, wireless connectivity, software and IT services.

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<https://www.youtube.com/watch?v=cicTw4SEdxk>

